AGRICULTURAL SUPPLY RESPONSE IN ETHIOPIA

by

ZERIHUN GUDETA ALEMU

Submitted in fulfillment of the requirement for the degree of

PhD

in the

Department of Agricultural Economics
Faculty of Natural and Agricultural Sciences at the
University of the Free State
Bloemfontein

Promoter:

Professor L.K. Oosthuizen

Co-promoter:

Professor H.D. Van Schalkwyk

May 2003

ACKNOWLEDGEMENT

I would like to thank the almighty God for giving me the opportunity to do my Ph.D. and also the patience and strength to complete this thesis.

I would also like to thank the following people and organizations who, directly and/or indirectly, made the completion of this thesis a reality:

Firstly, I would like to thank my promoter Prof. LK Oosthuizen and co-promoter Prof. HD van Schalkwyk for their professional advice. Your contributions were vital not only professionally but also morally. You were there for me to solve most of the problems I faced during the course of my study although some of them were personal. Thank you very much.

Secondly, I would like to thank the following government organizations for allowing me to have access to their data:

1. The Ministry of Economic Development and Cooperation (MEDaC).
2. The Ethiopian Central Statistical Authority (CSA).
3. Department of Economics, Addis Ababa University.
4. National Bank of Ethiopia.
5. Ethiopian Metrology Agency
6. Food and Agricultural Organization (FAO).

Last but not least, I would like to thank my family and friends. I would like to thank my wife, Genet Getachew Tiruneh. Sorry for the long office hours. You truly played the role of a very good mother and a wife. I would also like to thank all members of the Department of Agricultural Economics and to my friend Mr. Tesfaye Lema for your encouragement and support at various stages of this thesis.

ABSTRACT

This study had one major goal of measuring the responsiveness of agriculture to policy and non-policy related events. This was divided into three major objectives, namely, the contribution of agriculture to overall GDP growth, the responsiveness of aggregate agriculture to policy and non-policy related events, and the responsiveness of cereal producers to incentive changes.

A number of econometrics procedures were employed to achieve the objectives of this study which ranged from simple descriptive statistic techniques to advanced time series econometrics. One of these methods introduced an improvement to the conventional method of tests on the data generating process when a series is characterized by a break. In addition, due to lack of available econometrics or statistical packages tailored to achieving specific needs of this study, two computer programs were developed. The first program was used to decompose changes in the mean and variance of cereal production into four and ten component parts respectively. The second program was used to extract cycles from agricultural GDP and to determine periods of cyclical fluctuations.

The following were major findings of this study with regards to the first major objective: much of the growth in overall GDP has been the result of growth in the manufacturing and the services sectors; structural transformation has not yet been attained; and the contribution of agriculture in stimulating growth in other sectors of the economy has been positive in economic systems and policy environments where agriculture has been allowed to operate freely.

The following were the major findings of the study with regards to the second objective. The responsiveness of aggregate agriculture has so far been affected more by natural factors such as drought and fluctuations in aggregate agriculture are cyclical. The latter was attributed to weather variability. With regards to the third objective, the following were found: the crop sub-sector is responsive, the

country is increasingly becoming food insecure as a result of the susceptibility o: the crop sub-sector to changes in weather patterns.

The following are the recommendations of this study. Agricultural Development Led Industrialization strategy (ADLI) is the current development strategy of the country. For this strategy to achieve its short-and long-term objectives, the following measures are recommended. First, problems associated with state ownership of land should be harnessed. Second, market improvement and infrastructural development must be integral parts of the development planning process. Third, agriculture should be freed from policy constraints. Fourth, macro-policy reforms and efforts that enhance the responsiveness of agriculture at various stages should be encouraged. Fifth, agricultural research and agricultural extension capacity of the country must be encouraged to increase the supply of new drought varieties to mitigate the effect of drought on the instability of crop production.

TABLE OF CONTENTS

CHAPTER 3: THE CONTRIBUTION OF AGRICULTURE TO ECONOMIC GROWTH

CHAPTER 4: THE RESPONSIVENESS OF AGRICULTURE TO MAJOR POLICY AND NON-POLICY RELATED CHANGES

CHAPTER 5: THE LEVEL AND INSTABILITY OF CEREAL PRODUCTION

CHAPTER 6: CEREAL SUPPLY RESPONSE

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Ethiopia is located 8^0 00^0 North and 38^0 00^0 East. The country shares borders with Djibouti (337 km), Eritrea (912 km), Kenya (830 km), Somalia (1,626 km) and Sudan (1,606 km). The country comprises of a total area of 1.104 million square kilometers. The agricultural area accounts for 28 per cent of the total area. Arable land, permanent cropland and land used for pastures respectively account for 32.5, 2.4 and 65.1 per cent of the total agricultural area (FAO, 2000). In addition, the country is endowed with water resources, diverse plant, genetic and wildlife resources. Its water resource has a total runoff of over 100,000 million cubic meters, which has the potential to irrigate an estimated 3.5 million hectares. Its diverse plant, genetic and wildlife resources are the result of variations in climate, terrain and ecological systems. The country is divided into eighteen major agro-ecological zones. In terms of population, Ethiopia is the third biggest country on the continent next to Nigeria and Egypt. One out of ten Africans is an Ethiopian (Webb, *et al.*, 1992). Despite these resources at its disposal, the country is chronically food insecure, with close to 4.6 million people needing food assistance every year.

The agricultural sector is a major contributor to Gross Domestic Product (GDP), employment creation and foreign exchange earnings. According to recent estimates, close to 50 per cent of the current GDP comes from agriculture (MEDaC, 2000). The crop sub-sector contributes about 30 per cent of overall GDP and 62 per cent of agricultural GDP (EARS, 1997). The major crop types produced in the sub-sector are cereals, which include teff, maize, sorghum, barley, wheat, millet and oats; pulses like faba bean, chickpea, field pea, haricot bean, grass pea, lentil, fenugreek; oil crops like noug, linseed, rapeseed, sesame; fruit crops like enset, potato, sweet potato, taro and yam; vegetables like tomato, onions and brassicas; fruit crops like citrus and grapes; coffee, sugar cane, spices and cotton. Ranked in terms of hectares, cereals (75 per cent) are the first, followed by pulses (11.4 per cent), perennial crops (7 per cent), oilseeds (4.3 per cent) and others (2.5 per cent). Ranked in terms of output, cereals rank first followed by coffee (EARS, 1997).

Cereals are produced in the highlands in an average farm-level land-holding size of one hectare. The highlands constitute about 35 per cent of the country's land area (EEA, 2000). Cereals are mainly produced for home consumption. One of the major problems with cereal production is its dependence on rain, as irrigation is available to only 5 per cent of the farmers. Cereal production is highly constrained by the use of ancient production instruments such as hoes, sickles, wooden ploughs, etc. Fertilizers, improved seed varieties, herbicides and pesticides are limited respectively to 25, 2, 1 and 1 per cent of the farmers (EEA, 2000). In addition, it is highly constrained by crop diseases, significant post-harvest losses, shortages of draught animals, as well as losses of soil and water resources.

Livestock accounts for approximately one-fifth of the agricultural GDP (EARS, 1997). Its use, apart from serving as food in terms of meat and milk, includes its service as the major component of the farming system or its place as a source of power in crop production. Livestock is the primary source of income for 10 per cent of the country's population, and its byproducts such as hides and skins are the second most important foreign exchange earners next to coffee. Most of the livestock are found in the highlands. In terms of livestock population, the country ranks first in Africa and tenth in the world (EARS, 1997; EEA, 2000). Despite potential for growth, the sub-sector is characterized by low level of productivity. This has resulted in a low per capita consumption of meat and milk, which is estimated at 7.8 kilograms and 14.4 liters respectively (EARS, 1997). This is attributed to disease, malnutrition, under-nutrition and poor genetic potential.

Agriculture is a major foreign exchange earner. Presently, it accounts for over 90 per cent of total foreign exchange earnings, two-thirds of which come from the export of coffee (MEDaC, 1999; CIA, 2000; EARS, 1997). Export of t'chat, hides and skins, pulses, live animals, etc account for the remaining one-third of the foreign exchange earnings. Over 96 per cent of the total coffee production come from small-scale farmers in two regional states, namely, Oromiya and the Southern regional states. Coffee contributes 10 per cent of Ethiopia's GDP and is a livelihood for close to 25 per cent of the population (CIA, 2000). It is claimed that Ethiopia is the original home of coffee and that it is a major supplier of the best type of coffee called coffee arabica to the world.

In addition to problems that can be associated directly with sub-sectors within agriculture, overall agricultural development is constrained by institutional constraints, namely, lack of finance, low levels of agricultural research and extension, as well as a lack of infrastructure. Finance is crucial in any agricultural activity. In Ethiopia, lower agricultural productivity is attributed, among others, to a lack of modern input packages, such as fertilizer and improved seed and agricultural implements, including oxen, due to a lack of availability of funds (MEDaC, 1999; EARS, 1997; EEA, 2000).

Finance is a problem for small farmers in Ethiopia. In the 1970s and 1980s, its availability to private peasant farms was limited by the deliberate credit policies of the government. During these times, private peasant farms, despite their size in terms of cultivated area and agricultural produce were marginalized from credit allocation by higher credit prices. This was in line with the government objective of creating socialist production structures in rural areas, namely, producer cooperatives and state farms. In the 1990s, following changes in the political and economic system of the country and also reform on government-owned financial institutions, new privately owned financial institutions started to emerge (Yohannes, 2002). The changes abolished skewed distribution of credit but left some of the problems prohibiting farmers' access to credit unattended. Firstly, they cannot use the only resource they have at their disposal, land, to satisfy collateral requirements by banks. Secondly, there is the bureaucracy they have to go through to obtain funds from government-owned banks. To cater for the credit needs of farmers, who could not be assisted by private and government banks, new financial services called micro-finance institutions (MFI) have emerged to provide rural financial services to the rural community since 1996. Several NGOs are presently operating in rural Ethiopia.

A low level of agricultural research and extension is another factor prohibiting agricultural growth. The agricultural research system, in general, and the agricultural extension system of the country, in particular, has undergone changes for the past four decades. Integrated Rural Development Projects (IRD) and Minimum Package Projects (MPP) were dominant in the late 1960s and 1970s, Peasant Agricultural Development Extension Programme (PADEP) in the mid 1980s and Participatory Demonstration and Training Extension System (PADETES) in the mid 1990s. Predominantly, the systems have concentrated resources mainly on the introduction of fertilizer and improved seeds in high-potential areas. They are generally criticized for neglecting low potential areas where small landholding size and erratic rainfall have been major reasons for food insecurity.

Concentration of government efforts to develop agriculture on potentially high-yielding areas, good weather and grain liberalization were considered to be major causes of an increase in national cereal production in the recent past with a consequent fall in cereal prices below cost of production in potentially high-yielding areas. This is attributed to the absence of a marketing system that is capable of transporting surplus production over time and space. The depressing effect of lower cereal prices on the consumption of fertilizer and improved seed in potential areas is increasingly being felt.

The other factor constraining overall agricultural development has to do with the development strategy of the country. A scan through the development strategies of the country from the 1960s until the 1990s reveals that the selection of development strategy has been influenced by two opposite views regarding the role of agriculture in economic development. These views have been the product of the evolution of economic development theories for the past four decades.

The first view, which was pioneered by Lewis (1954), Hirschman (1958) and Prebisch (1959), regarded agriculture unresponsive to incentive changes. It thus condemned agriculture to serve as a reservoir of resources needed to develop the industry, which it viewed as a dynamic sector. This view influenced development policy making in Ethiopia between the 1960s and the late 1980s though some donor supported projects, which took the form of Integrated Rural Development Projects (IRD), were operating on and off in a few selected high potential rural areas of the country.

The second view, which was first introduced by Johnston and Mellor (1961) and Mosher (1966) and was later expanded by Timmer, Falcon, and Pearson (1983), Mellor (1998), and de Janvry and Sadoulet (1990), consider agriculture non-static and thus responsive to incentive changes. This view believes in the use of agriculture's resources for its own sake to enhance its growth before it could be used to develop other sectors of the economy. This view has been influencing policy making in the country since the mid 1990s.

1.2 PROBLEM STATEMENT

Various types of agricultural policies, which have influenced agriculture, have been implemented in Ethiopia since formal policy planning was started in the country in 1957. In addition to policies, the performance of the sector has been constrained by the frequent occurrence of drought situations. There is, therefore, a need to understand how responsive agriculture is to policy and non-policy related events.

Agricultural policies that have so far been implemented in Ethiopia can be grouped into three periods depending on differences in economic systems and development strategies that have been introduced in the country. The first period (i.e. 1960-1974) is known in the economic history of the country as the period when resource allocation in general was regulated by market forces. During this period, owing to the general perception of policy makers regarding the role of agriculture in a developing economy, agricultural policies that hastened the extraction of resources to develop the emerging non-agricultural sectors were implemented.

The second period (i.e. 1975-1992) was not totally different from the first period in terms of the overall development strategy of the country, which continued to be the development of non-agriculture. The difference lies on the mechanisms adopted to extract resources. Unlike in the first period where this was coordinated within a free marketing framework, in this period, resource extraction objectives were designed to operate within a command economic framework. Sizable changes in agricultural polices were introduced during this period. These include, the introduction of socialist production relations, the institutionalization of government marketing parastatal as sole buyers and distributors of agricultural produce and inputs, the introduction of fixed output and input pricing systems, and the installation of physical and policy barriers to the free operation of markets for agricultural products and inputs.

The third period (i.e. since 1992) is opposite of the first and the second periods in terms of the overall development strategies. In this period, before and after the development strategy of the country was changed from Industry-led to Agriculture-led in 1995, agricultural policies which favored the development of agriculture have been introduced. These include: the restoration of markets as governors of resource allocation, the introduction of trade and price liberalization, the lifting up of physical barriers to free trade, and the introduction of Structural Adjustment

Programmes (SAP) to ameliorate macro price distortions and to reform farming structure.

Non-policy related changes that have been influencing the responsiveness as well as overall performance of Ethiopian agriculture include natural factors such as the frequent occurrence of drought and non-natural factors such as civil strife. The country has never been free from the latter for many years. Thus, due to problem of measurement and lack of data, the effect of civil strife on the economic performance of Ethiopian agriculture is hard to measure. However, there is a growing need to study the responsiveness of agriculture to natural factors such as drought.

1.3 OBJECTIVES

The study has one major goal i.e. the investigation of responsiveness of agriculture to policy and non-policy related events. This goal is divided into three major objectives as shown below:

a) To measure the place of agriculture in the Ethiopian economy and its role in economic growth.

b) To measure the responsiveness of aggregate agriculture to major policy and non-policy related events and its degree of susceptibility to these events.

c) To measure the degree of instability in cereal production and the responsiveness of grain producers to policy changes.

The first objective will be divided into a number of specific objectives, namely, the role of agriculture in the economy in terms of overall GDP growth, its role in terms of food self-sufficiency, its ability to withstand the whims of nature, and its ability to stimulate growth in other sectors of the economy.

The second objective deals with the response of aggregate agriculture to sweeping changes in economic systems and non-policy related events. This objective will be achieved under the following three specific objectives. Firstly, the effect of major policy and non-policy related events on the long-term trend of aggregate agriculture. Secondly, the degree of persistence of the effect of major events on aggregate agriculture. Thirdly, the extraction of periodic influences of natural factors such as drought on aggregate agriculture.

The third objective deals with the estimation of crop level supply response. This will be achieved using two specific objectives. The first specific objective is concerned with the investigation of the level of and instability of cereal production in the country and the identification of factors causing instability in cereal production. This will be followed by the second specific objective, which deals with the estimation of crop level supply response.

1.4 DATA AND RESEARCH METHODOLOGY

The data analyzed were obtained from various sources, namely, the Ministry of Economic Development and Cooperation, the Central Statistical Authority, the Food and Agricultural Organization (FAO) and International Financial Statistics. The time series properties of the data were analyzed before any modelling methods were applied. This is a useful step in order to determine the data-generating process that the variables are made of and to ensure that consistent and efficient parameters are obtained, as most economic variables are non-stationary processes.

Variables were first analyzed to categorize them into trend stationary and difference stationary processes. Where appropriate, difference stationary processes were differenced while trend stationary processes were detrended to make them stationary processes. The conventional Augmented Dickey-Fuller

(ADF) procedure of testing for non-stationarity of a variable is widely criticized in econometrics literature for failing to take into account the effect of structural breaks or assuming a constant parameter structure. As most variables, in the Ethiopian context, are characterized by structural breaks emanating from the frequent revision of policies and natural factors such as drought, attempts were made, where applicable, to test for the significance of these breaks before tests for the true data generating processes were conducted. A modification was introduced to Perron's (1989, 1990) method to test for the data-generating process by treating the date of the structural break unknown a priori, as his method is widely criticized on the grounds that he picked the date of the break before making any analysis. In this study, the date of the structural break was treated as an unknown *a priori*. Thus the test for the data-generating process was conducted into steps. In step one, a test for the presence of a significant structural break in a variable was made by applying a recursive analysis using the Dickey-Fuller regression. In step two, depending on the result on step one, a decision on the appropriate model to test for the data generating process was made. Where the null hypothesis for the presence of a significant structural break was accepted, a test for the data-generating process was conducted using Perron's adjusted ADF procedure; otherwise, the conventional ADF procedure was applied.

Various models were employed to achieve the three major objectives of the study. The role of agriculture in stimulating growth in other sectors of the economy under different policy environments will be measured by applying a time varying parameter approach. The responsiveness of aggregate agriculture to changes in economic systems will be achieved by applying a combination of regression and univariate time series procedures. The level and instability of cereal production will be achieved by applying a variance decomposition technique. The responsiveness of grain producers to incentive changes will be achieved by applying an error-correction procedure.

1.5 ORGANIZATION OF THE STUDY

The remainder of the study is organized into six chapters. The study starts in chapter two, where the evolution of policy planning in Ethiopia since 1957 is reviewed. Chapter three discusses the contribution of agriculture in the Ethiopian economy. Chapter four examines the responsiveness of aggregate agriculture to policy and non-policy related events. In chapter five, factors causing instability in cereal production are studied. In chapter six, the responsiveness of cereal producers to policy changes is measured. Finally, in chapter seven, conclusions and recommendations are made.

CHAPTER 2

AGRICULTURAL POLICIES OF ETHIOPIA: AN OVERVIEW

2.1 INTRODUCTION

Agriculture is the backbone of the Ethiopian economy. It constitutes over 50 percent of the Gross Domestic Product (GDP), accounts for over 85 percent of the labour force and earns over 90 percent of the foreign exchange (MEDaC, 1999).

Studies on agricultural development policies of Ethiopia are found scattered over different papers and reports. A frequently quoted article, which is one of the basic reference materials in this study, is the article by Dejene (1990). His study focused only on the evolution of Integrated Rural Development Projects (IRDs) between the early 1970s and mid 1980s.

In this chapter, an attempt is made to go beyond IRD projects to give an overview of agricultural policies of Ethiopia in historical perspectives by dividing the economic history of the country into three periods i.e. 1959-1974, 1975-1992, and since 1992 based on differences in economic and political systems followed.

2.2 THE PERIOD 1950-1974

During the period 1950-1974, development policy was influenced by development theories of the 1950s such as Arthur Lewis's (1954, quoted in Johnston and Mellor 1961) "general transformation model", Raul Prebisch's (1959) "secular decline theory", and Hirschman's (1958) postulate on linkage effects.

Economic development theory attests that agricultural transformation passes through four stages i.e. Mosher's (1960), Johnston-Mellor's (1961), Schultz-

Ruttan's (Timmer, 1990) and D.G. Johnson environments (Timmer, 1990). The *Mosher's environment* entails that resources extracted from agriculture must be invested in agriculture to stimulate growth. In Ethiopia, what Timmer (1990) termed as a *"jump strategy"* was pursued. Development planning was started from "*Johnston-Mellor environment*" which emphasized mobilization of resources from agriculture to enhance growth in the non-agricultural sectors. Resources were mobilized from agriculture in the form of discriminatory investment policies. For example, only 14 and 21 percent of the total government investment was channelled to agriculture in the first and the second five-year development plans, respectively (IEG, 1957, 1962). This was despite agriculture's contribution to GDP and employment which stood at over 68 and 85 percent, respectively.

Agriculture was also discriminated against by sectoral policies. The First-Five Year Development Plan (FFYP) placed emphasis on raising foreign exchange earnings by improving coffee cultivation—Ethiopia's major foreign exchange earner (IEG, 1957). Similarly, the Second-Five Year Development plan added to its priorities the establishment of large-scale commercial farms (IEG, 1962). Cereal production, which came largely from subsistence farmers and which accounted for more than 80 percent of the cultivated area in the 1950s and 1960s, was neglected. However, shortages of food in the late 1960s shifted the attention of policy makers to agriculture. Thus, agriculture was given priority in the Third Five-Year Plan (TFYP) without modifications whatsoever to the overall growth strategy. The following statement, which is an extract from the TFYP, indicates the continuation of structural transformation as the development strategy of the country: "*...it must be remembered that, however great the effort and resource devoted to agriculture, and however successful the attempts to overcome the difficulties, it is the rate of development in the non-agricultural sector which will provide the incentive to increased agricultural production...*"(IEG, 1968).

The TFYP outlined two problems in the rural sector—the problem of production and the problem of the peasantry. A frontier model was applied to deal with the former, which expanded settlement and cultivation to new lands while Integrated Rural Development (IRD) Projects were launched to deal with the latter. The objective of IRD was comprehensive. It tried to introduce peasants with commercial market systems, improved distribution of seeds and fertilizer, provision of credit, dissemination of better implements, promotion of rural health, expansion of storage facilities, etc. (IEG, 1967).

IRD evolved into Minimum Package Projects (MPP) in 1971, because it was costly to replicate widely. MPP provided minimum services mainly fertilizers and credit. It was planned that MPP would expand its coverage to include the entire country by the end of the decade of 1970s. However, its life was cut short as its operation was discontinued in the mid 1970s because of donors' withdrawal of funding because of their dissatisfaction with the political situation of the time. Ten years after, that is, in 1981, IRD entered into its second phase—MPP II—following the World Bank's renewed commitment to finance the project (Dejene, 1990).

2.3 THE PERIOD 1975-1990

During the period 1975 – 1990, socialism was the political and economic system of the country. Sweeping changes in production structure and agricultural policies were introduced. These are discussed at great length in sections that follow.

2.3.1 Production Structure

During the period 1975-1990, socialist methods of production organizations were encouraged in two stages. First, productive assets, such as land, were nationalized in March 1975 and were distributed among peasant households on an egalitarian basis. Second, in an effort to distribute income and power in rural areas, which is in line with the radical school of thought, and also to meet the resource extraction objective, alterations in farming structures were made involuntarily. In addition to private farms, this created two additional production structures—producer cooperatives and state farms.

In an attempt to speed up the establishment of socialist production relations in rural areas, marketing and pricing policies, which marginalized private peasant farms, were introduced. This handcuffed production growth and made the economy vulnerable to natural calamities as witnessed in the 1980s (Befekadu and Tesfaye, 1990). This was because private peasant farms on average accounted for more than 90 per cent of the production and cultivated area in the country and were major earners of foreign exchange. Therefore, their marginalization had serious repercussions on the overall performance of the economy.

Six annual development campaigns were carried out by the Central Planning Supreme Council (CPSC) between 1978-1984. The campaigns were primarily designed to instil socialist production ideology among rural farmers. In addition, massive resettlement and villagization programmes were launched to promote collectivization (Dessalegn, 1990; Alemayehu, 1990). However, despite such efforts, collectivization campaigns could not sweep rural Ethiopia as it did in other socialist countries for it was less coercive unlike Russia, where it claimed many lives.

The 1983/84 drought was instrumental in the implementation of a "ten-year perspective plan". The plan upheld two objectives—improving 'surplus' extraction on the one hand, and self-sufficiency in food production on the other. Plans were redrawn and targets set to intensify the organization of farmers into producer cooperatives—to enhance resource extraction objectives. In 1983/84, there were only 1147 producer cooperatives throughout the country. Their number was planned to be increased to 15,344 by 1993/94 (ONCCP, 1983).

With regard to food self-sufficiency objectives, a 'new' extension approach, known as Peasant Agricultural Development Extension Program (PADEP), was introduced (ONCCP, 1983). PADEP shared similarities with MPP II in many respects. Later, at the end of the 1980s, it reshuffled its approaches to address agricultural development problems in low potential regions by introducing conservation-centred development projects (ONCCP, 1987).

Despite efforts to increase their number, producer cooperatives and state farms remained small compared to the peasant population (Dessalegn, 1990). In addition, their financial conditions were bleak as most of them were bankrupt and their survival was excessively tied to government subsidy. In short, their capacity to achieve their objective—resource extraction—was thwarted.

There was little surplus available for extraction from peasant farms, as outputs from these farms were barely sufficient for their maintenance. Moreover, high costs of monitoring and poor production-accounting records rendered tax assessment difficult and resulted in dependence on uniform taxation via state-controlled marketing mechanisms. Therefore, in the face of production stagnation, induced by excessive resource extraction, devising plans, which targeted self-sufficiency in food production, must have been a daunting task.

The TYPP was modified by a three-year plan (1987-1990) to give emphasis to major staple food crops such as teff, barley, wheat, maize, and sorghum (ONCCP, 1987). The TYPP was later discontinued with the introduction of a Mixed Economic Policy in March 1990. The mixed economic policy also brought an end to collectivized agriculture. Lands belonging to all collective farms were distributed to members while, lands held by some state farms were ploughed out in the next cropping seasons by people residing adjacent to these farms. Therefore, one can say that collectivization campaigns died prematurely in 1990 before collectivized agriculture could dominate production structures in rural areas.

2.3.2 Pricing and Marketing Policies

Markets, regulated or not, as vehicles for resource extraction to finance growth in the non-agricultural sectors were tested and led to failure in Russia in the 1920s. Collectivized agriculture was introduced in 1929 to tackle this by way of a vertically administered hierarchy. Collectivization transferred marketing decisions of peasant farms to the state (Brooks, 1990).

The time required to move to collectivized agriculture differed from one country to the next. In countries such as Russia, China and other former socialist countries, the transition was relatively quick (Lin, 1998; Brooks, 1990). In these countries, collective farms were major sources of surplus output for industrial growth. On the contrary, in Ethiopia, the transition to collectivized agriculture was relatively sluggish. As a result, peasant farms remained dominant production structures and hence major sources of surplus for growth in the non-agricultural sectors. The contribution of peasant farms to total agricultural land and output was over 90 per cent for the entire period. The significance of collective and state farms was very limited. Therefore, taxes collected from peasant farms by means of both marketing and non-marketing mechanisms were major sources of finance for growth in the non-agricultural sectors.

The marketing mechanism adopted to extract resources from agriculture was conducted through the Central Planning Authority, which was the highest body engaged in production and marketing decisions. Production targets were imposed on the lowest production and accounting units—individual peasant farms—through a vertically administered hierarchy. A government marketing parastatal called Agricultural Marketing Corporation (AMC) was established in 1976. To increase the grain procurement capacity of AMC, compulsory grain quotas, fixed procurement pricing systems, and grain checkpoints were introduced.

Compulsory flat quota procurement programmes were instituted and grain checkpoints were introduced in 1976. Three years later, in 1979, fixed quota procurement programmes replaced flat quota programmes. The shift was an indirect way of limiting farm autonomy as applied to Chinese and Russian collective farms (Lin, 1998; Lin, *et al.* 1990; Brooks, 1990). This furthered production stagnation as most farmers responded to declining incentives by changing their production mix to evade grain quotas (Alemu, 1995). Efforts were made in 1987 to boost production incentives by introducing a 6-10 per cent price hike in farm purchase prices of selected grains. This remained in force until the centralized marketing system was dismantled in March 1990.

The non-marketing mechanisms included land use fees and taxes on agricultural incomes. In addition, levies of different forms such as transaction tax, export duties, and the like, were applied to exporters of agricultural products. Coffee exporters used to pay 44 percent of their revenue to the government in the form of taxes and duties (Eshetu, 1990).

2.4 THE PERIOD SINCE 1992

The agricultural sector was the most affected by the command-driven economic system, which was said to have caused macro price distortions in the 1980s and in the early 1990s. As part of the macro price policy reform process, the following measures were taken: First, price and trade policies were liberalized between 1991-1992. Second, stabilization policies to correct macro price distortions were introduced in 1992. Third, as part of the structural adjustment program, short-, medium-and long-term timetables were drawn to privatize state farms in 1993. And fourth, the development strategy of the country was changed from Industry-led to Agriculture-led in 1994. Except for the fourth measure, the first three have their theoretical roots in the "Food Policy Approach". The approach was first introduced in 1983 by Timmer, Falcon, and Pearson in their book *"Food Policy Analysis".* It shows how macro-economic and sectoral policies can influence the decision-making process of food producers, food consumers, and food marketing agents in order to further social objectives (Timmer, *et al.* 1983).

2.4.1 Trade and Price Liberalization

2.4.1.1 Grain market

As part of the price and trade liberalization process, agricultural prices were decontrolled. In addition, parastatal's monopoly on marketing and distribution of food grains was abolished. Liberalization increased the number of traders, licensed and unlicensed and enhanced spatial integration of markets (Wolday, 1999; Asfaw and Jayne, 1998).

However, according to various studies, grain marketing in Ethiopia is still constrained by a host of setbacks. These include lack of effective competition, limited access to working capital, poor road conditions, limited storage facilities, and a presence of too many unlicensed grain traders, as well as high and unsystematic tax assessment (Wolday, 2001; Gebremeskel ,*et al.* 1998, EEA, 2000; Alemayehu, 1995). Therefore, much remains to be done to rely on markets as channels through which the benefits of macro-economic policy reforms reach the people that they are meant to serve.

2.4.1.2 Input market

Fertilizer and improved seeds are major inputs used in Ethiopian agriculture. Before 1992, the marketing of these inputs was monopolized by the state-owned parastatals—the Agricultural Input Supply Corporation (AISCO) and the Ethiopian Seed Corporation (ESC).

In Ethiopia, fertilizer is imported while improved seeds are produced locally. Fertilizer and improved seed prices were low before 1992 because of direct and indirect subsidies; indirect, by maintaining an overvalued currency and fixed pricing; direct, by means of budgetary mechanisms or budgetary allocations.

Fertilizer rationing was common before 1992 and producer cooperatives and State Farms were major beneficiaries of the system.

After 1992, fertilizer retail marketing was liberalized, while wholesale prices remained under the control of the government. Control over wholesale prices of fertilizers was finally phased out by the end of 1996/97.

Prior to the reform, ESC used to sell improved seeds directly to state farms and indirectly to small farms through AISCO. At present, improved seed marketing is partially liberalized. Ethiopian Seed Enterprise (ESE) and Pioneer Hybrid International (PHI) are popularizing the use of improved seeds in the country.

The demand for improved seeds in Ethiopia is declining (Wolday, 2001). Presently, it is applied on only 2 percent of the cultivated area. The decline is ascribed to its substitution by farmers' own seeds, as well as the high price of improved seeds (EEA, 2000). Prices set by the ESE do not vary with cost of transport. Neither does demand and supply conditions affect prices. Prices are pan-territorial based on a fixed cost-plus approach.

At present, in addition to AISE, there are two private and three party-affiliated fertilizer importing and distributing agencies engaged in fertilizer wholesale and retail operations. These include the Ethiopian Amalgamated Limited (EAL), Fertiline Private Limited, Ambassel Trading House Private Limited, Guna Trading Share Company, and Dinsho. In addition, wholesalers, retailers, cooperatives, and regional and zonal agricultural offices serve as marketing outlets selling fertilizer directly to farmers.

Importers are major actors in fertilizer wholesale and retail operations as the involvement of the private sector in fertilizer marketing is limited. According to Mulat, *et al.* (1998) and Wolday (2001), wholesale and retail operations involve high risk arising from high storage costs and risk of decline in quality if stored for the next season. In addition, new entrants into the business are discouraged as credit sales are directed at specific fertilizer importing/distributing agency. Equally important is the restriction that foreign exchange is obtained with restricted conditions regarding source of supply. This influences the quality of fertilizer imported (Mulat, *et al.* 1998; Wolday, 2001).

2.4.2 Structural Adjustment

2.4.2.1 Reform in the farming structure

Structural changes, which specifically affected agriculture, included a reform in farming structures. This was necessitated by production inefficiencies exhibited by state farms attributed largely to a poor incentive structure and the sub-optimal allocation of resources. For example, state farms incurred a loss of Birr 65 million in 1986/87. The loss skyrocketed to Birr 115 million in 1988/89 (Alemu, 1995). Collective farms were totally demolished immediately after a change in economic policy was announced in the dying minutes of the socialist government. Therefore, unlike former socialist countries, there was no collective farm left to undergo structural changes.

Reforms in the farming structures in the former socialist countries involved privatization of state and collective farms. This was considered the right move to secure and unrestricted property rights. But in Ethiopia, land reform was not part of the privatization process. Rather short-, medium-, and long-term plans were formulated to transform state farms within the framework of state ownership of land.

The short-term strategy (1991/1992) transformed state farms that had already been taken over by farmers, in the wake of the announcement of the mixed policy in 1990, and disposed of farms which were deemed unmanageable for technical reasons. The medium-term strategy led to privatization of state farms, which were found to be unprofitable and engaged in the production of non-strategic products.

The long-term plan retained those state farms that have strategic importance and required heavy investments (Alemu, 1995).

2.4.2.2 Form of land ownership

In former socialist countries, reforms in farming structures constituted privatizing state and collective farms, which involved transfer in the form of land ownership to secure and unrestricted private rights. It is believed that it will restore production efficiency.

In Ethiopia, only two farming structures were left in 1992, for collective farms were demolished shortly after the mixed economic policy was announced in March 1990. Therefore, a reform in the farming structure meant only privatizing state farms after consideration for their strategic importance was given. However, the process was partial. It concentrated only on the privatization of their assets with the exception of land, which remained in government hands.

Land ownership is a highly politicized issue in Ethiopia (Desalegn, 1999). Given the political history of the country, finding a model applicable to Ethiopia's situation is a difficult but not impossible task. For example, restitution to former owners, as applied in many other former socialist countries, is impossible, as no uniform land ownership system was practised before 1974.

The land holding system before 1974 was uneven. In the north, the rist system was dominant. It is "a claim on community membership in any village from which one could prove descent, and hence on a share of the common agricultural land" (Pausewang, 1990); but in the south, gult lordship was widespread. Gult lordship was introduced in the south as a result of Minelik's expansion southward. The gult[1] lords obtained land in the form of remuneration for their service as soldiers.

[1] The *gult* lords are a nobility of political and military leaders who had rights to collect a share of the produce of all agricultural land in a given area, in exchange for their administrative, political, cultural and judicial services (Pausewang, 1990)

In the south, the king made *gult* rights hereditary but left rights of *gult* holders in the north unchanged. As a result, *riste-gult* as a new system of holding emerged. Later, *riste-gult* rights evolved into a freehold system, as 'land ownership appeared a precondition for investment in modern agriculture' (Pausewang, 1990). North-South discrepancies in holding rights continued until holding rights were made uniform by the 1974 revolution, which turned land into state hands.

Therefore, prior to the 1974 revolution, inequitable land tenure patterns, concentration of land ownership in a small group, tenure insecurity, and exorbitant rent or share cropping arrangements were major impediments in agrarian reconstruction and development. Tenure insecurity was thought to be a cumulative effect of the following: absence of cadastral maps, unclear ownership and tenancy rights, unclear boundary demarcation, and undefined landlord-tenant relationships[2]. The traditional communal system of land ownership, which prevailed in the northern part of the country, eliminated the possibility of mortgage credit or of transactions on land. In addition, it obstructed farmers from investing in productive farming operations, particularly from safeguarding against soil and water erosion (IEG, 1962; IEG, 1967).

A uniform land holding system was introduced by the March 1975 proclamation, which declared *'land to the tiller'*. Consequently, land was proclaimed a state property and all types of transactions on land were outlawed. Peasants were granted only usufruct rights. The proclamation also declared use of hired labour (except for those who were unable to plow due to age or incapacitation), and sharecropping illegal.

Land distribution was carried out until all arable land was distributed. The limited availability of arable land, coupled with the growing demand for land, required the introduction of land redistribution schemes. Land redistribution continued up until it

[2] Tenants used to be arbitrarily evicted

was officially banned in 1989. The ban was meant to abate diminution in the size of holdings. Presently, intra-household land allocation is the primary source of access to land for the newly formed households.

Except for the buying and selling of land, most of the other constraints on land were relaxed by the March 1990 policy reform. The reform allowed sharecropping, the transfer of land to legal heirs, and the hiring of labour.

Nothing significant has been added to the land policy since a new constitution was enacted in 1994, except for proclamation No. 89/1989 of 1997. The constitution declared the right to the ownership of land to be exclusively vested in the state. It allowed land transfer from one user to another through short-term renting arrangements and intra-household land redistribution. Proclamation No. 89/1989 of 1997 introduced compensation to farmers who lose land in the process of redistribution for long-term investments as well as improvements they make on land (Section 8 and 9). In addition, the proclamation allows former holders of lawful standing to retain (to the extent the distribution would permit) portions of the land they have been improving (Section 7).

Some of the avenues through which the existing land policy impacts on agricultural production are decreases in land size, insecure ownership, and population pressure in rural areas. Average holding size is estimated at one hectare. It can be confirmed by analyzing data supplied by the Central Statistical Authority (CSA) that, at present, households with relatively large plots are decreasing while those with smaller ones are increasing. This is primarily caused by intra-and/or inter-household allocation of land. Small land size has affected agricultural production through a variety of channels.

According to Wolday (1998) and Mulat, *et al.* (1998), small land size has impacted on input use. They found out that input use is directly proportional to holding size. This is contrary to the view that intensification is high-on small-sized plots than bigger ones to compensate for shortages of land. Small land size has become a cause of excluding many farmers from benefiting from high input package, extended by the Ministry of Agriculture and Sasakawa Global 2000. To benefit from an input package, a peasant is required to own more than 0.25 hectare.

Tenure insecurity, which is considered a consequence of state ownership of land, is blamed for making peasants reluctant to apply sound land management practices and to make long-term investments on land (Teferi, 1995; Sutcliffe, 1995, Dessalegn, 1999). Land redistribution is a major source of tenure insecurity.

Population pressure in rural areas is blamed for the expansion of cultivation to areas which were marginal, and to areas previously covered by forests and woodlands. Forests, which covered 40 percent of the land area at the turn of the century, are presently at a level of less than 4 percent (FAO, 1997).

Average cultivated land as a percent of agricultural area has risen from 21 percent in the period 1961-1975 to 32 percent since 1992 (Table 2.1). Permanent pasture, which accounted for 79 percent of the total agricultural area between the years 1961-1975, is now reduced to 68 percent (Table 2.1). Land classified as non-suitable for farming, on the contrary, has risen. It increased from 57 percent of the total land area between 1961-1975 to 69 percent since 1992 (Table 2.1). This means that land, which used to serve as permanent pasture is increasingly being put under cultivation, and at the same time that significant amount of cultivated land is being withdrawn from agriculture. Land degradation contributed to the latter.

Table 2.1: Land allocation

Year	Cultivated land as a % of Agricultural Area	Permanent Pasture as a % of Agricultural Area	Non-suitable land for cultivation as a % of total land area
1961-1974	21	79	57
1975 – 1991	23	77	56
Since 1992	32	68	69

2.4.2.3 Agricultural development-led industrialization strategy (ADLI)

ADLI is opposite to the type of development strategy, which had been in operation for over three decades, 1957-1992. ADLI's theory had its early roots in Johnston and Mellor's (1961) article *"The role of agriculture in economic development"*, which for the first time highlighted the implications of Lewis's two-sector model for agricultural development policy. Though in a varied context, the theory was enriched by Mellor's (1990) theory of *"An agriculture-and employment-based strategy of economic growth"* and de Janvry and Sadoulet's (1989) theory of *"An Agriculture-led growth strategy"*.

Ethiopia is still in its initial phase of development in terms of major economic growth indicators. Agriculture accounts for over half of the GDP and more than 86 percent of the labour force is employed in agriculture (MEDaC, 1999). Therefore, the strategy requires that much of the investable resources extracted from agriculture be reinvested in the agricultural sector itself to stimulate growth in agriculture.

According to Mosher (1966), the following changes are required to get agriculture moving—institutional change; providing new technology to farmers; changes in the structure of markets and incentives; and investment in rural infrastructure. In Ethiopia, since the adoption of ADLI, changes have been introduced in different areas. These changes are briefly discussed in the following paragraphs.

Measures taken include investment in research, infrastructure and institutional changes. For example, a Five Year Road Sector Development Program was launched in September 1997 with the target of raising the road density by 7 percent, that is, to 0.46 km per 1000 population (MEDaC, 1999). In addition, specific policies such as small-scale irrigation, conservation of natural resources and environment were initiated.

The types of institutional changes introduced included the provision of various supports such as a package of inputs and credit, the launching of extension programme on a pilot basis, and ensuring the good functioning of supply and distribution schemes for fertilizer and improved seed varieties.

A new extension programme known as "Participatory, Demonstration and Training Extension System" (PADETES) with the primary aim of raising the productivity of the smallholder farmers was initiated. The new agricultural extension programme has been operational since 1995 on selected plots growing major cereal crops (maize, wheat, teff, and sorghum). Crops like pulses, oil seeds, and vegetables have been embraced by the extension programme since the 1997 cropping season.

2.5 SUMMARY AND CONCLUSION

In Ethiopia, development planning dates back to 1957. It can be broadly divided into two: Industry-led and Agriculture-led strategies. The first strategy dominated policy for over three decades, from the 1960s to 1980s, and was a product of three theories namely Arthur Lewis's (1954) two-sector classical growth model, Hirschman's (1958) postulate on linkage effects, and Raul Prebisch's (1959) secular decline hypothesis. These theories reduced the role of agriculture only to supplying resources needed for rapid growth in the non-agricultural sectors.

Two distinct approaches were deployed to achieve the objectives of the industry-led strategy. Prior to 1974, economic activity was governed by markets. Therefore, discriminatory investment policies to guide growth endeavors in the manufacturing sector were employed. However, between the period 1974-1992, economic activity was governed by the central planning authority. Hence, compulsory mechanisms were instituted to extract resources from agriculture to achieve growth objectives in the non-agricultural sectors.

Government's attention to agriculture was not part of the development planning process before 1992. Rather it was sporadic, for its occurrence was conditioned by food shortages at times when drought situations were rife. For example, the inclusion of IRD projects in the TFYP was instigated by food shortages in the 1960s. Though government intention to change farming practices through IRD projects were spelt out in the TFYP, much of the financial burdens were shouldered by external donors. The rise and fall of IRD projects in the 1970s due to lack of funding serves as a good example. In addition, the 1983/84 drought was instrumental in the implementation of the TYPP. One of the two objectives upheld by the TYPP was self-sufficiency in food production.

Ethiopia's experience with industry-led development strategy contradicts the experiences of many successful countries, including Russia. This is because, by the time these countries embarked on structural transformation, their agricultural sectors had been in good shape. But in Ethiopia, what Timmer (1988) called the *"jump strategy"* was adopted. This means that the *"Mosher's environment"* where development programmes are worked out to get agriculture moving by reinvesting resources extracted from agriculture back into itself, was omitted. Development planning was started in the second stage—*"Johnston and Mellor environment"* or structural transformation—where resources extracted from agriculture is used not for its own sake but to develop other sectors.

Measures to correct policy distortions were made in three stages. First, price and trade policies were liberalized and the exchange rate devalued between 1991-1992. Second, short-, medium-and long-term strategies were devised to change farming structures in agriculture in 1993. Unlike the experiences of former socialist countries, where changes in farming structures constituted changes in the form of land ownership, right to the ownership of land is exclusively vested in the state. State ownership of land is presently blamed for the current plight of Ethiopian agriculture. Third, the development strategy of the country was changed from Industry-led to Agriculture-led (ADLI) in 1994. ADLI has its roots in the earlier works of Johnston and Mellor (1961) and Mosher (1966) and in recent works by Mellor (1990), and de Janvry and Sadoulet (1990). According to the new strategy, priority is accorded to agricultural development. A number of measures in this regard have been taken in the past seven years. Though its impact is yet to be seen, measures to correct the existing marketing constraints and the impact that the existing land holding system imposes on agriculture need to be taken.

CHAPTER 3

THE CONTRIBUTION OF AGRICULTURE TO ECONOMIC GROWTH

3.1 BACKGROUND

In chapter two, a summary of agricultural policies in Ethiopia was given. In this chapter, an attempt is made to see how these policies affected the performance of agriculture in the Ethiopian economy. Hirschman's (1958) finding that investment in manufacturing as opposed to agriculture has the potential to contribute to economic growth was influential in policy making in Ethiopia before the 1990s. This had led to the formulation of strategies that favored manufacturing and to the delusion that growth in agriculture contributes little to growth in other sectors of the economy. Hirschman's theory had an impact on development strategy formulation in developing countries despite opposing recommendations coming from Johnston and Mellor (1961), Kuznets (1964), Mellor (1998), Timmer (1998) and Eicher *et al.* (1998). According to these latter economists, agriculture makes substantial contributions to economic growth. The implementation of a strategy by a developing economy, which neglects agriculture, is believed to introduce adverse consequences on the overall growth of the economy.

Chapter two, which summarized agricultural policies of Ethiopia from 1950s to present, identified two distinct development strategies, namely, Industry-led (i.e. between 1950s – 1994) and Agriculture-led (i.e. since 1995) Development strategies. Depending on differences in political systems, opposing economic policies were experimented for the realization of the Agriculture-led and Industry-led development strategies. Absolute monarchism was the political system of the country between 1960 and early 1970s. During this period, the development strategy was squeezed to operate within a free-market economic framework. On the contrary, socialism was the political system of the country between 1974 and 1992; hence, the strategy, which continued to be Agriculture-led, had to function within a command economic framework. The development strategy of the country was changed from Industry-led to Agriculture-led in 1995. This new strategy, which is presently known as Agricultural-led development strategy (ADLI) in the country, is operating within yet another economic system i.e. a free-marketing economic framework.

Agriculture was neglected between 1960s and 1995 in Ethiopia. The neglect between 1960 and early 1970s was purely the consequence of influential theories that favored growth in the manufacturing sector worldwide. However, between 1974 and 1992, in addition to theories, this could be attributed to ideological change. Like in many former socialist countries, in Ethiopia too, attempts were made to transfer resources from one sector to the other to forcefully make a sector contribute to growth in another sector. Russia had some success in this regard which can be exemplified by dividing its economic history between 1930s and 1989 into two periods, namely, the period between 1930 and 1953, known as an "extraction period", and the period between 1966 and 1989, known as the agricultural modernization era (Brooks, 1990). During the extraction period, resource transfer was deliberately managed to flow from agriculture to the manufacturing sector. On the contrary, during the agricultural transformation era, the focus was geared towards agricultural modernization; thus, resource transfer was managed to flow from the non-agricultural to agricultural sectors (Brooks, 1990). In Ethiopia, the time period between 1974 and 1992, during which socialism was the political and economic system of the country could be labeled the extraction period. This is because, during this time, much of the effort on the part of the government was focused on the transfer of resources from agriculture to the non-agricultural sectors (Eshetu, 1990). Thus one can argue that in Ethiopia, socialism was uprooted before a transition to the agricultural modernization era could be made.

This chapter builds on chapter two to achieve its objectives. Theories, which are summarized in chapter two with regard to the contribution of agriculture to economic growth, are put to the test. This will be achieved with the help of the findings from chapter two which will be used to structure the analysis on the contribution of agriculture to economic growth in general and to specific sectors in particular into three periods, namely, the period between 1960 and 1974, the period between 1974 and 1992, and the period since 1992. The chapter aims at achieving two objectives. Firstly, it attempts to compare the contribution of agriculture to overall GDP growth compared with other sectors of the economy. Secondly, it attempts to measure the effect of various agricultural policies, which are implemented in each period on the contribution of agriculture to growth in other sectors of the economy i.e. manufacturing and services sectors.

Hitherto, no study has been documented with regard to the second objective. Most similar studies focused much on the contribution of agriculture to economic growth such as supply of food, raw materials, foreign exchange and supply of labour for industrial employment. This chapter attempts to fill the gap by investigating causation between growth in agriculture and non-agriculture by means of Granger (1969) causality test procedures. It has the following weakness though. The focus is much on the contribution of agriculture to growth in other sectors of the economy and vise versa. No attempt is made to study backward as well as forward linkages between agriculture and the rest of the economy using input-output and other models due to huge set of data that these models require.

It is hypothesized in this chapter that manufacturing depends on agriculture for some of its raw materials; thus, growth in agriculture is presumed to cause growth in the manufacturing sector. This is based on the data that three-fourths of Ethiopian manufacturing output constitutes food, beverages, textile, tobacco, leather, printing, paper and non-metallic minerals (EEA, 2000). On the contrary, with regard to the growth effect of agriculture on the services sector, it is presumed to be very little. This may be supported by the finding that until late 1980s, growth in services GDP had been mostly the outcome of growth in public administration and defense (Pickett, 1991) than growth in the productivity of the agricultural sector which is the largest sector in the economy. If growth in the services sector had been the result of factors such as expansions in education, health, trade, transport and communication services, which are directly related to expansion in the productivity of the largest sector of the economy i.e. agriculture, a positive causality result between agricultural and service sectors could have been expected. According to Pickett (1991), expansion in education and health services improves the stock of capital, while expansion in trade, transport and communication services represents the continued widening of markets.

The following will be additional points that will be explored in this chapter. Firstly, the performance of agriculture in terms of self-sufficiency in food production. Secondly, factors responsible for changes in sectoral growth rates in each year and within each period.

3.2 METHODOLOGY

3.2.1 The Data

Time series data at 1995 prices on agriculture, manufacturing and services were collected from the Ministry of Economic Development and Cooperation (MEDaC). All the series begin in 1963 and end in 1998. Data on manufacturing represents large and medium-scale manufacturing operations. Data on services are composed of trade, hotels, transport, communications, banking, insurance, real estate, public administration, defense, education, health, etc. Data on these were found classified into seven groupings. Data on trade, hotels and restaurants were lumped together and put in the first group; transport and communication in the second; banking, insurance and real estate in the third; public administration and defense in the fourth; education on its own; health on its own; and finally domestic and other services in the last group. In addition, data on population, savings, consumption, investment and general price level were gathered from various sources. All the series in agricultural, manufacturing and service GDPs were converted into their natural logs to facilitate their interpretation as growth rates.

3.2.2 Tests on the Statistical Properties of Variables

Tests on the statistical properties of the variables were performed in two stages. In a country like Ethiopia where disruption in the long-term trend of macro variables is expected to occur due to man made and natural factors, a study on the significance of these factors, hereafter breaks, on the long-term trend of such variables must always precede conventional tests for unit roots. This is important because Perron (1989) showed that the application of conventional Augmented Dickey-Fuller testing procedures (equation 3.2) on series characterized by breaks has the tendency of incorrectly accepting the unit root null while the true data-generating process is in fact a trend stationary process. Therefore, in stage one, an attempt was made to detect dates of structural breaks in each series by applying a recursive analysis using the Dickey-Fuller regression procedure[1]. In step two, based on results obtained from step one, the type of unit root-testing method that should be implemented was chosen. Therefore, tests for unit root on variables identified to have break(s) in their series were conducted with the help of Perron (1989) adjusted Augmented-Dickey Fuller test procedure (equation 3.1) and on the remaining (i.e. for variables without breaks in their series), a conventional Augmented Dickey-Fuller test procedure (equation 3.2) was applied.

Where μ = intercept term; T_B =time of break; D (T_B) = 1 if $t=T_B+1$, 0 otherwise; DU_t

$$Y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + dD(T_B)_t + \alpha y_{t-1} + \sum_{i=1}^{K} c_i \Delta y_{t-i} + e_t \text{......................}(3.1)$$

= 1 if $t>T_B$, 0 otherwise; DT_t = t if $t > T_B$ 0 otherwise. The test for the hypothesis that

[1] This system was applied by Balke and Fomby (obtained from Balke (1991))

α=1 was computed using test statistics developed by Perron (1989). The values of k (see equation 3.1) were set at 1.

$$\Delta Y_t = \varphi_1 + \varphi_2 t + \alpha Y_{t-1} + \gamma_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad \text{.......(3.2)}$$

Where, α = (1-p), p is a parameter estimate of a first-order or AR (1) process.

3.2.3 The Model

Direction of causality between agriculture and other sectors of the economy is measured using the Granger causality test (1969). It is assumed that the information relevant to the prediction of the respective variables X and Y is contained solely in the time series data of these variables. The test is performed using the following vector autoregression (VAR) model.

$$\left.\begin{aligned} X &= \sum\nolimits_{i=1}^{m} \lambda_i X_{t-1} + \sum\nolimits_{j=1}^{m} \delta Y_{t-j} + u_t \\ Y &= \sum\nolimits_{i=1}^{n} X_{t-i} + \sum\nolimits_{j=1}^{n} \beta_j Y_{t-j} + v_t \end{aligned}\right\} \quad \text{.......(3.3)}$$

Where X is agriculture, Y is other sectors (manufacturing or service), u and v are uncorrelated error terms.

Causality was tested between agriculture (i.e. X) and manufacturing (i.e. Y) first and then between agriculture (i.e. X) and service (i.e. Y). To take into account the effects of exogenous factors, a time varying approach was used. This was achieved with the assistance of a rolling regression.

Unidirectional causality from agriculture to the other sector requires that $\Sigma\alpha$ be different from zero and $\Sigma\delta$ be equal to zero. Conversely, unidirectional causality from another sector to agriculture requires that $\Sigma\delta$ be different from zero and $\Sigma\alpha$ be equal to zero. Bi-directional causality is suggested when λ, δ, α and β are different from zero. No causality is suggested when λ, δ, α and β are equal to zero. This test was developed within an implicit framework of stationarity.

Depending on test results from the statistical properties of the variables in section 3.2.2, variables, which were identified as satisfying the properties of difference stationary processes were differenced until they were made stationary. On the other hand, variables satisfying the properties of trend stationary processes were detrended. These helped satisfy the basic assumptions of classical regression techniques. Cointegration tests are not applied here since agricultural GDP was a trend stationary process. This is in line with the literature that working with stationary/breaking trend data precludes the carrying out of tests for cointegration (Banerjee, *et al.*., 1992).

3.3 RESULTS AND DISCUSSION

In this section, first, a descriptive statistic procedure was employed to study comparative performance of agriculture as compared with other sectors of the economy and, second, Granger causality procedure was applied to study the contribution of agriculture to growth in other sectors of the economy and vice versa.

The section is divided into two major sub-sections. Section 3.3.1 discusses comparative performance of agriculture and non-agriculture. Section 3.3.2 discusses results on the contribution of agriculture to growth in other sectors of the economy at various stages of economic reform.

3.3.1 Comparative Performance

In this section, comparative performance between agriculture and non-agriculture are compared by dividing data at hand into three periods i.e. between 1963 and 1973, between 1974 and 1992, and since 1992.

3.3.1.1 Comparative performance between 1963-1973

During this period, the political arena was characterized by absolute monarchism. In the economic sphere, markets were the driving forces in resource allocation. Overall GDP increased on average by 4 per cent. This was made up of 7.8, 7 and 1 per cent growth in manufacturing, service and agriculture respectively (see Table 3.1). The rate was higher than the 2.6 per cent growth in population. Thus, income per head rose at an average annual rate of 1.4 per cent. This higher growth in GDP relative to population was a better achievement in relative terms. However, in terms of food security measurements (i.e. agricultural GDP growth rate minus population growth rate) the country did badly. Food production per head of population lagged behind population growth.

Table 3.1: Average growth rates and sectoral shares

Year	Agriculture		Manufacturing		Services		GDP Growth
	Growth	Share	Growth	Share	Growth	Share	
1963-1973	0.9	68	7.8	5	7	25	3.5
1975-1991	1.3	55	1.2	6.5	2.6	34	1.7
1992-1998	2	50	7	6.4	8	39	4.8

To compare the performance of agriculture relative to the manufacturing and service sectors, growth rates were calculated. A high GDP growth rate was registered in 1964 (Table 3.2). This was made up of a 10 and 14 per cent growth in the manufacturing and service sectors respectively. In the same year, the contribution of agriculture to overall GDP growth was negative (Table 3.2).

GDP growth was the lowest in 1973 (Table 3.2). The service sector was the only sector with positive contributions. The performance of the agricultural and manufacturing sectors in the same year was disappointingly negative. This could be largely attributed to political instability. In the remaining years, GDP growth rates were positive. These positive rates were the result of relatively higher performance in the manufacturing and service sectors. Therefore, one may say that much of the positive growths in GDP between 1963 and 1973 were made up of positive growths in the non-agricultural sectors (Table 3.2).

Table 3.2: Comparison of sectoral growth rates (1963-1974)

Year	Sectoral Share (%)			Growth Rates (%)			
	AGR	MANU	SERV	AGR	MANU	SERV	GDP
1963	81.7	4.0	20.6	--	--	--	--
1964	74.1	4.1	22.0	-3.0	10.1	14.1	6.9
1965	70.7	4.3	22.4	0.8	12.4	8.0	5.7
1966	71.2	4.5	22.6	3.2	6.4	3.2	2.5
1967	69.2	4.8	23.8	0.9	10.0	9.5	3.7
1968	67.9	5.1	24.6	2.1	11.5	7.1	4.0
1969	67.1	5.4	25.4	2.3	9.5	7.0	3.6
1970	65.7	5.7	25.8	2.0	9.9	6.0	4.1
1971	65.0	5.7	26.3	3.5	4.0	6.6	4.5
1972	63.9	5.8	27.1	0.7	5.3	5.7	2.5
1973	62.6	5.7	28.4	-0.6	-1.0	6.1	1.4
1974	61.5	5.6	29.5	-1.8	-1.2	3.7	-0.01

Source: Adapted from data from the Ministry of Economic Development and Cooperation (MEDaC). Numbers do not add up to 100 because of rounding off errors

The main reason for the relatively higher growth in non-agriculture as opposed to agriculture in this period rests on less attention being given to agriculture. Overall development strategy of the country was biased towards developing non-agriculture because of the belief that globally in the 1950s through 1970s manufacturing was considered the dynamic sector while agriculture was considered static and unresponsive to incentives (Lewis, 1954; Hirschman, 1958). Therefore, policies that gave special encouragement to the manufacturing sector were implemented.

Government investment policies were constantly updated to encourage investment in the non-agricultural sectors. Worth mentioning in this regard are the announcement of policy statement notice number 10 of 1950, decree number 51 of 1963, investment proclamation of 1964 and proclamation number 242 of 1966.

Encouraged by these favourable packages of policies, a number of new manufacturing enterprises totaling 273 were established by locals and foreign nationals.

3.3.1.2 Comparative performance between 1974 and 1991

A major introduction during this period was that of radical change in the political system, which gave rise to changes in economic organizations. Many of the means of production, distribution and exchange were nationalized in 1975. Further to a discriminatory government investment policy that was common before 1974, a Stalinist method of resource transfer from agriculture to developing non-agriculture was instituted.

Table 3.3: Comparison of sectoral growth rates (1975-1991)

Year	Sectors' share %			Growth rates %			
	AGR	MANU	SERV	AGR	MANU	SERV	GDP
1975	62.3	5.6	29.8	3.0	0.6	2.9	1.7
1976	61.7	5.6	30.1	0.1	1.8	1.9	1.1
1977	61.8	5.5	30.2	-1.5	-3.1	-1.4	-1.7
1978	59.4	6.1	31.1	2.5	17.4	9.9	6.6
1979	59.2	6.2	30.7	4.8	7.5	3.6	5.1
1980	57.7	6.5	31.4	-1.6	4.6	3.3	0.8
1981	55.4	6.8	32.9	-3.6	6.3	5.4	0.5
1982	57.1	6.5	31.7	13.6	5.4	5.9	10.2
1983	53.3	7.2	34.0	-12.5	3.6	0.6	-6.3
1984	46.7	7.6	38.6	-20.9	-5.6	2.5	-9.7
1985	49.3	7.7	36.4	16.0	12.3	3.7	9.9
1986	51.3	7.5	35.2	18.8	10.4	10.1	14.1
1987	50.0	7.5	37.1	-2.8	0.02	5.5	-0.01
1988	50.3	7.2	37.7	1.03	-3.92	1.9	0.4
1989	50.9	6.9	38.1	5.3	0.4	5.2	4.1
1990	55.9	4.9	34.7	5.2	-32.0	-12.7	-4.3
1991	56.5	4.8	34.5	-2.7	-5.5	-4.3	-3.7

Source of original data: Ministry of Economic Development and Cooperation

Overall performance was lower than that registered before 1974. On average, GDP grew by about 1.7 per cent between 1974 and 1990 (Table 3.1). The corresponding population statistic was 2.9 per cent. Income per head therefore fell on average by 1.2 per cent per year. The 1.7 per cent rise in GDP was made up of a 2.6 per cent growth in services, a 1.3 per cent growth in agriculture and a 1.2 per cent growth in manufacturing (Table 3.1). Given potentials, a further 1.7 percentage point increase in agriculture could have kept the economy alive and prevented decline in income per head of population. The failure of agriculture to grow at a pace higher than the population growth was largely responsible for a decline in living standards between 1974 and 1991.

Given that agriculture was a source of livelihood for over 80 per cent of the population, and that its contribution to total output stood at over 55 per cent in this period, a fall in agriculture relative to population could be one of the causes for the disturbances in major components of national income accounts. The effect on trade balance was direct. The failure of agriculture to feed the growing population created a food deficit, which was increasingly offset by food imports. Cereal import was 0.05 million tons in 1960. The figure rose to 0.11 tons in 1973 and to over 0.81 tons in 1991. Trends in food deficit in rural areas are given in Appendix C. The effect on gross private consumption is obvious. Empirical observations indicate that higher percentage of consumers' income in third-world countries, which falls in the range of 50 to 60 per cent, is spent on food (Johnston and Mellor, 1961). The rate could be even higher in Ethiopia. According to recent estimates, gross private consumption was 74.3 per cent of GDP in 1990 (Appendix B). The rate rose to 80.1 per cent in 1999 and fell back to 76.7 in 2000 (Appendix B). Thus, one can say that lower food production can be directly translated into lower gross private consumption.

The depressing effect of lower food production on the other national income account such as gross private investment comes indirectly through gross domestic saving. Considering that income is the sum of consumption and saving, lower income means lower saving. Lower saving in turn means lower gross domestic investment or capital formation and hence lower economic growth. Failure of domestic saving to grow at a pace higher or equal to the rate of investment introduces a negative resource balance, which in most cases was financed from external sources, mostly loans.

Domestic saving was 11.4 per cent of GDP between 1963 and 1973. However, its share declined to 4 per cent between 1974 and 1990 (Appendix B). Lower domestic saving meant lower gross domestic investment. The country was forced to rely heavily on foreign savings to bridge the resource gap thus created. This is because, external debt was 4.5 per cent of GDP between 1970 and 1973 (Appendix B). It rose to 25.6 per cent in 1981 and to 43.1 per cent in 1991 (Appendix B). Among other factors which were equally important for lower savings and therefore for lower capital formation between 1974 and 1991 were the imposition of capital ceilings on medium-and large-scale industries, the nationalization of foreign assets, financial disintermediation and exogenous determination of nominal interest rate.

The failure of agriculture to grow at a pace higher than population can also be accompanied by inflationary pressures that eventually impede economic growth. The consequence of these pressures is much more severe in developing economies (Johnston and Mellor, 1961). In an attempt to curb price inflation resulting from declining agricultural production, measures such as direct price control, maintenance of an overvalued exchange rate, ceilings on interest rates and control on wage rates were imposed. For example, as shown in Table 3.4, rate of inflation was contained in the range of 9.5 and 10.27 between 1974 and 1992. In addition, real exchange rate appreciated by 38 per cent between 1974-88 as compared with its 1966-73 level and real interest rate, calculated as nominal interest rate minus rate of inflation, was minus 4.07 on deposit rate and minus 2.79 on lending rate between 1985-92. Generally, the following are a few of the consequences of an overvalued exchange rate and a negative real interest rate. An overvalued currency introduces differential inflation rates between traded and nontraded goods (Dornbusch, 1980; Cordon, 1977) while a negative real interest rate affects the operation of financial or capital markets by causing financial disintermediation or financial repression, reduced saving and poor allocation of capital to productive investments i.e. employment creation objective of the government will be harmed by making capital cheaper than labor and encouraging labor saving technologies (Timmer *et al.*., 1983).

Table 3.4: Macro price variables of various periods

Real Exchange Rate			Consumer Price Index		Interest Rate %		
Year	**US$/birr**	**Index 1960 =100**	**Year**	**Inflation 1963=100**	**Year**	**Lending Rate**	**Deposit Rate**
1960-73	0.3737	117	1974-84	10.27	1985-92	6.71	5.43
1974-88	0.493	155	1985-92	9.5	1993-00	12.48	8.74
1960-88	0.44	137	1974-92	9.9	1985-00	9.6	7.1

Source: IMF, International Financial Statistics

Looking at external sources of distortions, one also finds that this period was characterized by frequent negative growths in GDP. Of the total of 17 years under consideration, 11 had positive GDP growth rates while the remaining six registered negative growths. Of the eleven years with positive growth, three were recovery to previous peaks, three were caused by good weather and the remaining five were years of normal growths. All years identified as years of negative growth were directly matched by negative growth in agriculture in the corresponding years. Agriculture had seven negative years of growth as compared to non-agriculture.

GDP growth was the lowest in 1983/1984 because of severe famine (Table 3.3). The famine decreased GDP by 9.7 per cent. Only services grew by 2.5 per cent in the same year while agriculture and manufacturing declined by 21 and 5.6 per cent, respectively. Agricultural GDP had an all-time low figure.

Except for slight improvements in agricultural GDP, which in itself is far lower than potential, growths in overall GDP, manufacturing and services were significantly lower than their averages between 1963 and 1973. The improvement could be attributed to achievements in agricultural extension activities, which helped popularize modern input use such as fertilizer and pesticides. Fertilizer and pesticide consumption were ten times higher than their levels between 1963 and 1973.

A few donor-supported agricultural extension projects were introduced during this period. Worth mentioning in this regard are Minimum Package Project I (MPP I) between 1971 and 1975 (IEG, 1962), Minimum Package Project II (MPPII) between 1981 and 1984 and Peasant Agricultural Development Extension Project (PADEP) between 1985 and 1990 (Dejene, 1990). MPP II was a marked departure from MPP I. It was designed to extend services to 13 administrative regions. However, its life was cut short in 1984 because of the 1983/84 drought. Immediately after the drought, a ten-year perspective plan (TYPP) was launched in a bid to achieve food self-sufficiency in food production. The plan spawned PADEP. PADEP was reshuffled in 1987 to incorporate major food crops in its extension activity.

As discussed earlier, in addition to bad weather, poor performance in agriculture was the result of a government campaign to promote collectivized agriculture. Collectivization created poor incentive structures in agriculture. It introduced discriminatory pricing and marketing policies. Also, it entailed the transfer of management autonomy of small and large production units to government parastatals.

Private peasant farms were the hardest hit by collectivization. The effect was directly reflected in agricultural GDP. During this period, private peasant farms accounted for over 90 per cent of the cultivated land and agricultural production. Agricultural collectivization was aided by various government-sponsored projects in overlapping phases. They were on their own major sources of confusion among rural farmers. For example, resettlement programmmes were implemented between 1976 and the late 1980s. Initially, they had the objective of raising productivity by using unutilized surplus land. But later, between 1981 and the late

1980s, the programme was abused by a government effort to create buffer zones to achieve certain political ends. Villagization programmes were in operation between 1977 and the late 1980s (Alemayehu, 1990). In addition, six annual development campaigns were in operation between 1978 and 1984 to instill socialist production relations among farmers (Dejene, 1990).

A major reason for the decline in the performance of the non-agricultural sectors compared to their levels between 1963 and 1973 could be changes in the structure of ownership and management of public enterprises. All manufacturing and leading service-rendering enterprises were nationalized without compensation in 1975. Capital ceilings were imposed to discourage the expansion of small-and medium-scale privately owned enterprises. In addition, ownership and management of large-scale operations were taken over by the ministries concerned. General managers used to operate only in accordance with guidelines prepared for them by the ministry.

3.3.1.3 Comparative performance since 1992

Markets have been the guiding forces in resource allocation since 1992. A relatively encouraging result in the overall performance of the Ethiopian economy has been registered. Unlike the period between 1974 and 1991, GDP growth during this period was higher than population growth. Production per capita therefore increased on average by more than 1.9 per cent per annum. However, in terms of self-sufficiency in food, measured by growth of agriculture relative to population, per capita production fell by over 1 per cent per annum.

The 4.8 per cent growth in GDP was made up of a record high growth of 2, 7 and 8 per cent in agriculture, manufacturing and services, respectively (Table 4.1). Like the period between 1974 and 1991, in this period too, much of the growth in GDP came from the non-agricultural sector. Many of the constraints that were thought to have impeded production between 1974 and 1991 were lifted with the exception of land, which continued to be state owned. In addition, the period enjoyed relatively favourable weather.

Measures taken in this period to correct past mistakes in policy-making could be broadly divided in to three. They were implemented in three phases. First, price and trade policies were liberalized and the exchange rate was devalued in 1992. Second, short, medium and long term strategies were drawn to change farming structures in agriculture in 1993. Third, development strategy of the country was changed from an industry-led to an Agriculture-led strategy in 1994. In addition, attempts were made in 1992/1993 to improve the efficiency of manufacturing enterprises to allow them to prove their viability before decisions to privatize them was made in 1995.

The following paragraphs analyze each year's growth figures and try to give a brief account of factors responsible for overall and sectoral GDP growths. Data are reported in Table 3.5.

Table 3.5: Comparison of sectoral growth rates (1992-1998)

Year	Agricultural GDP	Manufacturing GDP	Services GDP	Overall GDP
1992	6.06	36.07	17.40	12.0
1993	-3.65	8.86	8.10	1.70
1994	3.39	8.95	7.23	5.38
1995	14.68	7.58	6.96	10.62
1996	3.44	5.88	7.07	5.17
1997	-10.29	5.80	10.36	-0.54
1998	4.21	4.94	8.18	6.30

Source of original data: Ministry of Economic Development and Cooperation

GDP grew by 12 per cent in 1992. This was made up of 6, 36 and 17 per cent growths in agriculture, manufacturing and services, respectively (Table 3.5). The 36 per cent growth in manufacturing in 1992 was the largest. However, comparison of its actual production figure with similar levels of previous years revealed that the rate reflected nothing more than recovery to its previous peak. This may be viewed from two fronts—economic and political. On the economic front, the recovery could be attributed to the *Investment Code Reform No 15/1992*, which removed limits on the size of private enterprises and coordinated investment activities in state-owned industries. Prior to 1992, many state-owned manufacturing enterprises were bankrupt and a significant number of them operated at less than half their capacity due to lack of raw materials. Other equally important happenings, which might have contributed positively to the matter, were the enactment of *Public Enterprise Reform,* to strengthen the efficiency of the state-owned enterprises and the introduction of *Stabilization and Adjustment programmes.* On the political front, the year could be labelled a calm year—for the first time in 30 years there was political stability.

The 6 per cent growth in agriculture in 1992 could be the outcome of a host of changes in agricultural policies. For example, agricultural prices were decontrolled, the parastatal monopoly on marketing and distribution of food grains was abolished, restriction on wage labour in rural areas and on interregional migration was lifted, forced labour and resettlement programmes were abolished and collectivization was ended.

A sharp decline in GDP growth to 1.7 per cent was registered in 1993 (Table 3.5). Manufacturing and service sectors registered positive growth rates, but agriculture fell by 3.6 per cent. Neither sector-specific nor economy-wide policies are to blame for the negative growth in agriculture in this year other than the drought. Unlike past experiences, this year's drought spread to the southern part of the country. However, its effect was managed relatively well compared to the 1983/84 famine.

A GDP growth of 5.4 per cent, a rate better than the average 4.8 per cent growth was achieved in 1994 (Table 3.5). Like the two preceding years (i.e. 1993 and 1992), higher GDP could be explained by good performance in the non-agricultural sectors. Manufacturing and service sectors grew by 9 and 7 per cent respectively. Here too, caution is needed in interpretation. Comparison with the 1992 and 1987 peaks for agriculture and manufacturing revealed that these sectors were in their recovery stages. Therefore, the 5.4 per cent growth in 1994 could be ascribed to sustained growth in the service sector.

Among the major policy changes introduced in the year 1994, which might have helped improvement in the agricultural sector, were the establishment of *The National Fertilizer Industry Agency* by Proclamation No. 106 of 1994, the introduction of inputs and credit packages, and the launching of a new extension programme on a pilot basis. The last two were part of a new development initiative called Agricultural Development Led Industrialization Strategy (ADLI). The initiative replaced the Agriculture-led development strategy, which had been in operation ever since formal development planning was started in Ethiopia in 1957.

The year 1995 witnessed a 10.6 per cent growth in GDP (Table 3.5). Agriculture grew by 14.7 per cent, manufacturing by 7.6 per cent and services by 7 per cent (Table 3.4). Growth in GDP in this year was real because all time high actual production increases were registered across the board. Good performance in the agricultural sector was the result of favourable weather and positive interventions from governmental and non-governmental sides. The number of farmers involved in the new input package and extension programmes was increased, legislation that facilitated farmers' access to improved credit was enacted, a public expenditure review favouring agriculture was made and a medium-term adjustment programme was initiated.

Favourable weather and the spread of the extension package programme could be responsible for the good agricultural performance in 1996. The formulation of a new comprehensive medium-term adjustment programme for the period 1996/97 to 1998/99 with support obtained from IMF through its Enhanced Structural Adjustment Facility programme, from the World Bank, and other donors also played a role by pumping funds into the agricultural sector. In this period, overall GDP grew by 5 per cent while the agriculture, manufacturing, and services sectors registered 3.4, 5.9, and 10.4 percentile growth rates respectively. Agricultural GDP attained its new peak in this year.

In 1997, agricultural production fell by 10.3 per cent, but the manufacturing and services sectors registered positive growth rates (Table 3.5). Growth in overall GDP was negative. The decline in agriculture was so high that its negative impact on GDP could not be compensated for by positive growth in the manufacturing and services sectors. The year 1997 is characterized as an *El-Nino* year. The following policy measures were taken in the fiscal year 1997, namely elimination of fertilizer subsidies, major expansion in extension programmes, provision of permits to private traders to engage in fertilizer trade, and issuing of rural land administration proclamation number 89/1997 and 7/97.

3.3.2 The Contribution of Agriculture to Growth in non-agricultural sectors at different Stages of Economic Reform

This section is devoted to the discussion of the contribution of agriculture to growth in other sectors of the economy. The section is composed of three sub-sections. The first section discusses results on the prevalence of significant structural breaks in the variables used in the analysis. The second section discusses on results on the data generating process of the variables. Finally, section three discusses results on Granger causality i.e. between the agricultural and the non-agricultural sectors of the economy.

3.3.2.1 Results on Structural Breaks

In section 3.2.2.1, a testing procedure was introduced in cases where breaks were not known a priori. Results, based on this testing procedure, are reported in Figure 3.1 below. Figure 3.1 depicts test results for the null hypothesis that there is no break against the alternate hypothesis that there is break in the series. Furthermore, the procedure identifies date of structural break in the series.

According to the results obtained, the no-break null for agricultural GDP was rejected at the 5 per cent level of significance in 1985. This corresponds to drought and famine, which, in terms of damage caused, was the largest. It was severe and extensive, and its effect in terms of loss of life was great compared with all other drought years that the country has witnessed in its recent history. According to Pickett (1991), the drought and the famine were similar to the great famine, which occurred at the turn of the century.

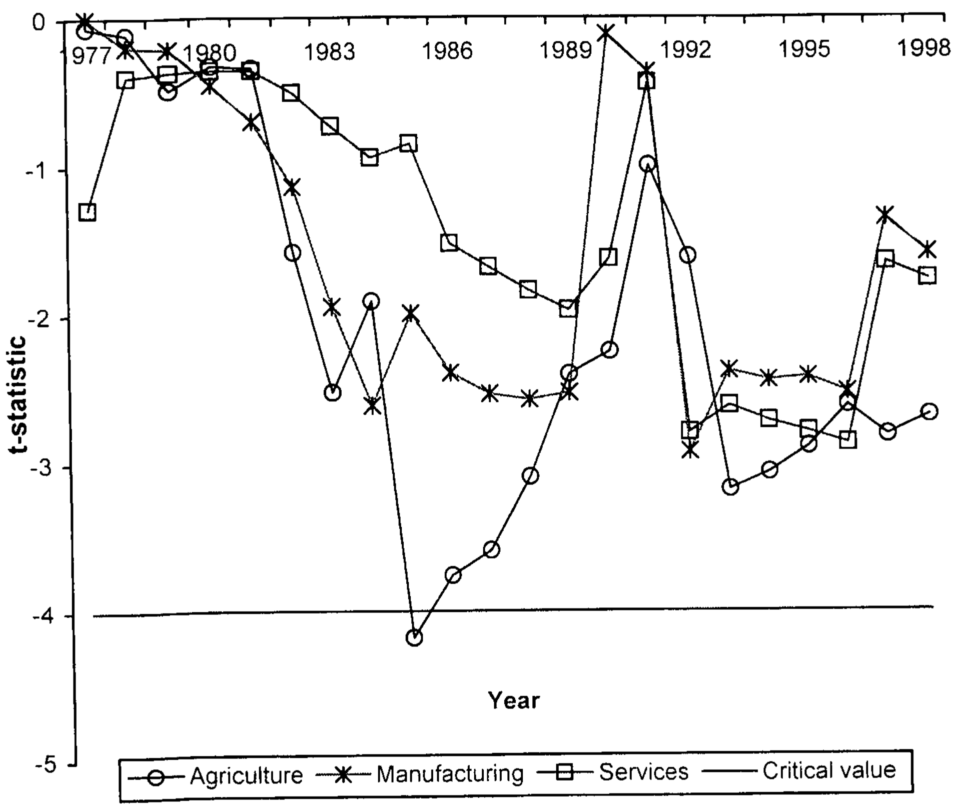


Figure 3.1: Recursive analysis using the Dickey-Fuller regression to test the presence of a structural break

Figure 3.1 also shows that the highest t-statistic for the manufacturing GDP is below the critical line. This means that there is no break in this series. This highest t-statistic occurred in 1992. This may be attributed to various factors. The following aspects are prominent: the sector started to enjoy management autonomy as a result of the country's adopting a market economic system; limits on the size of the private enterprises were removed by the investment code reform No 15/1992; and a public enterprise proclamation was enacted. The public enterprise proclamation attempted to strengthen the efficiency of the state-owned enterprises in recognition of the fact that privatization would be a lengthy process and that some state-owned enterprises would continue to function under government control.

No break could be detected in the services GDP. The highest t-statistic in this variable occurred in 1996. The following were some of the major effects of shifts in policies which could have precipitated these events: an attempt was made to liberalize the financial sector; sector policy reform for the transport sector was introduced; and a review of public expenditure and privatization of state-owned retail stores and hotels was made. Banking and insurance were opened to domestic private investors in 1995. Currently, there are about eight commercial banks and nine insurance companies. The Ethiopian privatization agency, which was created by proclamation No 2/1994, started its first phase of privatization in June 1996 (TGE, 1994). In this year, 101 retail shops and 13 hotels and restaurants were privatized from the services sector alone. A transport sector memorandum, which articulated reform in the transport sector, was introduced by proclamation No 12/1996 (FDRE, 1996). This served as a platform for the launching of a Five-year Road Sector Development Programme in September 1997.

3.3.2.2 Results on the Data-generating Process

As said in section 3.3.2, testing the presence of a break(s) in a variable is crucial before a choice of the type of unit root testing procedure (conventional ADF or Perron ADF) is made. It is believed that this minimizes the risk of incorrectly characterizing a time series variable as a difference stationary process while the true data-generating process is a trend stationary process and vice versa.

As shown in section 3.2.2.1, agricultural GDP exhibits a break in its series. Hence, a test for unit root was conducted using Perron's (1989) adjusted Augmented Dickey-Fuller procedure (equation 3.1). On the contrary, no breaks could be detected in the manufacturing GDP and services GDP; thus, a test for unit roots in these series were conducted using conventional Augmented Dickey-Fuller procedures (equation 3.2). Results on unit root tests are reported in Table 3.6 below.

Table 3.6: Unit-Root Test Results for Agricultural, Manufacturing and Services Gross Domestic Products

Coefficients	Sectors		
	Agriculture*	Manufacturing	Service
μ	8.796 (1.706)	1.1900 (0.381)	0.987 (0.373)
β	0.007 (0.010)	0.10 (0.004)	0.11 (0.005)
θ	-1.166 (0.377)	---	---
γ	0.048 (0.015)	---	---
dD	-0.013 (0.096)	---	---
α	-1.094 (0.395)	0.671 (0.110)	0.702 (0.117)
c	0.795 (0.216)	0.298 (0.162)	0.279 (0.161)
Ř-Bar Sq.	0.827	0.93	0.98
F-statistic	F(8, 23) 19533	F(3,30) 152	F(3,30) 912
DW-statistic	1.96	1.95	1.86

* After second order serial correlation in residuals is corrected using Cochrane-Orcutt Method. Numbers in brackets are standard errors.

According to results obtained, the unit root null for agricultural GDP was rejected at the 1 per cent level of significance using test statistic developed by Perron (1989). This means that agricultural GDP is a trend stationary process; thus, agricultural GDP was represented in equation 3.3 as a trend stationary process. Unit root test results, based on conventional ADF test procedure, revealed that manufacturing GDP and services GDP are difference stationary processes (columns 2 and 3). Furthermore, a test on the order of integration of these variables indicated that they were integrated or order 1 or I (1). This suggests that they appear in equation 3 in their first differences.

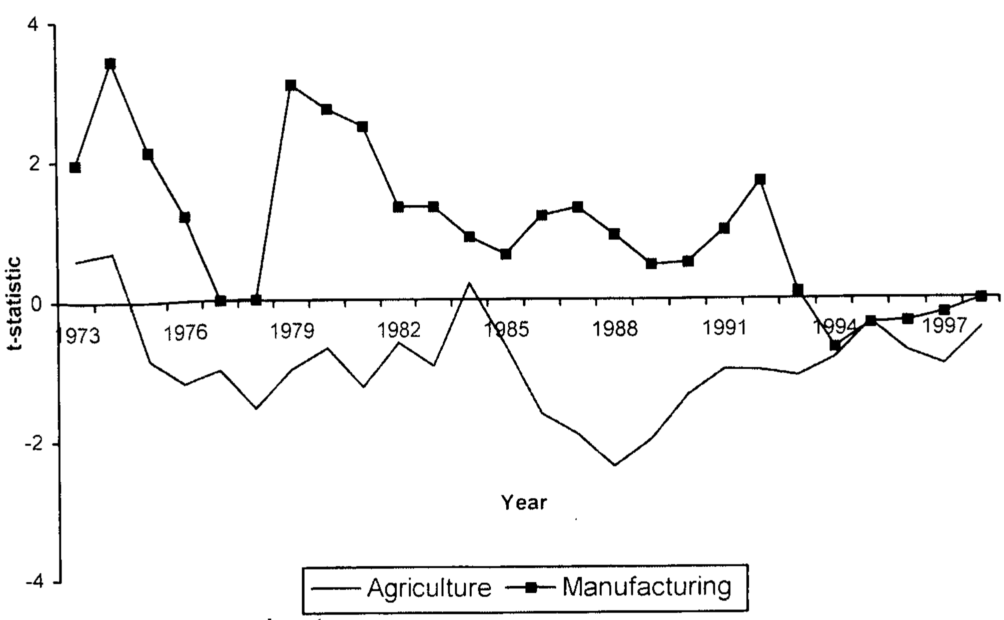
3.3.2.3 Results on Granger Causality

In this section, results obtained by applying the vector autoregressive (VAR) model are presented (see Figure 3.2 and 3.3). Two VAR models were run. Firstly, to investigate causality between the agricultural sector and the manufacturing sector. Secondly, to investigate causality between the agricultural sector and the services sector. Lag lengths of the two VAR equations were determined by applying the Akaike information and the Schwartz Bayesian criteria. A rolling regression with a window size of 9 years was applied in the two VAR models to capture variability in causality over time. Causality was determined between the variables for the time period 1963-1971, then from 1964-1972, and to the end of the period.

3.3.2.3.1 Granger causality: agriculture to manufacturing and vice versa

The contribution of agriculture to growth in the manufacturing sector was insignificant throughout. On the contrary, the contribution of growth in the manufacturing sector to growth in agriculture was significant before 1975 (Figure 3.2). Reasons for these findings are given in the following paragraphs. Rather than considering the coefficients of these variables as zero and thus unimportant, attempts are made next to interpret the slopes of the t-statistics of agriculture and manufacturing (Figure 3.2). As can be seen from Figure 3.2 below, the slopes of the t-statistics of agriculture and manufacturing changed signs corresponding to changes in the economic systems and agricultural policies of the country.

According to figure 3.2, the time-varying t-statistic of growth in agricultural GDP in the equation, where manufacturing GDP is a dependent variable, were positively



sloped before 1975. The same was true with t-statistic of growth in manufacturing GDP in the equation where agricultural GDP is a dependent variable. These could be attributed to the following. The period prior to 1975 is known in the economic history of the country as a period during which markets were major actors in resource allocation. Some positive interventions in the form of comprehensive package projects were introduced in the late 1960s in a few promising highland areas of the country with the assistance obtained from a few donors to introduce modern production techniques in agriculture. The project was discontinued in the mid 1970s as a result of donors' dissatisfaction with the overall political system of the country.

Growth in the manufacturing sector and also its positive contribution to growth in the agricultural sector, prior to the 1974 revolution, could be attributed to the development strategy of the country, which focused on import substitution. Various proclamations were introduced to achieve this objective. These included Legal Notice number 10 of 1950 to encourage foreign capital investment in the country, decree number 51 of 1953 to provide for the encouragement of capital investment in the country and proclamation number 242 of 1966 to assist in expanding agricultural and industrial activities (EEA, 2000).

The slopes of the time varying t-statistics of agricultural GDP and manufacturing GDP became negative after 1975 (Figure 3.2). This occurred following the announcement of socialism as the political and economic system of the country in 1974. In the agricultural sector, turning land ownership exclusively into the hands of the government assisted in unifying the age-old north-south disparity in land holding rights. The reform made land the property of the government and disallowed all types of transactions on land. Grain production increased in the aftermath of the reform but this could not be sustained for "the *government was preoccupied with the political and military struggle which followed the 1974 revolution*" (Dejene, 1990). In the manufacturing sector, all medium and large-scale manufacturing enterprises were nationalized in 1975.

The slope of the time varying t-statistic of agricultural GDP was close to zero between 1978 and 1985, became negative between 1985 and 1989 and has been positive since 1989 (Figure 3.2). The zero-slope between 1978 and 1985 implies that agriculture had little impact on the growth of the manufacturing sector. This maybe attributed to various events: the establishment of producer cooperatives; the introduction of fixed output and input pricing systems; and the imposition of physical barriers on the free trade of agricultural outputs.

The slope of the t-statistic of agricultural GDP was negative between 1985 and 1989. This could be the result of the 1984/85 drought and famine. The drought had direct consequences for the asset base of farmers in the drought-hit areas. Many farmers residing in these areas were reported to have attempted to absorb the risk by selling or slaughtering their oxen, a major productive asset (Webb, *et al.*, 1992).

The slope of the t-statistic of agricultural GDP has been positive since 1989. This could be the outcome of a number of factors. Firstly, the prices of some of the agricultural products were revised in 1987 due to pressure from the World Bank and the African Development Bank. Secondly, the command-based economic system of the country was replaced by market-based economic system.

The following changes were introduced in input and product pricing and marketing: output price liberalization, AMC was restructured, control on grain movement was removed and political favouritism in terms of easy access to input for government-owned production units was removed. The following changes were introduced in the structure of production in the agricultural sector: forceful membership requirements to join producer cooperatives were banned and some state farms were sold. The other important change that was introduced during this time was the change in the overall development strategy of the country from an Industry-led to an Agriculture-led development strategy in 1994.

Figure 3.2 further shows that the slope of the t-statistic for manufacturing GDP was negative between 1980 and 1994 and the slope has maintained a positive sign since 1995. The time between 1980 and 1994 can be divided into two periods. Firstly, there is the period between 1980 and 1992, when all medium and large scale manufacturing enterprises were owned and managed by the government, with little management autonomy whatsoever exercised by individual enterprises in the production and marketing of their output. Secondly, there is the period between 1992 and 1994 when these enterprises were granted management autonomy, following the change in the economic system of the country from a command-based to a market-based economic system in 1992.

Attempts were made by the government in 1992/1993 to improve the efficiency of manufacturing enterprises to allow them to prove their viability before decisions to privatize them were made in 1995. Inefficiencies in these enterprises used to be attributed to their operating below full capacity for lack of inputs. This also assisted the government in buying time to make decisions with regard to the list of manufacturing enterprises that would continue to remain under its control. The positive slope of the t-statistic for manufacturing GDP after 1995, on the other hand, implies that the contribution of the manufacturing sector to growth in the agricultural sector has started to gain momentum. This may be attributed to the cumulative effect of positive changes in policies, which allowed the greater participation of the private sector in the manufacturing business.

3.3.2.3.2 Granger causality: agriculture to services and vice versa

The contribution of agriculture to growth in the services sector was significant before 1976. But the contribution of the services sector to growth in agriculture was insignificant throughout. Reasons for this situation are given in the paragraphs below.

According to Figure 3.3, the time-varying t-statistic of growth in agricultural GDP in the equation where services GDP is a dependent variable is positively sloped before 1975. The same was true with the slope of the t-statistic of services GDP in the equation where agricultural GDP is a dependent variable. As stated earlier, the period before 1975 is known as a time when markets were major actors in resource allocation. The types of positive interventions made to develop agriculture during this time were discussed elsewhere in the same chapter. Like growth in the manufacturing sector, growth in the services sector may be attributed to the government drive to attract foreign direct investment into the country. The proclamations and declarations, which came out during this time, were discussed in section 3.3.2.3.1.

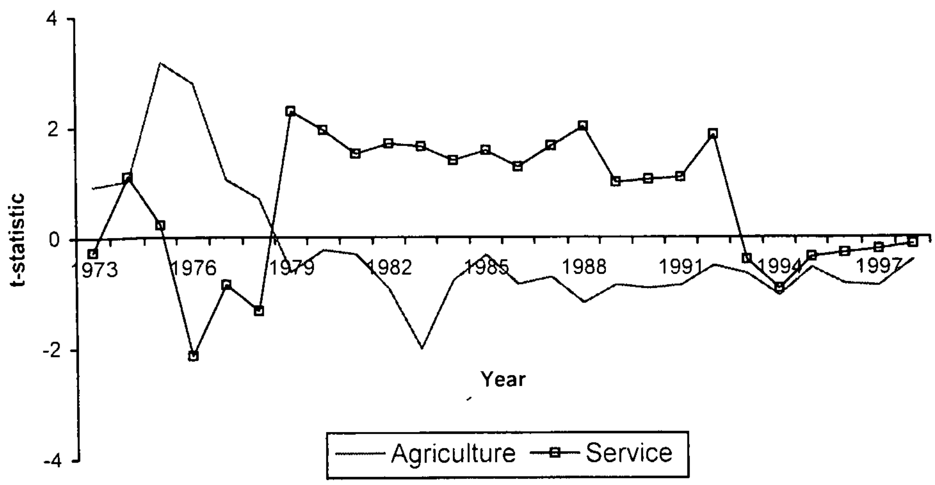


Fig 3.3: Time-varying t-statistics of Agriculture and Services

As can be further seen in Figure 3.3, the slope of the t-statistic for agricultural GDP was negative between 1975 and 1978. This implies that the contribution of agriculture to growth in the services sector was decreasing between 1975 and 1978. This may be attributed to the nationalization of major services rendering organizations after socialism was declared the political and economic system of the country in 1974.

Figure 3.3 also shows that the slopes of the t-statistics of agricultural GDP and services GDP have been near zero between 1978 and 1993. This indicates that the contribution of agriculture to growth in the services sector, and vice versa, was negligible. A look at the components of services GDP reveals that growth in the services GDP between 1978 and 1992 was the outcome of expansion in the public sector. This was, in turn, attributed to government control over economic activity following the nationalization of major economic sectors. In short, expansion in the services sector had little to do with expansion in economic activity because much of the growth in the services sector was not the result of expansion of education, health, trade, and transportation and communication services. It was rather caused by the expansion in administration and defense expenditures. Expansion in education and health services is believed to improve the stock of capital, while expansion in trade, transport and communication services represents the continued widening of markets.

3.4 SUMMARY AND CONCLUSION

In this section, summary and conclusions are given. It is divided into two sub-sections. The first section summarizes findings and gives conclusions based on findings obtained with regard to the comparative performance of agriculture as compared with other sectors of the economy. The second section summarizes the contribution of agriculture to growth in the manufacturing and service sectors.

3.4.1 Comparative Performance

The performance of agriculture can be measured by means of different indices. These include the contribution of the sector to overall GDP growth, its ability to feed the growing population, its capacity to stand the whims of nature, and its role in the economy in terms of stimulating growth in other sectors of the economy. In this section, performance was measured using the first two indices.

It was found that much of the growth in overall GDP during the three periods was the result of growth in the manufacturing and the service sectors. The contribution of agriculture was relatively low. These can be ascribed to natural as well as policy distortions.

Sectoral shares of the three sectors were also computed and used as one measure of the performance of agriculture relative to the manufacturing and services sectors. It was found that the shares of agriculture from GDP and the labour force presently stand at 50 and 85 per cent, respectively. What does this imply in the light of the more than 30-year-old government objective of structural transformation? If Timmer's (1990) method of characterizing stages of agricultural transformation is applied, one could say that the country is still stumbling in the first stage of economic development. Therefore, Johnston and Mellor's (1961) stage of economic development—structural transformation—is not yet attained.

It was also found that there was a trend decline in the share of agriculture from GDP and that this was offset by an upward trend in that of services but not of manufacturing (Table 3.1 and Figure 3.1). Is this a welcome development? According to Kuznet's (1966) observation on the historical growth of the now developed nations, downward trends in agriculture were offset by upward trends in manufacturing. Growth in services is a welcome development provided that it emanates from expansion of education, health, trade, transport and communication services. It is believed that expansion of education and health facilities improves the stock of capital while expansion of trade, transport and communication services represents the continued widening of markets (Pickett, 1991). Hence, further scrutiny on the composition of and actual changes in each component of services was needed to see whether the downward trend in agriculture and the upward trend in services are normal patterns of economic growth.

Closer examination of the components of service GDP reveals that public administration and defense together were behind the upward trend in service GDP between 1973 and 1997(Appendix A). Their contribution to GDP was 3.8 per cent in 1960, 5.3 per cent in 1970, 8.6 per cent in 1980, 10 per cent in 1990 and 10 per cent in 1996 (Appendix A). On the other hand, the contribution of education and health to GDP were maintained at 2.1 and 1.1 per cent in the 1980s and mid-1990s (Appendix A). There was no significant change in the share of transport and communication to GDP, which stood at 3.4 per cent in 1960, 5.7 per cent in 1970 and 6 per cent in 1990 (Appendix A). Therefore, the upward trend in services to offset the downward trend in agriculture should not be perceived as normal patterns of sectoral changes associated with economic growth.

Performance of the sector during the three periods under study was also studied by computing measures of food security, which was found to be negative in the three periods. Results indicated that the country was never self-sufficient in food production during the period under study. Lack of self-subsistence in food production has had severe repercussions on the major components of national income accounts. This is true of a country such as Ethiopia where close to 75 per cent of consumers' income is spent on food. Major components of the national income account that are directly affected by this are the trade balance (export-import), gross private consumption and domestic resource gap (saving-investment). The failure of agriculture to grow at a pace higher than population also results in the introduction of measures such as price controls, overvalued exchange rate, ceilings on wages, etc. in an attempt to control the pressure that food shortage exerts on the general price level.

The capacity of agriculture to withstand the effect of natural calamities on its performance has been limited and neither has the consequence of drought been confined to agriculture alone. It has spilled over and affected the performance of other sectors of the economy as well. Much of the fluctuations in GDP correspond to good or bad agricultural performances, which in turn correspond to good or bad weather years. Major bad weather years were experienced in 1973/74, 1983/84, 1993/94, and 1997/98 causing 1.2, 17, 4 and 10 per cent decline in agriculture respectively. On the other hand, major good weather years, which occurred in 1982, 1986, 1992 and 1995 respectively, caused 13, 19, 6 and 15 per cent growths in agriculture.

3.4.2 The Contribution of Agriculture to Growth in other Sectors of the Economy

Causal relationships between agriculture and non-agricultural sectors were investigated in an attempt to gauge the contribution of growth in agriculture to growth in other sectors of the Ethiopian economy over time. According to results obtained, the coefficients for agricultural GDP were found to be insignificant for all years between 1975 and 1998. This means that agriculture was a passive sector during these years, a finding that was confirmed at the 5 per cent level of significance. The contribution of agriculture to growth in the services sector was significant before 1975, while its contribution to growth in manufacturing was positive and increasing, albeit insignificant. In addition, the contributions of growth in the manufacturing and service sectors to growth in agriculture were positive and increasing before 1975, reflecting the beginning of integration of agriculture into the economy.

In addition, attempts were made to study the slopes of the t-statistics in order to see to what extent they changed signs following changes in economic systems and policies, which were introduced between 1963 and 1998. The t-statistics of agriculture had a positive slope prior to the introduction of a socialist economic system in 1974 in both the manufacturing and service equations. In both the manufacturing and service equations, the slope changed sign to negative between 1975 and 1978. It became close to zero between 1979 and 1995 in the manufacturing equation and between 1979 and 1998 in the equation for services. It is also found from the manufacturing equation that it has taken until 1989 for agriculture to recover from the drought in 1985. The non-significance of the t-statistics of agricultural GDP between 1990 and 1998, given positive policy changes in 1990 and 1992, could be attributed to structural constraints. Structural constraints, which influenced agriculture before 1992, continued to have negative effects on agriculture in the 1990s even after some of the major policy constraints were removed.

These findings imply that the contribution of agriculture to growth in the other sectors of the economy has been dependent on the type of economic systems followed and non-policy constraints faced at various levels of economic reform. Therefore, with the consideration that agriculture responded adversely to growth in other sectors when faced with policy and structural constraints during the socialist era; and that its contribution to growth in the manufacturing sector showed a sign of revival, following the creation of healthier policy environments between 1989 and 1990, the following can be concluded: The freer agriculture is from policy constraints, the higher its contribution becomes to growth in the manufacturing and services sectors.

For agriculture to make an even larger contribution to growth in the other sectors of the economy, the following policy measures need to be addressed. The existing land tenure system must be reformed to allow land to be legally exchanged at scarcity value and to ensure its utilization in its best uses. In addition, infrastructural developments are needed to ensure farmers' access to markets, credit and government support systems. Land has been in state hands since 1975 meaning that farmers are granted only usufruct right. According to different researchers, this has become a reason for a decrease in holding size, tenure insecurity, and population pressure in rural areas. Continuous land redistribution has presently caused over 63 percent of the farm households to rely for their livelihood on less than one hectare of land (CSA, 1996). Studies show that decrease in holding size and increase in the demand for land for cultivation by newly formed households has limited the application of modern agricultural technologies in production and resulted in the extension of cultivation to areas previously designated as permanent pasture and forests (Alemu, 2002). Tenure insecurity is attributed to the fear that another round of official land redistribution would make farmers end up with smaller plots of land. This is believed to have resulted in poor land management practices, deforestation and weaker investment in long-term soil conservation practices (Sutcliffe, 1995; Teferi, 1995). Over 80 per cent of the country's labor force is currently tied up in the agricultural sector. This is attributed partly to the existing land policy which has limited free movement of labor from rural to urban areas by denying access to land to households which are sustainably absent from rural areas (Dessalegne, 1999).

Presently, government focuses more on introducing new production technology in agriculture through a new agricultural extension program. Considering that production is predominantly at subsistent level, efforts underway are too little to make production market oriented, which is the only way that the rest of the economy can benefit from agricultural growth. This needs to be tackled by making market improvements an integral part of the development planning process.

CHAPTER 4

THE RESPONSIVENESS OF AGGREGATE AGRICULTURE TO MAJOR POLICY AND NON-POLICY RELATED EVENTS

4.1 INTRODUCTION

Findings from chapter three revealed that agriculture would continue to dominate economic activity for a long time to come. This is because it is unlikely that its contribution to GDP (over 50 percent), employment creation (over 85 percent) and foreign exchange (over 90 percent) would come down in the foreseeable future. Furthermore, it was learnt that events as big as major policy paradigm shifts and natural and manmade factors have occurred at certain time intervals and intensity levels for the past five decades. These events are believed to have contributed directly or indirectly to the present status of Ethiopian agriculture. In this chapter, the responsiveness of aggregate agriculture to these events (hereafter referred to collectively as "structural breaks") is examined.

Events that are policy and non-policy related are referred to in this chapter as major policy-regime changes and natural events respectively. Both have repercussions on the economic activity in general and on agricultural productivity in particular. Wars, both internal and external, have been major deterrents to agricultural productivity. They consumed the country's meager resources and reduced the quality and quantity of the labour force in rural areas. However, the effects of wars are not considered in this study for the mere reason that various types of wars have been fought in the country for many years. Attempts to incorporate their effects would make the analysis difficult since dates on which these events occurred are not easily discernable.

Information on policy and non-policy related structural breaks were obtained in chapter three. The years 1974 and 1992, which correspond to the occurrence of major policy regime changes, were taken from chapter two where agricultural policies of Ethiopia were reviewed. These dates were used to divide the data set into three time periods in order to gauge the impact of policy regime changes on the responsiveness of aggregate agriculture.

The first (i.e. 1960 to 1974) corresponds to the period when markets served as major actors of resource allocation. The second (i.e. 1975 to 1992) corresponds to the period when markets ceased playing a central role in resource allocation as a result of the introduction of a command economic system. And the third (i.e. since 1992) corresponds to the period when the role of markets as governors of resource allocation has been restored. Within each period, a number of policies, which impacted on agriculture in particular and economic performance in general, were implemented. These were discussed in greater detail in chapter three.

According to chapter three, much of the fluctuation in agricultural GDP corresponds to fluctuations in rainfall. Fluctuations in rainfall from its average are increasing (Webb *et al.,* 1992). Furthermore, "*a 10 percent decline in rainfall below the long-term average results in a 4.4 percent fall in national production*" (Webb *et al.*, 1992). These are indications that drought will continue to have greater impact on national production. Bad weather years were recorded in 1973/74, 1983/84, 1993/94, and 1997/98, which respectively resulted in 1.2, 17, 4 and 10 percent decline in agricultural GDP. And relatively better weather years were recorded in 1982, 1986, 1992 and 1995. These respectively resulted in 13, 19, 6 and 15 percent growth in agricultural GDP. Considering the difficulty involved with regard to quantifying and thus incorporating all drought years in the model, only the 1983/84 drought will be used as representative to all drought years. This is inline with test results on the significance of structural breaks that was found in chapter three (see figure 3.1). The 1983-1985 drought together with the 1974 and 1992 major shifts in policy regimes increased the number of breaks into three and the number of periods into four.

In addition to measuring the responsiveness of aggregate agriculture to structural breaks (i.e. objective one), the following will be the two additional objectives that will be addressed in this chapter. Firstly, the degree of persistence of the effect of structural breaks on the performance of aggregate agriculture (i.e. objective two). Secondly, the contribution of structural breaks to the occurrence of cyclical fluctuation in agricultural GDP (i.e. objective three).

4.2. METHODOLOGY

This section is divided into three sub-sections. The first sub-section discusses the regression analysis procedure that will be employed to measure the responsiveness of aggregate agriculture to the structural breaks. The second sub-section outlines methods that will be adopted to determine the data generating process to which aggregate agriculture belongs i.e. whether it is made up of trend or difference stationary processes. And the third sub-section introduces a univariate time series procedure that will be employed to extract cycles from agricultural GDP. Results on the first, second and third subsections of this section on methods are reported in section 4.3.1, 4.3.2, and 4.33 respectively.

4.2.1 Regression Analysis

The way changes in trends in agricultural GDP series are characterized following structural breaks will be studied first to decide how these breaks should be quantified. For this the method by Balke (1991), on the characterization of trends as segmented or shifting trends will be adopted. First, the agricultural GDP series will be divided into four regions based on the three major structural breaks. Next, the natures of the changes in the trend lines will be studied to characterize them as segmented or shifting trends. If a change in a trend possesses the characteristics of a shifting trend, the structural break in question will be quantified in the regression equation with an intercept dummy; otherwise, a composite dummies comprising slope and intercept dummies will be used.

The regression procedure chosen in this study is given by equations 4.2.1.1 to 4.2.1.4. These equations are split samples created on the basis of the break dates, namely, 1974, 1983 and 1992. The equations are used to test whether there is a significant difference between any consecutive intercepts (α) and/or slopes (β). If the null hypothesis on the equality of the slope and intercept coefficients of any two consecutive periods is rejected, there is a significant diversion in the trend of agricultural GDP. This may imply that the structural break in question introduced a significant diversion in the long-run trend of agricultural GDP and hence is significant. Equation 4.2.1.1 refers to the period before 1974, equation 4.2.1.2 to the period between 1974 and 1983, equation 5.2.1.3 to the period between 1983 and 1991, and finally equation 4.2.1.4 to the period since 1992.

$$y_1 = \alpha_1 + \beta_1 x_1 + u_1 \quad (4.2.1.1)$$
$$y_2 = \alpha_2 + \beta_2 x_2 + u_2 \quad (4.2.1.2)$$
$$y_3 = \alpha_3 + \beta_3 x_3 + u_3 \quad (4.2.1.3)$$
$$y_4 = \alpha_4 + \beta_4 x_4 + u_4 \quad (4.2.1.4)$$

Where the explanatory variables x_1, x_2, x_3 and x_4 together form X or the full sample time trend variable, the dependent variables y_1, y_2, y_3 and y_4 are split sample periods and together form Y or the full sample real agricultural GDP, α= intercept, β=slope and u = error term (See Maddala, 1992 pp. 312-314 for further explanations about this model).

Assuming that the error terms in the four periods have the same distribution, equations 4.2.1.1 to 4.2.1.4 were manipulated to yield equation 4.2.1.5.

$$y = \phi_0 + \phi_1 D_1 + \phi_2 D_2 + \phi_3 D_3 + \varphi_0 x + \varphi_1 D_{11} + \varphi_2 D_{22} + \varphi_3 D_{33} + u \quad (4.2.1.5)$$

Where, $\phi_0 = \alpha_1$, $\phi_1 = (\alpha_2 - \alpha_1)$, $\phi_2 = (\alpha_3 - \alpha_1)$, $\phi_3 = (\alpha_4 - \alpha_1)$, $\varphi_0 = \beta_1$, $\varphi_1 = (\beta_2 - \beta_1)$, $\varphi_2 = (\beta_3 - \beta_1)$, $\varphi_3 = (\beta_4 - \beta_1)$. D_i takes the value 1 for observations in period i+1, and zero otherwise. D_{ii} takes the value of t for period i+1 and zero otherwise. If ϕ_1=0 then α_2

= α_1. If φ_1= 0 then β_2 = β_1. These imply respectively that there are no differences between slope and intercept coefficients for the first and the second periods, nor that the 1974 break introduced a significant difference between growth rates of these periods. Note that equation 4.2.1.5 is limited to making comparisons of parameters of interest between the first and the second and also between the first and the third periods. This means that a supplementary regression model must be run to make comparisons between differences in growth rates between the second and the third period.

Regression results on the responsiveness of aggregate agriculture to structural breaks are reported in section 4.3.1.

4.2.2 The Data Generating Process

In this section, an attempt is made to describe the methods that are used in this chapter to measure the extent of the sustained impact of a break on agricultural GDP. This is similar to asking how long the introduction of a major change in policy will continue to affect agricultural activity in general. A widely applied method to measure whether agricultural GDP belongs to a trend stationary TSP (deterministic trend) or difference stationary DSP (stochastic trend) classes of non-stationary processes.

TSPs are processes where fluctuations arising from the occurrence of a break(s) are dominated by temporary deviations from the natural rate and have a tendency to dissipate in a short period of time. If, on the contrary, a time series is found to be a DSP, it cannot be called trend reverting since the effect of a shock persists for a long time (Beveridge and Nelson, 1981; Campbell and Mankiw, 1989).

Therefore, characterizing agricultural GDP either as a TSP or DSP process is an indirect way of gauging the persistence of a break(s) on a time series. This is conventionally done by conducting a unit root test such as those represented by equation 4.2.2.1. They are widely known as Augmented Dickey Fuller tests (ADF).

$$\Delta Y_t = \varphi_1 + \varphi_2 t + \alpha Y_{t-1} + \gamma_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (4.2.2.1)$$

Where, Δ stands for change, α = (1-p), p is a parameter estimate of a first-order or AR (1) process.

In this study, however, an approach different from conventional ADF will be employed to study the statistical property of agricultural GDP and hence to decide in which classes of stationary processes that agricultural GDP falls. This is because, it was shown by Perron (1989, 1990) that conventional ADF techniques have a greater likelihood of failing to reject the unit root null when in fact the true data generating process is a deterministic trend. However, the approach chosen in this study differs from Perron's (1989, 1990) procedure by the way the break was treated. In this study, the date of structural break was treated as an unknown a priori. This means that the test on the statistical property of the series will be conducted in two steps.

$$Y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + dD(T_B)_t + \alpha y_{t-1} + \sum_{i=1}^{K} c_t \Delta y_{t-i} + e_t \qquad (4.2.2.2)$$

Where μ = intercept term; T_B =time of break; D (TB) = 1 if $t=T_B+1$, 0 otherwise; $DU_t = 1$ if $t>T_B$, 0 otherwise; $DT_t = t$ if $t > T_B$ 0 otherwise.

In step one, a recursive analysis using the Dickey-Fuller regression (equation 4.2.2.1), as applied by Balke and Fomby on US data, will be employed to identify breaks (obtained from Balke, 1991). This is an important step to rescues the approach from critics commonly pointed at Perron's method. Perron's method was criticized on the basis of the argument that he picked the date of the break before analysis (Maddala, 1992). After the presence of structural break(s) in the series is confirmed in step one, test for unit root null against its deterministic trend alternative will be conducted using equation 4.2.2.2.

Results on the persistence of the effects of structural breaks on aggregate agriculture are reported in section 4.3.2.

4.2.3 Univariate time Series Procedure

In this section, how a univariate time series procedure will be used to extract cycles from aggregate agriculture will be explained. Unavoidably, studies on cycles begin their analysis by studying the nature of the trend component. This helps avoid the trend component from overwhelming the cycle component. Therefore, knowledge about the true nature of the trend component is the starting point in the study of cycles (Gottman, 1981).

Trend can be characterized as deterministic or stochastic. This characterization was a result of extensive research in the field in the 1970s and early 1980s. Chan, Hayya and Ord (1977), Beverage and Nelson (1981) and Nelson and Plosser (1982) are among the widely quoted works in this regard. They introduced the concept of a stochastic trend in econometric literature. Prior to these articles, a trend was assumed to be deterministic polynomial function of time (Beverage and Nelson, 1981).

An economic time series variable is said to contain a deterministic trend if it increases by some fixed rate throughout. On the contrary, the rate of increase or decrease in a stochastic trend is not fixed. It has a tendency to vary from average by random amounts (Nelson and Plosser, 1982; Stock and Watson, 1988; Balke, 1991). If a trend is a polynomial function of time, least squares is an appropriate technique to detrend it. If it is stochastic, differencing is the appropriate technique. Therefore, a study on cycles must always be preceded by a separate study to decide on the appropriate filter.

The use of a wrong filtering technique has a far-reaching consequence in the study of cycles. Chan, *et al.* (1977) showed that if least squares is used to eliminate trend when in fact the true process is random walk, we get large spurious positive autocorrelation in the first few lags. On the other hand, if differencing is applied on a process, which is first-order polynomial, a spurious first lag negative autocorrelation is created in the residuals. A statistical testing technique was developed in the late 1970s by Dickey and Fuller to distinguish between stochastic and deterministic trends. It is called an Augmented Dickey Fuller (ADF) test (equation 4.2.2.1).

Studies on cycles begun to emerge in the 1940s. Burns and Michell were the pioneers (Quoted from Simkins, 1992). They applied qualitative methods which gave more emphasis to the identification of turning points (Simkins, 1992). Presently two distinct methods are widely quoted in econometrics literature in connection with cycles namely traditional and Nelson and Plosser methods. According to the traditional method, the cyclical component is a product of residuals from trend line.

Nelson and Plosser's (1981) method has been popular since 1980s. This coincided with the development of econometrics of non-stationary time series by Dickey and Fuller (1981). Therefore, unlike those in the traditional school who applied least squares detrending straight, they believe in the a priori investigation of the structure of a time series variable under consideration. Nelson and Plosser believe that least squares detrending are appropriate only in cases where the data generating process is made up of deterministic trend. According to them, if the data generating process exhibits a stochastic trend then the series must be differenced until it is made stationary before an autoregressive integrated moving average (ARMA) model is fitted from which the cyclical component can readily be extracted.

A method similar to the one described in section 4.2.2 that will characterize trends as deterministic or stochastic will precede efforts that aims to extract cycles from a series. Like trends, cycles will be classified either as deterministic or probabilistic. This will be done by studying oscillations in the correlogram of residuals, which will be obtained using equation 4.2.2.2 after decision on the appropriate filter is made.

Deterministic cycles are sinusoids having precise regular cyclicities. They have a fixed frequency, phase and amplitude. On the contrary, nondeterministic cycles wander around a particular frequency, phase, and amplitude. This will be determined by a statistical technique, which takes into account the correlogram of residuals. Deterministic cycles are said to have a correlogram, which is cyclic whose oscillations do not damp to zero rapidly. On the contrary, non-deterministic cycles are characterized by whose oscillation damp down to zero fairly quickly (Gottman, 1981).

Equation 4.2.3.1 is used continuously until all cycles are removed from the detrended agricultural GDP.

$$\varepsilon_t = A\sin\frac{2\Pi}{P}t + B\cos\frac{2\Pi}{P} + u_t \qquad (4.2.3.1)$$

Where P is period, ε is residuals, A and B sinusoidal parameters and u is error term. P is computed by writing a computer program using Mathlab. The program is given in table 4.1 below.

Table 4.1: A Computer Program to Calculate Periods of Cyclical Fluctuations

```
for year=1963:2000;
e=[]';
end
y=fft(e);
y(1)=[];
n=length(y);
power=abs(y(1:n/2)).^2;
nyquist=1/2;freq=((1:n/2)/(n/2))*nyquist;
end
plot(freq,power);
Title('Periodogram');
ylabel('power');
xlabel('(years/cycles)');
period=1./freq;hold on;
index=find(power==max(power));
mainPeriodStr=num2str(period(index));
Plot(period(index),power(index),'r.','MarkerSize',25,'ErseMode','none');
Text(period(index)+2,power(index),['period=',mainPeriodStr],'EraseMode','none')
```

Results on the extraction of cycles from aggregate agriculture are reported in section 4.3.3.

4.3 RESULTS AND DISCUSSION

In this section, results are reported in three sub-sections. The first sub-section presents results and discussions on the responsiveness of aggregate agriculture to the structural breaks. The second sub-section presents results and discussions on the persistence of the effect of structural breaks. Finally, the third sub-section presents results and discussions on the effect of a structural break, namely, drought on the cyclical behavior of aggregate agriculture.

4.3.1 The Effect of Structural Breaks

First, the characteristics of trends associated with each structural break were analyzed to quantify the structural breaks that enter into the regression equation. It was found that segmented trend lines could best represent the four trend lines that represent the agricultural GDP series, which is divided into four regions. Hence the three breaks that entered into the regression equation were represented by composite dummies i.e. both slope and intercept dummies were used.

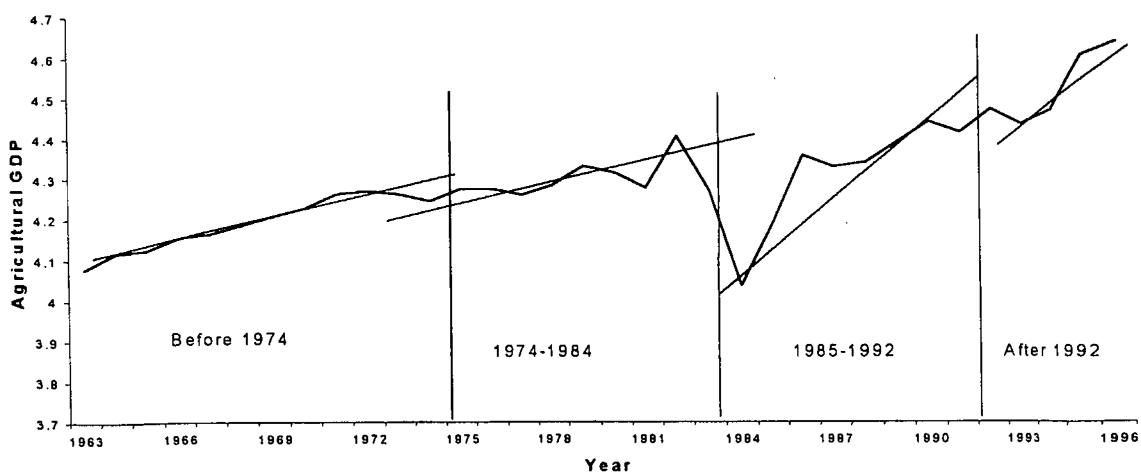


Figure 4.1: Logarithms of agricultural GDP and segmented trend lines

According to the first regression result obtained by fitting equation 4.2.1.5 (reported in Appendix F), the coefficient estimates of ϕ_1 and φ_1 were not found to be significant. These implied that $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$. This means that the changes in the economic system of the country in 1974 did not introduce a significant diversion in the trend of agricultural GDP between 1975 and 1982 from its 1961 to 1974 level.

Possible explanations for these could be that with the exception of the announcement of socialism as the new economic system of the country, and the popular land reform in 1974, major changes in economic policies were not introduced. This started to come out in the late 1970s, following the establishment of the Central Planning Supreme Council (CPSC) in 1978. The CPSC was entrusted with the responsibility of making major economic decisions of what, for whom and how to produce.

To improve the specification of the model, non-significant variables were deleted in the first round. This reduced the number of equations to three and required extension of the first period to 1982 and the third and the fourth periods were renamed as periods 2 and 3, respectively. The result was obtained using equation 4.3.1.1, which is reported in Table 4.2.

$$y = \phi_0 + \phi_1 D_1 + \phi_2 D_2 + \varphi_0 x + \varphi_1 D_{11} + \varphi_2 D_{22} + u \qquad (4.3.1.1)$$

Where, $\phi_0 = \alpha_1$, $\phi_1 = (\alpha_2 - \alpha_1)$, $\phi_2 = (\alpha_3 - \alpha_1)$, $\varphi_0 = \beta_1$, $\varphi_1 = (\beta_2 - \beta_1)$, $\varphi_2 = (\beta_3 - \beta_1)$. D_i takes the value 1 for observations in period i+1, and zero otherwise. D_{ii} takes the value of t for period i+1 and zero otherwise. If $\phi_1=0$ then $\alpha_2 = \alpha_1$. If $\varphi_1= 0$ then $\beta_2 = \beta_1$.

Table 4.2: Test results after variable deletion method was applied

Equations	Intercept		Slope	
	Coefficient	Significance	Coefficient	Significance
1	4.10	(172***)	0.01	(6.3***)
2	3.39	(20.3***)	0.04	(5.5***)
3	2.90	(5.6***)	0.05	(3.1***)

*** 1% level of significance, ** 5% level of significance, * 10% level of significance

According to Table 4.2, the intercept and slope coefficients of the second and the third periods are different compared to the first period. This implies that trends in agricultural GDP registered significant shifts after the 1983/84 drought. The question that remains to be answered is whether this holds true for the period after the comprehensive macro-policy change was introduced in 1992.

It is hard to compare parameter estimates of the third and the second period with the help of equation 4.3.1.1. This is because the standard errors of parameters for the coefficients of α_2, α_3, β_2 and β_3 and also the covariances of (α_2, α_3) and (β_2,β_3) cannot be readily computed from the same equation. A separate model was thus fitted to achieve this objective. Variance covariance matrix of the coefficients obtained from the new model is reported in table 4.3.

According to this result, the two nulls for the equality of the parameters of interest in the second and the third period were accepted. This means that changes of policies, which have been operational since 1992, have not caused that much diversion in the long-term trend in agricultural GDP from its 1983-91 level.

Table 4.3: Variance-covariance matrix of coefficients

	α_1	α_2	α_3	β_1	β_2	β_3
α_1	0.0006	-0.0000	0	0	0	0
α_2	-0.0000	0.0000	0	0	0	0
α_3	0	0	0.0279	-0.0011	0	0
β_1	0	0	-0.0011	0.0000	0	0
β_2	0	0	0	0	0.2721	-0.0085
β_3	0	0	0	0	-0.0085	0.0003

According to the theory for optimizing behavior of farm households—advocated by the neoclassical theory of production economics—farm households organize production to produce agricultural products for sale but not for home consumption. The way production decisions are made in Ethiopia contradicts this view. Production activities, especially those comprising staple foods, are meant primarily for home consumption but not for sale. This reduces farmers' response to changes in incentives. The subsistence production situation is exacerbated by a host of structural factors, namely, technological constraints, credit constraints, land tenure, infrastructure, etc.

The application of modern agricultural technologies such as chemical fertilizers, improved seeds, pesticides and others are presently available to a limited number of farmers. According to MEDaC (1999), less than 25 percent of Ethiopian farmers currently apply chemical fertilizers and improved seeds are available to only 2 percent of the farmers. This could be attributed to financial and institutional constraints. The financial constraints refer to lack of money and productive assets which are exacerbated by imperfect credit markets, while the institutional constraint refers to the limited role that agricultural extension has played to popularize modern input use. The agricultural extension system of the country has been reorganized three times since 1970.

During 1975-1990, the amount of credit available to small farmers, who accounted for over 90 percent of the cultivated area and for over 95 percent of the agricultural produce, was limited by deliberate credit policies of the socialist government. In addition, small farmers were marginalized from credit allocation by higher credit prices. The allocation of lesser quantity of credit to small farmers could be attributed to the main policy focus of the socialist government, which focused on ensuring expansion of socialist production relations by creating two new production structures—producer cooperatives and state farms. Small farmers were marginalized from the credit system, which segmented the formal credit market into three and enabled the government to charge higher interest to small farmers. For example, between 1986 and 1990, bank-lending rates were 5 percent for producer cooperatives, 6 percent for state farms and 7 percent for private farms.

Presently, the availability of credit to small farmers is constrained by a host of setbacks. Firstly, restriction on the buying and selling of rural lands has limited use of land to satisfy collateral requirements by newly emerging private banks. This has made small farmers rely for credit on government-owned specialized financial institutions. Secondly, the system now in place restricts farmers' choice of supplier of inputs to buy inputs at lower prices and on favourable terms (Mulat *et al.,* 1998; Wolday, 2001). Input-loan delivery is coordinated by the input coordinating units (ICU). The ICU is established at various levels—Peasant Associations (PAs), district zone, regional, and federal. Requests are first submitted to PAs, and then they are submitted to district, zonal, and regional ICUs. On receipt of requests, regional states borrow the estimated loan amounts from Commercial Banks of Ethiopia (CBE) and take responsibility for loan disbursement and loan collection (Wolday, 2001).

The existing land policy has played a part in the non-responsiveness of agricultural GDP to policy changes. The policy has resulted, among others, in land fragmentation, deforestation, lower land productivity and small holding size. Land fragmentation is increasing for several reasons. Fragmented plots are believed to limit the potential increase in output by limiting application of modern inputs. Deforestation is on the rise. This has reduced areas presently covered by forests to less than 4 percent (FAO, 1997). Lower land productivity is attributed to tenure insecurity. One source of insecurity is the fear that land will be redistributed. This is believed to have made peasants reluctant to apply sound land management practices and to make long-term investments on land (Alemu, 2002). Decrease in holding size to its present average level of one hectare is the outcome of continuous land redistribution after land fell in state hands in 1975. Increase in area planted had for long served one source of production increase in the country. Presently, increase in areas planted is believed to have become an impossible option due to decrease in holding size to its threshold level.

Infrastructure here refers to a number of factors having a direct and/or an indirect effect on the response of agriculture to policy changes. In Ethiopia, poor road conditions are good examples of problems related to physical infrastructure. They are also major causes for the prevalence of subsistence production. Poor roads limit the availability of consumer goods in rural areas. According to Beynon (1989), non-availability of basic consumer goods in rural areas pushes marginal utility to additional cash earnings close to zero. Poor infrastructure also limits farmers' economic, social and political tie with other sectors of the economy by hampering information dissemination on output, prices and market situations in general.

Access to all-weather and feeder roads has remained to be deterrents for agricultural growth in Ethiopia for long. A report by the international road federation indicated that the country had the lowest road density (0.02) in the continent in 1991(obtained from Alemu, 1995). Estimates show that, at present, close to 75 percent of the farms are more than half a days walk from all-weather roads (Wolday, 2001). With regard to road fleets, the country has only one railway, connecting the capital with Djibouti, and air transport is marginally used in the marketing and distribution of inputs and produce. However, since September 1997, following the launching of a Five Year Road Sector Development Programme, a target to raise the road density by 7 percent i.e. to 0.46 km per 1000 population has been set[1].

The significance of the 1983 famine could be attributed to the effect it had on the productive, as well as non-productive assets of vulnerable farm households. Vulnerable households responded to the devastating drought in order to mitigate the effects of drought by selling their productive and non-productive assets (Webb, *et al.*, 1992). Productive assets like oxen are a major means of production the lack of which were one of the production constraints in the aftermath of the famine.

The fact that major policy changes had little effect on the trend of agricultural GDP should not be interpreted as meaning that policies had no impact at all. The 1983/84 drought was a consequence of a failure of policy design and implementation, which neglected agriculture and focused on the development of the non-agriculture sector. Policies, which gave priority to agriculture as agriculture is the largest sector in the economy in terms of employment (over 80%) and GDP contribution (over 50%), could have better prepared the economy to stand/minimize the effect of the drought.

[1] In line with government's priority areas of intervention, nearly a quarter of total capital expenditure every year is channelled into road construction.

4.3.2 The Degree of Persistence of Structural Breaks

In this section, results on the sustained impact of the effect of a structural break of any type on agricultural GDP series are reported. To avoid the consequence of wrongly characterizing the data generating process of the series as a result of failure to consider breaks in the analysis, a recursive analysis was conducted using Dickey-Fuller analysis to test for the presence of significant structural breaks. Result on test for the presence of structural breaks in agricultural GDP series is already reported in figure 3.1. It confirmed that agricultural GDP is characterized by a major break, which occurred in 1985.

The year 1985 corresponds to a severe drought year. This implies that the use of equation 4.2.2.1 to test the unit root null poses the danger of accepting the null as it assumes a constant parameter structure during the entire period (Maddala and Kim, 1998). Thus equation 4.2.2.2 was employed to test for unit root. The result is reproduced in table 4.4. This was arrived at after correction for second order serial correlation was made using Cochrane-Orcutt iterative procedure. The procedure converged after 15 iterations. According to the result, the test for unit root (i.e. $\alpha=1$) was rejected at one percent level of significance using test statistic developed by Perron (1989). This means that agricultural GDP is a trend stationary process. The implication of this is that fluctuations in agricultural GDP are temporary deviations from the long-run trend and thus dissipate in a short period of time.

Table 4.4: Test for Unit-Root using Adjusted ADF Procedure

Dependent Variable is LAGRGDP*			
Regressor	**Coefficient**	**Standard Error**	**T-Ratio [prob.]**
Constant	8.769	1.706	5.155
Time	0.007	0.010	0.699
DU	-1.166	0.377	-3.091
DT	0.048	0.015	3.157
T_B	-0.013	0.096	-0.139
LAGRGDP	-1.094	0.395	-5.301#
DLAGRGDP	0.795	0.216	3.680
R-squared	0.827	R-bar-Squared	0.827
S.E. of Regression	0.056	F-stat. F (8, 23)	19.533
Mean of Dependent Variable	4.323	S.D. of Dependent Variable	0.139
Residual Sum of Square	0.073	Equation Log-likelihood	51.852
Akaike Info. Criterion	42.85	Schwartz Bayesian Criterion	35.983
DW-statistic	1.955		

* LAGRDP is logarithm of Agricultural GDP, DLAGRGDP is lag of logarithm of agricultural GDP. # T-statistic for the null hypothesis $\alpha=1$

4.3.3 Cycles in Agricultural GDP

In this section results on the cyclical fluctuations of agricultural GDP are reported. Attempts to extract cycles from agricultural GDP series were preceded by decisions on the use of appropriate filtering techniques to remove trends from the series. According to results obtained on the data generating process in chapter three, agricultural GDP is made up of trend stationary processes; thus, detrending rather than differencing was applied.

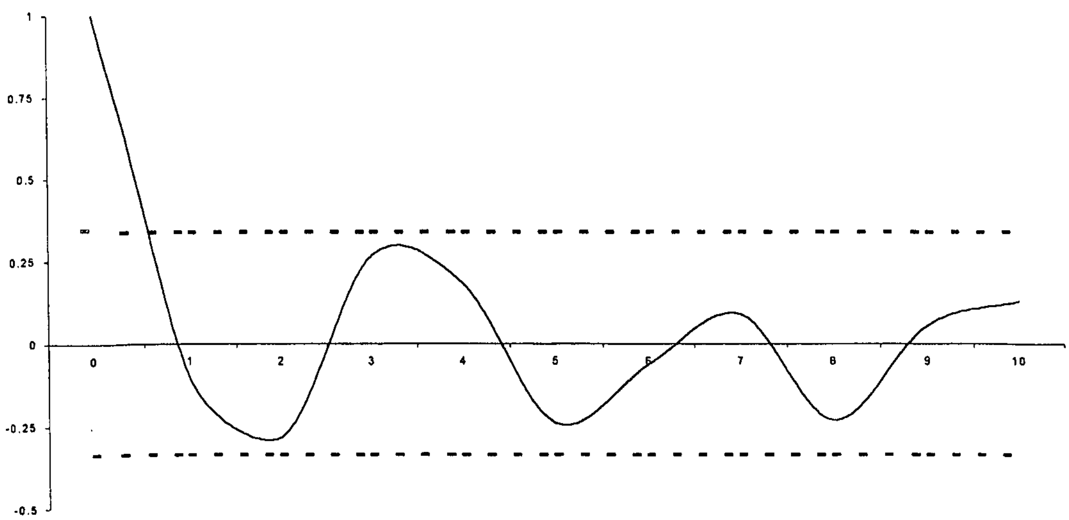


Fig 4.2: Correlogram of Residuals

To check that what is left after the trend is removed from the agricultural GDP series truly represent cycles, a correlogram of residuals was studied. This is shown in figure 4.2. It can be noted from this graph that the correlograms are cyclic. This proves that cycles do exist. To determine whether the identified cycles are deterministic or probabilistic, correlograms were further studied. It is noted that the oscillations do not die off very rapidly. These are evidences that the cycles are deterministic (Gottman, 1981).

Therefore, a periodogram was first run to calculate P (for period) in equation 4.2.3.1 and then its value was substituted back into the same. This continued until it appears convincing that cycles were completely removed from the residuals. Table 4.5 gives final values for P, A and B.

Table 4.5: Regression Results on the cyclical behavior of Agricultural GDP

Period	Sinusoidal parameters	Coefficient	P-value
8.25	A	0.031368	0.032899
	B	0.033123	0.023131
16.5	A	-0.022633	0.054076
	B	-0.02287	0.046371

According to table 4.5 and figure 4.3a and 4.3b, drought, which is a major reason for production fluctuation in agricultural production, occurs every 8.25 years, which is equivalent to ninety-eight months. This result is comparable with the actual major drought years that have already occurred in the past.

Therefore, it can be held that the cycles extracted in this section are attributable to the periodic occurrence of drought. This result is important in the sense that it supplements efforts underway by a government-affiliated office, namely, the Disaster Preparedness and Prevention Commission (DPPC), which aims at minimizing the effects of drought. DPPC is guided by a recently ratified policy called the National Disaster Prevention and Management Policy (NDPMP).

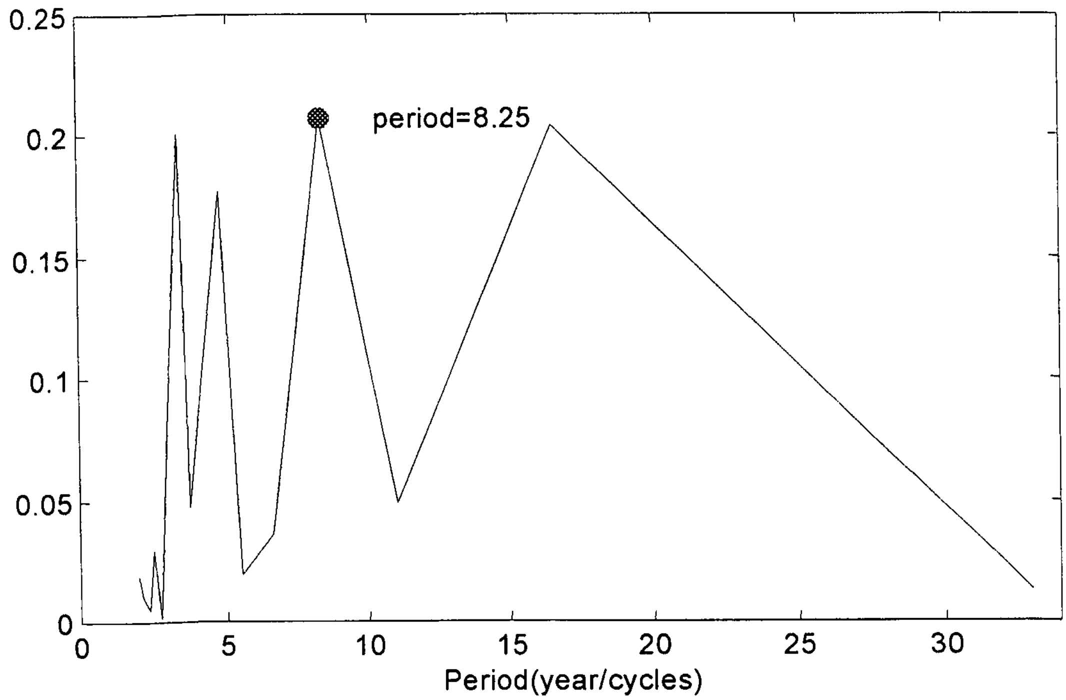


Figure 4.3a: Cycles occur every 8.25 Years

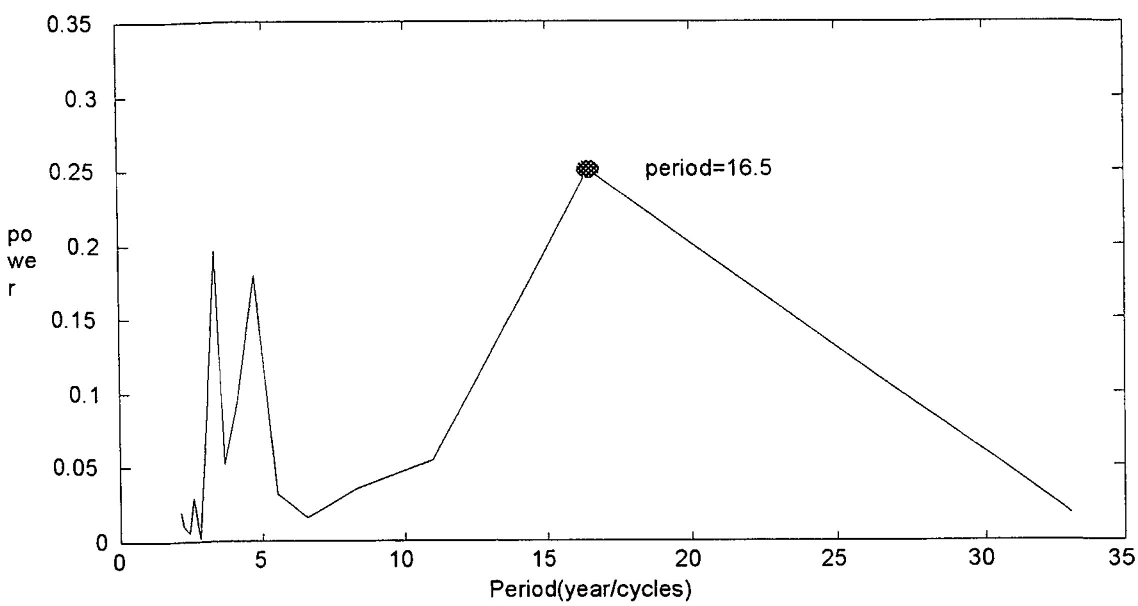


Figure 4.3b: Cycles every 16.5 Years

4.4 CONCLUSION

In this chapter, attempts were made to investigate the responsiveness of aggregate agriculture to major structural breaks, the degree of persistence of shocks (structural breaks) on aggregate agriculture, and the effect of structural breaks on the cyclical fluctuation of aggregate agriculture. The responsiveness of aggregate agriculture was measured by constructing a regression equation and testing for the significance of estimates of policy and non-policy related variables. The extent of the sustained impact of a break on aggregate agriculture was determined by investigating the class of non-stationary process to which agricultural GDP belongs. The effect of structural breaks on the cyclical fluctuation of agricultural GDP was measured with the help of a univariate time series procedure.

According to results obtained from the regression equations, aggregate agriculture was found to be responsive more to the 1983/84 drought than changes in economic systems. The reason for this could be that production is at subsistence level. This is exacerbated by low level of application of modern agricultural inputs, credit, and the existing land tenure and poor infrastructure. Theoretically, the way forward, when faced with this kind of situation, is to try to integrate farm households with the market system. This needs to be done side by side with improvement in rural infrastructure, expansion in credit availability, expansion in agricultural extension and reform in the existing land policy.

The reason why only the 1983/84 famine was significant in the regression equation could be associated with the effect the drought had on the asset base of farm households. Oxen are the most important examples of productive input while the lack of these assets constrains the productive capacity of farm households. Many households, in the drought-hit areas, fearing that they would eventually lose their livestock due to lack of water and pasture, attempted to absorb the risk by selling them. According to a study, unusually lower livestock prices are used as warning mechanisms by relief agencies that mass starvation is around the corner (Webb, *et al.*, 1992). It can be said that the drought was a cumulative effect of a failure of policy design and implementation. Thus a policy better than those practised between 1972 and 1991 could have better prepared the economy to withstand a drought.

Civil wars that have been fought for many years have been deterrent to economic growth in Ethiopia for many years by consuming the meager resources that the country has. The impact of these wars is not discussed in this study for lack of data. It thus suggested that follow up studies should work on this.

The result obtained regarding the extent of the sustained impact of a break on aggregate agriculture was supportive of the result from the regression equation. It was found that aggregate agriculture has a significant break in 1984/85, which corresponds to the major drought year. In addition, it was found that aggregate agriculture is a trend stationary process. The economic implication of the latter is that shocks to agricultural GDP, which might originate from natural or man-made factors, including major changes in policies, dissipate in a short period of time, leaving little impact on the long-term performance of agricultural GDP.

The result on the extraction of cycles from aggregate agriculture indicated that agricultural GDP is made up of cycles. The cycles are positively correlated with the occurrence of drought. It was further found that cycles in agricultural GDP occur every 8.25 years. It is hoped that this result would supplement efforts underway at the national level to minimize the effects of drought. A National Disaster Prevention and Management Policy (NDPMP) was introduced recently. In addition, the former Relief and Rehabilitation Commission has been reorganized as a Disaster Preparedness and Prevention Commission (DPPC). Their common objectives include directing relief and development to areas vulnerable to drought to achieve long-term development.

CHAPTER 5

THE LEVEL AND INSTABILITY OF CEREAL PRODUCTION

5.1 INTRODUCTION

Cereals include teff, barley, maize, sorghum, oats, millet and wheat. Together, they account for 85% and 90% of the total cultivated area and total production of field crops. They also account for over 90% of modern input consumption (CSA, 2000; MEDaC, 1999). This makes cereal production the most dominant field crop, followed by pulses and oilseeds. This can be attributed to its use as a staple food in the country. Teff is a staple food in the northern and central parts as maize and sorghum are in the south and eastern parts, respectively.

Cereals are major food items in Ethiopia. However, their levels of production are very low and this has shadowed the ability of agriculture to guarantee food security. This can be supported by results from food gap analysis made by dividing data on cereal production into three periods depending on differences in the political and economic systems followed for the last four decades (Appendix C). The analysis was done only for rural dwellers alone to investigate the severity of food insecurity in rural areas.

Cereal per capita was 142 kilograms per person per annum before 1974 (Appendix C). It declined to 113 and 106 kilograms respectively between 1974 and 1991 and since 1992 (Appendix C). This is after a 2.5% allowance for animal feed and an 11% post harvest loss and a 6% average requirement for seed are made. Except for the period prior to 1974, cereal availability has not been stable. Comparison with recommended food intake of 225 kilograms of cereals per person per annum (equivalent to recommended food intake of 2100 kcal per person per day) revealed that food deficit rose from its average level of 83 kilograms in the imperial era to

112 kilograms in the socialist era and presently it stands at 119 kilograms per person (Appendix C).

Although results from food gap analysis indicate that cereal output per capita is decreasing, it is found that cereal production has shown significant growth with an annual growth rate of 3% between 1960 and 2000. This was accompanied by a more than proportionate increase in the standard deviation of production. The standard deviation of production as measured by the coefficient of variation (CV) around trend rose from 2% between 1960 and 1975 to 10% between 1974 and 1990 and to 13% between 1989 and 2000. These are indicative of increased instability in cereal production.

Studies of production instability hypothesize that variability increases with higher use of inputs, expansion of areas planted, weather variability and incentives. It was assumed in this chapter that the effect of short-term fluctuations in input use, weather and other factors, which affected production variation in the short-term, could be captured by yield (i.e. output per hectare). On the other hand, the effect of factors that could be considered long-term sources of production instability is assumed to be captured by fluctuation in areas cultivated (Hazell, 1988, 1985 and 1984).

Studies that focus on the identification of factors responsible for production variability are critical for the food security of a country (Singh and Byerlee, 1990; Hazell, 1984,1985). The objective of this chapter is to study the extent of instability in cereal production and to investigate whether this has anything to do with the changes in the economic policy of the country. The study is conducted in three steps. In step one (section 5.2), we analyzed factors with potential influence on the variability of cereal production. In step two (section 5.3), an attempt was made to measure the extent of the variability in cereal production. And in step three (section 5.4), components of change in cereal production were decomposed by applying a variance decomposition procedure.

5.2 FACTORS WITH POTENTIAL EFFECTS ON VARIABILITY IN CEREAL PRODUCTION

Several variables could be behind instability in cereal production, namely, fluctuations in areas sown, fluctuations in yield, fluctuations in weather conditions and agricultural policies. Fluctuations in areas sown and yields of crops reflect the separate influences of long-term and short-term sources of variation (Hazell, 1984). The following paragraphs discuss the possible impact of these variables on fluctuations in cereal production.

5.2.1 Change in Areas Sown

In Ethiopia, changes in areas sown constitute the primary source of production increase. This can be attributed to the domination of small-scale farmers, characterized by low input and low output rain-fed mixed farming with traditional technologies. Small-scale farmers constitute over 95% of total area sown and over 90% of agricultural output (MEDaC, 1999).

Expansion in areas sown as a source of production increase is being challenged by a decrease in holding size. Decrease in holding size is a direct consequence of the existing land policy, which disallowed transaction on land and entertained new claims for land through its land redistribution schemes until 1989. However, in 1989, land redistribution was officially banned. This has made those who want to plough, but who are without land, rely on family plots or enter into sharecropping arrangements for farming.

According to the 1996/1997 survey, 63% of households held less than 1 hectare, while those holding between the range of 1.01 to 2.00 hectares and more than 2 hectares were 24% and 13%, respectively (CSA, 1997). Comparisons with earlier survey reports indicated that the number of households with relatively larger plots is decreasing while smaller plots are increasing. This can be attributed to the effect of land redistribution schemes.

Land use data at national level reveal that the potential increase in areas sown as a means of production increase is gloomy in the future. The amount of land being withdrawn from agriculture due to land degradation is increasing (Table 2.1). Lands classified as non-suitable for farming have increased from 57% of the total land area between 1961-1975 to its present level of 69% (Table 2.1). At the same time, cultivated land as a percentage of agricultural area is increasing. It rose from 21% between 1961-1975 to 32% between 1992-2000. The increase is the result of the expansion of cultivation to areas that used to be designated as permanent pasture and forests (Table 2.1). Forests which covered 40% of the land area at the turn of the century are presently reduced to less than 4% (FAO, 1997).

5.2.2 Change in Yields

Yield represents production per hectare. Yield is affected by agricultural research and extension, weather, incentives, etc. In this section, focus is made only on the effect of agricultural research and extension on yield.

Increase in yield entails increased use of high-powered inputs. The availability and the diffusion of the latter rest on the growth of agricultural research and extension. The term high-powered input here refers to chemical fertilizers, pesticides, seeds of improved varieties, herbicides, and the like. Agricultural research and extension are in turn affected by our choice of development policies. A policy that prioritizes agriculture in resource allocation is vital in the expansion of agricultural research and extension activities. Agricultural research generates improved seed varieties. On the other hand, agricultural extension popularizes the use of modern inputs generated by agricultural research among farmers.

The beginning of agricultural research in Ethiopia dates back to the 1947 by the Ambo Agricultural High School. Later the Jimma Agricultural and Technical School in 1952 and the Alemaya College of Agriculture in 1956 joined the Ambo

Agricultural High School (Goshu, 1995). In 1966, the Institute of Agricultural Research (IAR) was established (Goshu, 1995). It was renamed The Ethiopian Agricultural Research Organization (EARO) in the 1990s. Today, their number is increased by two with the introduction of the Regional Research Center and the Biodiversity Institute into the agricultural research arena (EEA, 2000).

Despite the long history of agricultural research in the country, farmers in the country have benefited little in terms of improved seeds. Currently, improved seed is used on only 2% of the countries cultivated area (Wolday, 2001). This is attributed to high price and farmers' preference in using own seeds (Wolday, 2001). Lack of resources, inappropriate policies and institutional deficiencies are also to blame for the low level of agricultural research in the country (EEA, 2000).

Agricultural extension dates back to the introduction of Integrated Rural Development (IRD) projects in the country in the late 1960s (IEG, 1967). IRD had many objectives. It attempted to introduce peasants in a few promising regions to a commercial market system, improved distribution of seeds and fertilizer, provision of credit, dissemination of better implements, promotion of rural health, expansion of storage facilities, and the like (IEG, 1967). The project was renamed as a Minimum Package Project I (MPPI) in 1971 and its services were scaled down to the provision of fertilizer and credit services with the intention of expanding its coverage to include the entire country. However, its operation was halted in the mid-1970s. This occurred following donors' withdrawal of funding after socialism was introduced as the political system of the country. The MPPI was renamed as MPPII in 1981 due to the renewal of the World Bank's commitment to finance the project. In June 1984, the MPP was replaced by the Peasant Agricultural Development Extension Programme (PADEP). Its difference from IRD and MPP projects rests on its programme to develop and disseminate appropriate technologies at the zonal level, using a training-and-visit approach (Dejene, 1990). PADEP gave way to a new agricultural extension programme known as the 'Participatory, Demonstration and Training Extension System' (PADETES) in

1994/95. The main difference between PADEP and PADETES is that PADETES merges the training-and-visit approaches of PADEP with the technology diffusion system of the Sasakawa Global 2000. Overall, agricultural extension systems of the country since 1960 have concentrated on the promotion of the use of 'input packages' in high yielding areas of the country. The system neglects low yielding areas, which are the most food insecure regions of the country. These regions are characterized by erratic rainfall and small land holding sizes.

Fertilizer, pesticide and herbicide consumption in the country has been increasing since the 1970s. This coincided with the expansion of agricultural extension services in the 1970s. Average fertilizer and pesticide-herbicide consumption figures were 5758 and 5889 metric tons in the 1960s. These increased to 54456 and 43402 metric tons respectively in the 1970s and 1980s, and to 130130 and 51557 metric tons respectively in the 1990s (FAO, 2001). Despite such encouraging jumps in total consumption, only 25% of the farmers currently use fertilizer. Yield does not show significant change for the past 25 years. This could be attributed to its application alongside with local seeds, which has a tendency to reduce the effectiveness of fertilizer in increasing yield.

5.2.3 Agricultural Policies

Agricultural policy is a broad concept. It includes output policy, input policy, land policy, research policy, irrigation policy, and many others. The land policy and the research policies of the country were discussed in the previous section so these perspectives are not repeated here. In addition, the irrigation policy is not considered either. This is because, in Ethiopia, cereal production is predominantly rain-fed. In the remainder of this section, attempts to summarize the output and input price policies of Ethiopia since the 1960s and their possible impact on the variability of cereal production are made. Output policy refers to output price and output marketing policies, whereas input policy focuses on variable input price and variable input delivery systems (Ellis, 1992).

The types and diversity of output and input policies vary from one economic system to the next. Contrary to command-based economic systems, prices in the market-based economic systems are determined by markets. In such systems, the role of the government is limited to ensuring the proper functioning of markets. In the command-based economic systems, government fixes farm output and input prices, manages output marketing and input delivery systems, and imposes physical marketing restrictions on free market operations. Theoretically, government control over output-input pricing and output-input marketing and delivery systems targets resource transfer from agriculture to develop the manufacturing sector. In practice, however, according to Ahmed (1988), it attempted to ensure food availability, at cheap prices, to the politically active section of a society, mostly urban dwellers and the military. The difference between the selling price and producer price mostly found its way to run inefficient administration of parastatals (Ahmed, 1988).

Be it in a command-based or a market-based economic system, market and non-market mechanisms of resource transfer from agriculture to develop non-agriculture were influenced by the perception that structural transformation of the economy solves economic backwardness. In command-based economic systems, non-marketing mechanisms were erected to strengthen government monopsony over farmers' produce. Some of the non-marketing mechanisms included fixed quota delivery to government marketing parastatals at government set rates, and the introduction of grain checkpoints to restrict free grain movements.

Ethiopia has seen three economic systems since formal planning was started in the country in 1957. These include a market-based economic system (1957-1974), a command-based economic system (1975-1989) and finally a return to a market-based economic system (since 1992). In the paragraphs that follow, attempts to focus on the possible impacts of agricultural policies on fluctuations in cereal production will be made.

Before 1974, output prices used to be determined by markets. In addition, output-marketing systems were free from government control. With regard to input pricing and delivery systems, modern input use was not known by the majority of small-scale farmers until IRD projects were introduced with the assistance of donors in a number of promising regions of the country in the late 1960s. The first government-controlled grain marketing parastatal in Ethiopia was the Ethiopian Grain Board (EGB). It was established in 1950 by a proclamation no. 113 of 1950. Its primary objective was to combat unlawful tendencies fostering monopoly in the grain markets. Ten years later, in 1960, EGB was renamed as the Ethiopian Grain Corporation (EGC) and its role was strengthened by the proclamation no. 267 of 1960 which allowed EGC to incorporate a grain-price stabilization scheme as one of its additional objectives.

Between 1974 and 1990, the free market-based output and input policies were replaced by a command-economy-based output and input policies. The output pricing policy was replaced by a fixed pricing system in 1976 and the output marketing policy was changed with the establishment of the Agricultural Marketing Corporation (AMC) in the same year as a sole collector of grain from farmers. AMC's power in grain marketing was increased by subsequent government policies. Various physical measures were also erected to enhance grain procurement capacity of the AMC. These include restrictions on the free flow of grain by farmers from surplus producing to deficit regions and imposition of severe penalties on farmers failing to comply with fixed grain quotas deliveries. The penalties ranged from the denial of access to service cooperative shops to buy non-agricultural goods to depriving them of their right to have access to land (Befekadu and Tesfaye, 1990). These positioned AMC as a sole collector of grain from farmers at fixed rates.

The input pricing and marketing policy of the country was also in line with socialist principles. Chemical fertilizers and improved seed varieties are the most important types of modern inputs. Prices of these inputs were fixed by the government. In addition, input delivery systems were controlled by two state-owned parastatals, namely, the Agricultural Input Supply Corporation (AISC) and The Ethiopian Seed Corporation (ESC). Much of the fertilizer and seeds supplied by AISCO and ESC were sold at favourable prices to the newly created socialist-based structures of production organizations, namely, Producer Cooperatives (PC) and State Farms (SF). The system marginalized private farms, which accounted for over 90% of areas sown and cereal production between 1975-1989 (Alemu, 1995).

Therefore, one may argue that output and input policies of the country in the 1980s had repercussions for farmers' incentives. This resulted in production stagnation. According to Gutu (1990), cereal production per person declined by 3% a year in the 1980s. The change in the mix of production, due to switches in production from cereals to other crops, could also have played its part in production stagnation. According to Befekadu and Tesfaye (1990), switches from cereal production to oilseeds were some of the strategies adopted by many farmers to evade grain delivery quotas to the AMC.

The socialist-based output and input policies were changed by the March 1990 policy reform. The reform introduced a mixed economic system. It vowed for gradual dismantling of socialist-based production structures and proposed the introduction of new output and input policies within a framework of a market economy. To this end, fixed pricing was abolished and the monopsony power of AMC in grain market was revoked. In 1992, the political set up of the country was changed. This strengthened the major changes that were introduced by the March 1990 reform. AMC was renamed as the Ethiopian Grain Trade Enterprise (EGTE) and, like the EGC of the 1960s, its role was reduced to playing the same role as private traders. It was restricted to wholesale trade for regulatory purposes only. However, the problem of infrastructure and lack of clear vision in the agricultural output marketing system of the country, has rendered EGTE to be unable to accomplish its very objective of price stabilization. A case in point is the trend decline in the producer prices of cereals for the past eight years, which was attributed to higher production as a result of good weather conditions and expansion in agricultural extension activities. It was reported that many farmers who acquired modern inputs through loans from government institutions in the year preceding the harvest were unable to repay due to lower grain prices. This is reported to have caused decline in farm input utilization in recent years. This has a huge impact on the realization of the agriculture-led development strategy which aims at achieving self-sufficiency in food production through the promotion of the use of input packages.

In the area of input pricing and marketing, fertilizer retail prices were liberalized while wholesale prices remained under the control of the government. Control over wholesale prices of fertilizers was phased out in 1996/97. Currently, there are six fertilizer marketing agencies, namely, the Agricultural Input Supply Enterprise (AISE), the Ethiopian Amalgamated Limited (EAL), Fertiline Private Limited, 'Ambassel' Trading House Private Limited, 'Guna' Trading Share Company and 'Dinsho'. Wholesalers, retailers, cooperatives, and regional and zonal agricultural offices are also serving as marketing outlets for fertilizer as they sell fertilizers directly to farmers.

With regard to the pricing and marketing of improved seeds, the Ethiopian Seed Corporation's (ESC) monopoly over seed production and distribution, which lasted for 14 years since 1978, was ended in 1992. At present, seed marketing is partially liberalized. In addition to the Ethiopian Seed Enterprise (ESE), which controls close to 95% of the improved seed supply (Mulat, *et al.*, 1998), Pioneer Hybrid International (PHI) is engaged in the popularization of improved input use in the country. Various research results have shown that the recent changes in the output and input policies have improved the performance of the grain and input markets. In the grain market, the policies have caused an increase in the number of grain traders and resulted in the spatial integration of grain markets (Wolday, 1999; Asfaw and Jayne, 1998). This does not, however, imply that efficiency has been attained. Grain markets are presently constrained by lack of effective competition. Very few traders control over 43% of the grain traded at the wholesale level, and 79% of the annual grain sale occurs immediately after harvest (Gebremeskel *et al.*, 1998). This means that efficiency in the grain market is constrained by factors like limited access to working capital, limited storage facilities, poor road conditions, presence of too many unlicensed grain traders and high and unsystematic tax assessment (Wolday, 2001; Gebremeskel *et al.*, 1998; Alemayehu, 1995).

In the input market, improvement in fertilizer consumption is registered recently. This is attributed largely to the introduction of the new extension programme in 1994. This being the case, however, fertilizer marketing is affected by supply and demand side problems. On the supply side, fertilizer marketing is constrained by the limited involvement of the private sector in the running of wholesale and retail outlets, delays in the availability of hard currencies for fertilizer imports, and the like. On the demand side, fertilizer marketing is affected by high fertilizer prices, household assets, and availability of extension services, to name a few (Mulat *et al.*, 1998; Wolday, 2001).

5.2.4 Weather Variability

As stated in the earlier sections, expansions in areas sown, fluctuations in fertilizer availability and policy related factors have the potential to cause variations in cereal production. The importance of weather variability in the variation of cereal production is discussed here.

Given that only 25% and 2% of Ethiopian farmers utilize fertilizer and improved seeds respectively (MEDaC, 1999), and that cereal production is predominantly rain-fed, modern inputs are not likely to dominate the effect of weather on cereal production. According to Jaeger (1991), "*cereals are the most susceptible crop to* *moisture stress, and for most countries, variations in average yields of cereals result primarily from variations in weather."*

A number of studies attribute the continued dependency of cereal production on weather change to inappropriate economic policies. According to these studies, events as big as drought do not happen suddenly. They result from an accumulation of a host of economic problems, which, over time, erode the capacity of farmers to cope (Webb *et al.*, 1992; Pickett, 1991). An attempt is made to prove this premise by comparing standard deviations of cereal production (measured by CV) for the three economic systems that the country has seen since the early 1960s. Results showed that CVs were the highest during the times when the country had non-conducive agricultural policies (tables 5.1 and 5.2). Between 1975 and 1990 alone, fluctuations in cereal production, solely attributable to weather variability, occurred in nine out of a total of 17 years.

5.3 CHANGES IN CEREAL PRODUCTION: A DESCRIPTIVE METHOD

In this section, an effort is made to identify factors causing instability in cereal production. Since Ethiopia has seen changes in its economic systems twice, since the 1950s (a command-based economic system in 1974 and a market-based economic system in 1992), an effort is made to divide the time series data on cereal production, areas sown, yield and producer prices into three periods, namely, 1960-1974, 1975-1989 and 1990-2000. It is believed that this division assists in identifying factors responsible for instability in cereal production as we move from one economic system to the next. The study was conducted into two stages. In stage one, changes in cereal production between the first and the second periods is analyzed (i.e. 1960-1974 and 1975-1989). In stage two, changes in cereal production between the second and the third periods is analyzed (i.e. 1975-1989 and 1990-2000).

5.3.1 The Period between 1960-1974 and 1975-1989

According to Table 5.1, teff is ranked first, followed by maize and sorghum in terms of share from total production, whereas in terms of share from total areas sown, teff is still ranked first, while maize and barley take second and third positions respectively (Appendix A). Table two further shows that average cereal production increased by 7% between 1961-1974 and 1975-1989. Maize accounted for the 93% of the total increase, sorghum 33%, barley 15%, and millet and oats for the rest. The same table also evidences that the CV[1] of total cereal production rose from 2% to 10%, an increase of 400%. Maize (from 4% to 31%) and teff (from 1% to 7%) accounted for the lion's share.

Table 5.1: Changes in the Mean and Variability of Cereal Production between 1961-1974 and 1975-1989

Crop Type	AVG Production			Coefficient of Variation (%)			F-ratio			Probability of 5% Shortfall Below Trend	
	1st P	2nd P	% Δ	1st P	2nd P	% Δ	Production	Area	Yield	1st P	2nd P
Wheat	724	675	-7	4	12	300	0.35**	1.09	0.08	74	70
Barley	790	843	6	9	8	-11	0.03	0.02	0.02	74	77
Maize	834	1164	39	4	31	675	0.10	0.10	0.02	79	69
Oats	5	31	474	45	37	-18	0.00	0.00	0.04	69	74
Millet	144	194	34	3	17	467	0.04	0.39**	0.18	92	69
Sorghum	882	1000	13	179	21	-88	0.12	1.71	0.09	70	76
Teff	1261	1093	-13	1	7	600	0.20	5.13***	0.24	99	74
Cereal Total	4641	4996	7	2	10	400	0.18	9.99***	0.07	80	72

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

The last three columns of table 5.1 depict results on the tests of equality between production variances of cereals as measured by F-ratios. It was found that the F-ratios for changes in the variances of total cereal production were not significant. This might have occurred as a result of production stagnation in the 1980s (Gutu,

[1] These are based on results on the fitted trend lines of polynomials of different order. Three deterministic trend lines are fitted for each cereal crop making the total number of equations estimated to be equal to 63.

1990), attributable largely to adverse agricultural policies (Befekadu and Tesfaye, 1990) and the frequent occurrence of drought situations which caused change in production composition (Webb, *et al.*, 1992). Agricultural policies of the country were oppressive in the sense that they focused much on the transfer of resources from agriculture to non-agricultural sectors and little of its resources were used for its own growth. Most of the efforts made to develop agriculture between early 1970s and late 1980s were donor-driven and sporadic as they were mostly conditioned by the occurrence of drought situations (Alemu *et al.*, 2002).

Various policy measures were taken within the framework of a command-based economic system, which were discussed in section 5.2.3. The following were a few of the policy measures which contributed to production stagnation: output marketing and input delivery systems were controlled by government parastatals; fixed grain quota deliveries at fixed prices to government marketing parastatal were instituted; sale of grain in open markets was allowed only to grain producers who satisfied fixed quota deliveries to government marketing parastatals; grain checkpoints were erected to restrict free flow of grain to deficit areas, and the like. With regard to the effect of adverse drought situations, the CVs of cereal production may be used as evidence. The CV for total cereal production rose from 2% to 10%, by 400%.

Table 5.1 further depicts that the F-ratio for total areas sown to cereals is significant. This may be attributed to the 1975 land reform. The reform made land the exclusive property of the state. Land was distributed to all farmers in the 1970s. In the 1980s, access to land was given through land redistribution. This continued until 1989. Presently, areas, which used to be considered inaccessible, marginal or non-suitable for cultivation, are being put under cultivation.

The CVs of the crops were also individually analyzed to determine factors behind instability in their variances (column 5 and 6 in table 5.1). Except for barley and sorghum, all the others had high values between 1975 and 1989. The relatively low level of instability in barley and sorghum may be attributed to environmental factors. Barley is cultivated in areas 1900 metres above sea level where the effects of drought are less severe. Sorghum is cultivated mainly in low rainfall areas. It is preferred to other crops in these areas for its drought tolerance. Given that drought occurred in nine out of 17 years during this period, higher CVs of the other crops can be attributed to climatic factors. It should be remembered that vulnerability to climatic change is in turn a direct consequence of adverse policy scenarios (Webb, *et al.*, 1992).

5.3.2 The period between 1975-1989 and 1990-2000

According to table 5.2, cereal production increased by 13% between 1975-1989 and 1990-2000. Teff accounted for 67% of the total increase, wheat 47%, sorghum 17%, and millet and oats for the rest. The CV of total cereal production rose from 10% to 13%, an increase of 30%. This may be attributed to a higher increase in the CV of teff from 7% to 13%[2].

Table 5.2: Changes in the Mean and Variability of Cereal Production between 1974-1990 and 1990-2000

Crop Type	AVG Production			Coefficient of Variation (%)			F-ratio			Probability of 5% Shortfall Below Trend	
	1st P	2nd P	% Δ	1st P	2nd P	% Δ	Production	Area	Yield	2nd P	3rd P
Wheat	675	982	45	12	8	-33	0.53**	0.25	0.66**	70	80
Barley	843	823	-2	8	10	25	1.98	0.423	2.49	77	79
Maize	1164	921	-21	31	19	-39	5.06***	0.15	9.6***	69	86
Oats	31	51	65	37	30	-19	1.94	2.83*	1.21	74	75
Millet	194	222	14	17	33	94	0.55**	0.39**	0.22	69	78
Sorghum	1000	1111	11	21	17	-19	0.38*	0.08	3.03**	76	79
Teff	1093	1531	40	7	13	86	0.27	0.04	0.19	74	77
Cereal Total	4996	5644	13	10	13	30	0.53**	0.03	1.44	72	80

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

Table 5.2 shows that the F-ratio for a change in the variance of total cereal production is significant. Area and yield instabilities had little to do with this because their F-ratios were insignificant. To further probe the matter, the CVs of the producer prices of cereals (proxy for incentive change) were studied. It was found that they were lower in the third period, both individually and as a group (Table 5.3). This means that producer prices had little to do with production instability between 1990 and 2000. Therefore, by assuming that the 30% increase in the CV of total cereal production is caused predominantly by good weather, and believing that no other factor can cause this but weather, it is conclude that much of the instability in production during the third period is the result of favourable climatic change. This is in line with Jaeger's (1991) generalized theory that variability in the average production of cereals resulted primarily from variation in weather.

To measure the implications of an increase in total cereal production variability on food security, probabilities that total cereal production may fall by 5 percent or more below the trend each year were computed[3] for the periods 1975-1989 and 1990-2000. These are arrived at by using the estimates of the variance of production around trend from the detrended series and by assuming that the variance of production remains constant for all the years within a period. The computed probabilities increased from 75 per cent in the period 1975-1989 to 81 percent in the period 1990-2000.

Table 5.2 further shows that tests of the significance of the F-ratios for some of the individual crops are significant (see last three columns). It is found changes in the production variances of individual crops to be significant for wheat, maize, millet

---

[2] In relative terms, the coefficient of variation of oats is the highest, but in absolute terms, its impact on the variability of total cereals is the lowest since its contribution to change in total cereal production stands between 3% and 7%.

[3] Detrended production in year t is denoted by $\hat{a}_t = \bar{a} + e_t$ where $\bar{a}$ is period mean and e_t is deviation from mean. The probability of a shortfall of 5 percent or more below trend is derived from Pr $\{0.95\ \bar{a} \geq \bar{a} + e_t\} = \Pr\{-0.05\ \bar{a}/\sigma_e \geq e_t/\sigma_e\}$. σ_e is the standard deviation of e_t. Assuming that e_t is approximately normally distributed, the desired probability can be obtained from tables for the cumulative normal distribution (Hazell, 1985).

and sorghum. These originated from increases in the yield variances, except for millet whose instability is attributed largely to change in sown areas. Given the existing limit in the availability of chemical fertilizers (i.e. for only 25% of farmers) and improved seed varieties (i.e. for only 2% of farmers), the increase in yield variances may be attributed largely to relatively good weather. This can be supported by two findings. Yield variability is caused much by climatic factors since the adoption of new technology is likely to cause greater stability rather than instability in yields over years (CIMMYT, 1989). Furthermore, "*yields of crops grown with new technologies appear to have larger variances, but typically their coefficients of variation are lower than those of traditional technologies*" (Hazell, 1989b).

Table 5.3: Producer Prices of cereals: 1961-1974, 1975-1989 and 1990-1994

Crop Type	**Coefficient of Variation %**			**Changes %**	
	1st Period	2nd Period	3rd Period	1st and 2nd	2nd and 3rd
Wheat	7.75	18.01	10.4	132.3871	-42.2543
Barley	13.15	17.24	10.76	31.10266	-37.587
Maize	13.78	20.96	9.7	52.1045	-53.7214
Oats	16.16	24.5	6.52	51.60891	-73.3878
Millet	16.95	26.62	9.47	57.05015	-64.4252
Sorghum	17.49	20.95	9.1	19.78273	-56.5632
Teff	9.76	15.73	11.15	61.16803	-29.1163
Cereal Total	9.25	15.9	10.03	71.89189	-36.9182

To address some of the doubts with regard to the factors responsible for the significant change in the variance of total cereal production in the third period, a further analysis, widely known as a variance decomposition procedure was applied. This method attempts to analyze the components of change in the mean and variance of total cereal production. This is discussed at some length in section 5.4.

5.4 COMPONENTS OF CHANGE IN CEREAL PRODUCTION: A VARIANCE DECOMPOSITION METHOD

In this section, changes in the average and variance of cereal production are analyzed between the second and the third periods. Changes in the average cereal production is believed to come from four sources, namely, changes in the mean yield, changes in the mean area, changes in the covariability between areas and yields and change in interaction terms. Likewise, the variance of total cereal production can be decomposed into ten parts: change in the mean yields, change in mean areas, change in yield variances and covariances, change in area variances and covariances, change in area-yield covariances, change in interaction between changes in mean yields and mean areas, interaction between changes in mean areas and yield variances, interaction between changes in mean yields and area variances, interaction between changes in mean areas and yields and changes in area-yield covariances and change in residuals (Hazell, 1984, 1988).

5.4.1 Method of Analysis

Year-to-year fluctuations in areas sown and yields were computed as follows. First, to decide on whether year-to year fluctuations should be computed by detrending or differencing the time series data, the classes of non-stationary process to which the variables under consideration belong were determined a priori (See Chan *et al.*, 1977 for the consequences of inappropriately differencing or detrending a time series variable). The class of non-stationary process to which a variable belongs is conventionally tested by applying the Augmented Dickey-Fuller (ADF) procedure. However, this procedure assumes that the data under consideration is free from significant influence of structural breaks (see Perron 1989 for the consequences of applying conventional ADF on a data characterized by structural breaks). This was tested by applying a recursive analysis using the Dickey-Fuller regression to the full time series and none of the breaks was found to be significant. Next, ADF was applied to test for unit root in the series which gave that the data on area sown and yield for each crop are difference stationary processes.

Estimates of the differenced production functions for each crop were computed from the products of the differenced area and yield series. Finally, changes in the average and variance of total cereal production were decomposed into four and ten parts respectively with the assistance of a computer program that was written using a Matlab program. The model used to decompose change in average production was found from Hazell (1984). Table 5.4 shows the constituent parts of change in the variance of cereal production (See Hazell, 1984).

Denoting Q to be production, *A* area sown, and *y* yields; total cereal production is $Q = \sum_j A_j y_j$.

Average production is given by:

$$E(Q) = \sum_j E(A_j y_j) \qquad (5.1)$$

Variance is given by:

$$V(Q) = \sum_i \sum_j Cov(A_i y_i, A_j y_j) \qquad (5.2)$$

By expanding the variance we obtain:

$$V(Q) = \sum_j V(A_j y_j) + \sum_{i \neq j} \sum_j Cov(A_i y_i, A_j y_j) \qquad (5.3)$$

Each component term may be expanded as follows:

$$E(A_j y_j) = \bar{A}_j \bar{y}_j + \text{cov}(A_j, y_j) \qquad (5.4)$$

Following Bohrnstedt and Goldberger,

$$\text{cov}(A_i y_i, A_j y_j) = \bar{A}_i \bar{A}_j \text{cov}(y_i, y_j) + \bar{A}_i \bar{y}_j \text{cov}(y_i, A_j) +$$
$$\bar{y}_i \bar{A}_j \text{cov}(A_i, y_j) + \bar{y}_i \bar{y}_j \text{cov}(A_i, A_j) - \text{cov}(A_i, y_i)\text{cov}(A_j, y_j) + R \qquad (5.5)$$

Where A bar and y bar denote mean areas and yields, and R is a residual term consisting of higher-order cross moments.

Changes in V (Q) and E (Q) can be partitioned into constituent parts with the aid of equations 5.4 and 5.5.

Using equation 5.4, average production (i.e. E (Q)) in the third period is

$$E(Q_3) = \bar{A}_3 \bar{y}_3 + \text{cov}(A_3, y_3) \quad (5.6)$$

Equation 5.6 may be written as:

$$E(Q_3) = (\bar{A}_2 + \Delta \bar{A})(\bar{y}_2 + \Delta \bar{y}) + \text{cov}(A_2, y_2) + \Delta \text{cov}(A, y) \quad (5.7)$$

Therefore, the change in average production between the second and the third period may be obtained from:

$$\Delta E(Q) = E(Q_3) - E(Q_2) = \bar{A}_2 \Delta \bar{y} + \bar{y}_2 \Delta \bar{A} + \Delta \bar{A} \Delta \bar{y} + \Delta \text{cov}(A, y) \quad (5.8)$$

According to equation 6.8, change in average production comes from four sources. The first two terms represent changes in mean yield and mean area respectively. The third term is an interaction effect and the fourth term represents the covariability of areas and yields.

Components of change in the variance of production can be decomposed in a similar way, using equation 5.8. Change in each component can be computed using the equation shown in table 5.4.

Table 5.4: Components of Change in Production Covariances

Sources of Change	Component of Change
Δ in mean yields	$\bar{A}_{1i}\, \Delta\tilde{Y}_j$ cov $(y_{1i}, A_{1i})+ \bar{A}_{1j}\, \Delta\tilde{Y}_i$ cov $(y_{1j}, A_{1i}) + [\tilde{Y}_{1i}\Delta\tilde{Y}_j + \tilde{Y}_{1j}\Delta\tilde{Y}_i+\Delta\tilde{Y}_i\Delta\tilde{Y}_j]$ cov (A_{1i}, A_{1j})
Δ mean areas	$\tilde{Y}_{1i}\Delta\bar{A}_j$ cov$(A_{1i}, Y_{1i})+ \tilde{Y}_{1j}\, \Delta\bar{A}_I$ cov$(y_{1i}, A_{1j}) + [\bar{A}_{1i}\Delta\bar{A}_j + \bar{A}_{1j}\, \Delta\bar{A}_j +\Delta\bar{A}_j\, \Delta\bar{A}_i]$ cov (y_{1i}, y_{1j})
Δ in yield variance and covariance	$\bar{A}_{ji}\ \bar{A}_{jj}\Delta$cov (y_i, y_j)
Δ in area-variance covariance.	$\tilde{Y}_{1i}\, \tilde{Y}_{1j}\Delta$cov (A_i, A_j)
Δ in area-yield covariance.	$\tilde{Y}_{1j}\, \bar{A}_{ji}\Delta$cov$(A_j, Y_i)+\tilde{Y}_{1i}\, \bar{A}_{ij}\, \Delta$cov (y_j, A_i)-[cov $(A_{1j}, y_{1i})+\Delta$cov$(y_i, A_i)]\Delta$cov(A_j, Y_j)- cov $(A_{1j}, y_{1j})\ \Delta$cov(A_i,y_l)
Interaction b/n Δ in mean yield and mean areas	$[\Delta\bar{A}_i\Delta\tilde{Y}_j$ cov $(y_{1i}, A_{1i})+ \Delta\, \tilde{Y}_i\, \Delta\, \bar{A}_j$ cov $(A_{1I},y_{1j})]$
Interaction b/n Δ in mean areas and yield variances	$[\bar{A}_{1i}\Delta\, \bar{A}_j + \bar{A}_{1j}\Delta\, \bar{A}_I + \Delta\, \bar{A}_i\Delta\, \bar{A}_j]\ \Delta$cov (y_i, y_j)
Interaction b/n Δ in mean yields and area variances	$[\tilde{Y}_{1i}\Delta\, \tilde{Y}_j + \tilde{Y}_{1j}\Delta\, \tilde{Y}_I + \Delta\, \tilde{Y}_i\, \Delta\, \tilde{Y}_I]\ \Delta$cov (A_i, A_j)
Interaction b/n Δ in mean areas and yields and Δ in area-yield covariance.	$[\tilde{Y}_{1j}\Delta\, \bar{A}_j + \bar{A}_{1i}\Delta\, \tilde{Y}_j\, \Delta\, \bar{A}_i\Delta\, \tilde{Y}_I]\ \Delta$cov $(y_i, A_j) +[\tilde{Y}_{1I}\, \Delta\, \bar{A}_j + \bar{A}_{1j}\Delta\, \tilde{Y}_I+\Delta\, \tilde{Y}_i\Delta\, \bar{A}_j]\ \Delta$cov (A_i, yj)
Δ in residual	Δcov (A_iy_I, A_jY_j) – sum of the other components

$\tilde{Y}$ and $\bar{A}$ are mean values of yield and area respectively, Δ is change.

Components of change in variance shown in table 6.5 above were computed by developing a computer program using Matlab as shown in Appendix D.

5.4.2 Results and Discussion

Trend lines were fitted to the full time series data of each crop to detrend their respective areas and yield. The type of equations chosen (linear or polynomial) to detrend the data is determined, based on goodness of fit and within sample period prediction error. Quadratic equations gave better fits for almost all the crops. To avoid the possibility of violating the homoscedastic assumption of a least squares procedure from the use of longer series, arising from changes in economic systems, a generalized least squares estimation procedure was used. Finally, estimates of detrended production functions for each crop were computed from the products of the detrended area and yield series.

Table 5.5 shows the results of the decomposition of the change in average cereal production. Increase in area-yield covariance accounts for all the increase in the average cereal production between 1975-1989 and 1990-2000. It further reveals that all the other components of change in average production, namely, change in mean yields, change in mean area and the interaction term between changes in mean yields and mean areas are not significant. This means that yield and area sown contribute negligibly to increase in the mean of cereal production between 1975-1989 and 1990-2000.

In terms of individual crop's contribution to change in the average production of total cereals, teff accounts for 43%, wheat for 23% and sorghum for 21% of the total change in cereal production (column 6 table 5.5).

Table 5.5: Component of Change in the Average Production of Cereals; 1975-1989 and 1990-1999

Crops	Change in Mean Yields	Change in Mean Area	Change in Area-Yield Covariance	Interaction Between Changes in Mean Yields and Mean Areas	Contribution to Change in Average Production of Total Cereals
	%				
Maize	-9.4	-6.3	2.4	10.6	-2.7
Wheat	-1.5	-1.4	24.6	1.2	22.9
Barley	0.0	0.6	8.4	0.0	9.0
Teff	5.1	0.5	42.4	-5.0	43.0
Sorghum	0.0	4.9	24.4	-8.0	21.3
Oats	-0.1	0.1	0.2	0.2	0.4
Millet	0.2	0.5	6.2	-0.6	6.3
Total cereals	-5.8	-1.0	108.5	-1.7	100

Table 5.6 shows the results from the decomposition of the change in the variance of total cereal production. According to the results obtained teff on 80%, wheat on 17%, and sorghum on 13% account for almost all the increase in the variance in total cereal production. In addition, it is revealed by the same table that area and yield have little to do with the increase in the variance in total cereal production between 1975-1989 and 1990-2000. On the contrary, their contribution to change in the variance in total cereal production decreased by 110% and 37% respectively. This is attributable largely to the 117% and 35% decrease in the mean yields and mean areas of maize. If maize can be excluded from the analysis, the contribution of many of the components will be near zero except for the residuals, which will fall to 150%. This will make residuals to be the single important component contributing for the entire change in the variance of total cereal production between 1975-1989 and 1990-2000. Without the exclusion of maize, however, whose variance declined by 80%, increase in the variance of total cereals is explained in part by the increase in the sum of the interaction terms (i.e. 156%) and in part by the increase in the residuals (i.e. 192%). Residuals represent variables other than areas sown and yield which are not and cannot be included in the model. Weather variability is one of the most important candidates represented by residuals.

Table 5.6: Disaggregation of the Components of Change in the Variance of Total Cereal Production; 1975-1989 to 1990-1999

Crops	Change in Mean Yields	Change in Mean Areas	Change in Yield Variances and Covariance	Change in Area-Yield Covariances	Change in Interaction Terms	Change in Residuals	Row Sum
	%						
Maize	-116.84	-34.50	-41.59	27	218.49	-44.5	-15.2
Wheat	-0.50	-3.59	-0.97	-51	-1.48	73.1	16.7
Barley	-0.01	1.20	-0.25	5	-5.84	-7.6	-5.4
Teff	-1.74	-5.98	-0.71	-31	3.52	115.9	79.9
Sorghum	7.15	5.17	-0.03	-4	-49.92	43.8	13.3
Oats	-0.10	0.30	0.12	11	-0.07	-10.4	0.5
Millet	1.88	0.75	0.08	-9	-7.10	21.4	10.1
Total cereals	-110.14	-36.66	-43.35	-52	157.59	191.7	100.0

5.5 SUMMARY, CONCLUSION AND RECOMMENDATIONS

An attempt was made in this chapter first to show the level of cereal production and food insecurity and then to identify sources of increased instability in cereal production since 1960 and to show the extent to which policy changes have contributed to production instabilities. The study was conducted in three steps. In step 1, factors widely suspected in the literature to cause fluctuations in cereal production were described and their effect on cereal production in Ethiopia was analyzed. These included changes in area sown, changes in yield, agricultural policies and weather. It shows that area and yield have little effect on instabilities in cereal production. This is because there is a land shortage and modern input use is limited to a limited number of farmers. An increasing amount of land is being withdrawn from cultivation due to land degradation and that demand for additional land for cultivation is being met by extending cultivation to areas previously designated as permanent pasture and forests. In addition, holding size is decreasing (currently average holding size is less than one hectare) due to population pressure in rural areas and due to the land policy of the country, which prohibits transactions on land. The limited impact of yield on instability in the national cereal production is evidenced by the limited contribution that agricultural research and extension have made in respect of the availability of improved seed varieties and the expansion in the use of chemical fertilizers. Currently, the use of improved seeds and chemical fertilizers is limited to 2% and 25% of farmers respectively.

To gauge the contribution of the various marketing and pricing policies to production instability for the past four decades, marketing and pricing policies of the country were studied. It was found that cereal production was constrained by command-based systems of marketing policies between 1975-1989. Much of the production stagnation during this period was attributed to these policies. Research outputs on the marketing and pricing policies between 1990-2000 were also reviewed. They indicate that although some of the limitations that hindered the free operation of markets in the command-based economic system were corrected, grain pricing and marketing are still inefficient as a result of a host of constraints. These, together with the subsistence nature of cereal production in the country (which puts a limit on farmers' responsiveness to price changes), are believed to have limited impact on instability in cereal production.

In step 2, an attempt was made empirically to gauge the contribution of each factor to instability in cereal production for the past four decades. This was done with the help of average production, coefficient of variation (CV) and F-ratios (i.e. to test the differences between the production, area and yield variances of consecutive periods). The data were divided into three periods on the basis of differences in economic systems in order to capture the effects of these systems on the factors themselves. Between 1961-1974 and 1975-1989 (Table 5.2), the following were found: average production increased by 7%, coefficient of variation increased from 2% to 10% (i.e. by 400%), and F-ratios for the change in the variances of production did not show significant change, which implied that there was no production instability. The insignificant F-ratio for production is attributable to production stagnation in the 1980s, which in turn is attributable to the oppressive agricultural policies of the period. Higher CV during 1975-1989 as compared with 1961-1974 is attributed to increase in the frequent occurrence of drought situations. F-ratio for the change in the variance of areas sown was significant. This is attributed to the land reform which made land available to all those who wanted to till land in the 1970s.

Between 1975-1989 and 1990-2000 (Table 5.3), average production increased by 13%, and the CV by 30%, while the test on the significance of the F-ratio for the change in the variance of cereal production was significant. The higher CV indicated the continued influence of climatic variations (relatively good weather this time) on cereal production. Investigation of the factors responsible for the significant F-ratio reveals that total area sown to cereals and yield are not responsible for the change in the variance of total cereal production. This is because they both had insignificant F-ratios. Therefore, given that the period 1990-2000 is characterized by a relatively good weather situation, the increased instability in total cereals was attributed to weather variability.

In step 3, an attempt was made to further probe into factors behind significant variation in cereal production between 1975-1989 and 1990-2000, using an exact method procedure to decompose changes in the mean and variance of total cereal production. Decomposition of the component of change in the average production of cereals shows that total areas sown to cereals and yield of cereals have little to do with the increase in the mean of cereal production. The entire increase in the mean of total cereals was attributable to increase in area-yield covariance. It was further found that teff, wheat and sorghum account for close to the entire change in the mean of total cereal production. On the other hand, decomposition of the component of change in the variance on total cereal production reveals that much of the increase in the variance of total cereal production is accounted for by residuals. Residuals are assumed to represent weather variability. These imply once again that weather variability is the cause for the recent increase in the variance of total cereal production.

The three steps mentioned above singled out weather variability rather than change of policies as a major reason for instability in cereal production. Increased instability in cereal production is directly reflected in increased market and price instabilities and has a significant effect on the welfare of farmers and people in the low-income bracket. Increasing the agricultural research and extension capacities of the country in order to improve the supply of new technologies can minimize the root cause for production instability arising from weather variability. It is believed that cereals grown with new technologies have lower coefficients of variation than cereals grown with traditional technologies (Hazell, 1989b) . This implies that new technologies ensure greater stability rather than instability in cereal production.

CHAPTER 6

CEREAL SUPPLY RESPONSE IN ETHIOPIA

6.1 INTRODUCTION

It was shown in chapter two to chapter five that the agricultural sector had been neglected until 1994 because growth was thought to be synonymous with industrialization. This view was justified by the belief that industry is the dynamic sector, while agriculture is static and unresponsive to incentives. This belief led to the taxing of agriculture by turning domestic terms of trade against agriculture. The consideration that agriculture is unresponsive implied that resources generated in agriculture could be transferred to other sectors of the economy without significantly affecting agricultural growth.

Efforts gradually to liberalize agriculture have been initiated since 1992. In addition, the age-long policy of industry-led growth was replaced by an agriculture-led growth strategy in 1994. The rationale behind these is the belief that the supply response of agriculture is high and that the continuation of the taxing of agriculture will have a multifaceted impact on the growth of the sector and other sectors of the economy through its functional role in the economy. The primary objective of this chapter is therefore to determine the responsiveness of Ethiopian farmers to incentive changes by estimating supply-response functions.

There are a number of studies that have attempted to estimate supply response of Ethiopian farmers using historical data. These include the World Bank (1987), Fernando (1992), Alemu (1995) and Abebe (1998). These studies can be criticized on two grounds. Firstly, the modelling technique used. They applied Nerlovian Partial Adjustment models, which are considered weak for the following reasons. Firstly, their inability to give an adequate distinction between short- and long-run elasticities (McKay, *et al.*, 1998; Townsend, 1997). Secondly, it uses integrated series, which poses the danger of spurious regression (Granger and Newbold, 1974; Nelson and Plosser, 1982; Townsend, 1997). Thirdly, the assumption that production adjusts to a fixed target of supply, towards which actual supply adjusts, is considered unrealistic under dynamic conditions (Nerlove, 1979). Fourthly, there is empirical evidence that the dynamics of supply can be better described by Error-Correction Models (ECM) than Partial Adjustment Models (McKay, *et al.*, 1998; Hallam and Zanoli, 1993). In this study, an ECM is employed. It gives clear distinction between short-run and long-run elasticities, it makes use of both non-stationary and stationary data and introduces in the model a dynamic adjustment coefficient.

The second, common weaknesses of past studies are that they used proxy variables to producer prices, they used a small number of observations in supply-response estimation, they made little or no attempt to take into account the effects of structural breaks on their price-elasticity estimates, and they used non-stationary data. These aspects cast doubt on the validity of these studies. In an attempt to solve these problems, a relatively larger number of observations were used, statistical properties of the data were studied and available variables which are thought to be good predictors of planned supply of teff, wheat, maize and sorghum, namely, real producer prices of own and substitute crops, rainfall, policy variables and others were collected from various sources. It is hypothesized in this study that the planned supply of teff, wheat, maize and sorghum are positively affected by own prices, negatively by prices of substitute goods and negatively or positively by changes in the price policy regimes depending on the nature of the changes.

6.2 THE DATA AND VARIABLES

The data set begins in 1966 and ends in 1994. It was obtained from the following sources: Food and Agriculture Organization's statistical database (FAO) and various issues of the Central Statistical Authority (CSA). The data were indexed at the 1990 prices and converted to logarithms in order easily to interpret coefficients of interest as elasticities. Several variables predict agricultural supply. Considering the problem with the quantification of some of these variables, supply response is estimated using variables indicated in equation 1 below.

$$Y_t = \alpha_0 + \alpha_1 P_{1t} + \alpha_2 P_{2t} + \alpha_3 R_t + \alpha_4 T_t + \alpha_5 DTB_t + \alpha_6 D_t + \varepsilon_t \qquad (6.1)$$

Where,

Y_t is the dependent variable representing area planted at time t. Area planted is preferred to output for the reason that the latter fails to reflect planned production decisions of farmers because of its susceptibility to weather variability.

P_{1t} represents a vector of own prices. It is calculated by dividing the nominal producer price of the crop in question by the GDP deflator i.e. nominal GDP divided by real GDP. Unlike other studies, price of fertilizer is not used as a price deflator in this study. This is because, according to available data, less than 25 percent of the farmers apply chemical fertilizers in production. P_{1t} is expected to have a positive sign and it is interpreted as the long run price elasticity of supply.

P_{2t} is a vector for the real producer price of competing outputs. P_{2t} measures the opportunity cost of producing other crops. Wheat and teff compete for land. The same is true with sorghum and maize due to similarities in planting seasons. Therefore, wheat is considered a substitute to teff while maize is to sorghum and vice versa. The effects of changes in own prices on quantity supplied are represented by movements along the same supply curve, whereas changes in the producer prices of competing crops are expected to cause increase or decrease in supply (or shift in supply curve), depending on the direction of change in the price of the competing crop.

R_t is rainfall. An attempt was made to capture the effect of rainfall on the planned supply of teff and wheat by adding rainfall figures for the months of June, to

September of three weather stations located in Bahir Dar, Debre Markos and Debre Zeit. For maize, rainfall data were collected from five weather stations, namely Bahir Dar, Debre Zeit, Debre Markos, Gore, Jima and Combolcha. For sorghum, data on rainfall were collected from Combolcha and Gore weather stations.

T_t stands for time trend. Historical data on infrastructural developments, expenditure on agricultural research and extension, applications of modern techniques like fertilizers and improved seed varieties on crop basis are hardly available. Therefore, these variables cannot be easily represented in the acreage supply-response equations directly and individually. Rather, an attempt is made to capture their effects collectively by introducing time-trend variables in the long-run equations of each crop.

DTB_t and D_t stand for structural breaks. These are in line with Newbold, et al., (2000) systematic method of identifying and also capturing the effects of exogenous variables on the parameter estimates. The inclusion of these variables in the regression equation has the advantage of salvaging the whole exercise from the celebrated 'Lucas critique' which states that Ordinary Least Squares (OLS) estimates cannot be assumed to be independent of changes in the exogenous variables (Maddala, 1992). The method enables the analyst to detect and also evaluate exogenous variables, which, among others, could result from transitions to new policy regimes. This was achieved by examining series of residuals from the fitted models of long-run equations and by identifying cases where the absolute values of the residuals exceeded two standard deviations. Each break date (i.e. TB) identified in this way is represented by a pair of dummy variables (see equation 6.2). According to results obtained (Section 6.4.3), such events occurred in 1972, 1976, 1982, 1984, 1990, 1992 and 1993. The years 1972, 1982, 1984 and 1993 stand for years in which grain supply was affected by different-from-normal weather patterns. Except for the year 1982, the three represent years during which adverse drought situations occurred.

$$\left.\begin{array}{l} DTB_t = 1 \text{ if } t = TB \text{, and 0 otherwise} \\ D_t = 1 \text{ if } t > TB \text{, and 0 otherwise} \end{array}\right\} \quad \text{......(6.2)}$$

The remaining years, i.e. 1976, 1990 and 1992, may be associated with radical changes in the economic systems of the country. Socialism was announced the political and economic system of the country in 1975/76, a mixed economic system was introduced in 1990 and a free-market economic system in 1992. Socialism brought with it nationalization of land, agricultural collectivization, a fixed pricing system of grain, forced grain delivery requirements to government parastatals, villagization and resettlement programmes. The change to a mixed economic system in 1990 lifted many of the constraints which had adverse consequences on agriculture, namely agricultural collectivization, fixed pricing, fixed quota delivery systems and checks on the free movement of grain. The change to a free market economic system in 1992 strengthened the reform process that was started in the 1990s by initiating macro-economic policy reforms.

6.3. METHODS

Co-integration and error-correction techniques are applied in this study. These techniques are believed to overcome the problem of spurious regressions and to give consistent and distinct estimates of long-run and short-run elasticities that satisfy the properties of the classical regression procedure. This is because all variables in an ECM are integrated of order zero, I (0). Spurious regression and inconsistent and indistinct short-run and long-run elasticity estimates are major problems exhibited by traditional Adaptive Expectation and Partial Adjustment models (Hallam and Zanoli, 1993; McKay, et al.., 1998). Co-integration and ECMs have been used in agricultural supply response analysis in other countries by a number of researchers, namely Townsend (1997), Schimmelpfennig, et al.. (1996), Townsend and Thirtle (1994).

One major use of the co-integration technique is to establish long-run equilibrium relationships between variables. However, two conditions must be met for co-integration to hold. First, individual variables should be integrated of the same order. Second, the linear combination of these variables must be integrated of an order one less than the original variables (Engle and Granger, 1987). In other words, if the variables under consideration are integrated of order one, or I (1), the error term from the co-integrating relationship should be integrated of order zero, I (0), implying that any drift between variables in the short run is temporary and that equilibrium holds in the long run.

If deviation from the long-run equilibrium path is bounded or co-integration is confirmed, Engle and Granger (1987) show that the variables can be represented in a dynamic error-correction framework. Therefore, in this paper, like similar studies elsewhere, supply response is modelled in two stages. First, a static co-integrating regression given by equation 1 is estimated for each crop and tests for co-integration are conducted. Second, if the null for no co-integration is rejected, the lagged residuals from the co-integrating regression is imposed as the error correction term in an error correction model. An example of an ECM model is shown below.

$$\Delta Y_t = \varphi_0 + \varphi_1 \Delta P_{1t} + \varphi_2 P_{2t} + \varphi_3 R_t + \varphi_5 \Delta DTB_t + \varphi_6 \Delta D_t$$
$$-\lambda(Y_t - \alpha_0 - \alpha_1 P_{1t} - \alpha_2 P_{2t} - \alpha_3 R_t - \alpha_4 T_t - \alpha_5 DTB_t - \alpha_6 D_t) + \upsilon_t \quad \text{......}(6.3)$$

Where Δ represents first differencing, λ measures the extent of correction of errors by adjustment in Y_t. φ_1 measures the short-run effect on supply of a per cent change in own price (or short-run price elasticity of supply) while α_i measure the long-run price elasticities.

6.4 RESULTS AND DISCUSSION

6.4.1 Order of Integration

The test for the order of integration is the first step in any co-integration analysis. If a series is integrated, it accumulates past effects. This means that perturbation to the series does not return to any particular mean value. Therefore, an integrated series is non-stationary. Order of integration of such a series is determined by the number of times that it must be differenced before it is actually made stationary. It follows that if two or more series are integrated of the same order then a linear relationship can be estimated. Examining the order of integration of this linear relationship is similar to testing for the null hypothesis that there is no co-integration against its alternative that there is co-integration. In this section, an attempt is made to determine the order of integration of the variables. This is followed by the test for co-integration in section 6.4.2.

Table 6.1 shows that all acreage variables are integrated of order 1 or I (1), both in the non-trended and trended models. Real producer prices of the crops under study are I (1) in the non-trended models, except the real producer price of sorghum which is I (0). But in the trended model, except for the producer price of wheat, all the other prices are I (0). Table 6.1 further shows that rainfall data on teff, wheat, maize and sorghum growing seasons of selected regions are stationary or are integrated of order one (I (1)).

Table 6.1: Unit root test statistics for cereals

Variable Name	DF Test with intercept	DF test with intercept and trend
Log area planted in teff	-1.90	-1.89
Δ Log area planted in teff	-7.49	-7.79
Log area planted in wheat	-1.71	-1.26
Δ Log area planted in wheat	-3.86	-3.81
Log area planted in maize	-1.94	-2.80
Δ Log area planted in maize	-5.30	-5.18
Log area planted in sorghum	-1.99	-2.60
Δ Log area planted in sorghum	-4.68	-4.48
Log area planted in barley	-3.13	-3.06
Δ Log area planted in barley	-5.41	-5.22
Log producer price teff	-2.24	-5.52
Δ Log real producer price teff	-4.32	-5.39
Log producer price wheat	-2.40	-4.45
Δ Log real producer price wheat	-3.20	-4.35
Log real producer price maize	-2.90	-5.24
Δ Log real producer price maize	-3.77	-5.13
Log real producer price sorghum	-3.04	-5.25
Δ Log real producer price sorghum	-3.89	-5.18
Log of teff and wheat growing season rain	-3.74	-4.35
Log of maize growing season rain	-3.22	-3.61
Log of sorghum growing season rain	-4.94	-4.92
Critical values, 95% confidence level	-2.98	-3.59

Note: Δ = first difference.

The inconclusive results with regard to producer prices were dealt by differencing the series. This is in line with literature that differencing, even though the true data generating process is stationary, has little consequence on the consistency of parameter estimates compared to working with levels while the true data-generating process is difference stationary (Maddala, 1992: 261). What differencing does to data, which is already a stationary process, is to create a moving average error, and hence, inefficient estimates, which can be corrected by estimating the differenced equation using an OLS technique. But if data in levels are wrongly considered stationary and are modelled without being differenced, its likelihood of violating the assumptions of classical regression procedure is very high. This results from an over time increase in the variance of errors. Therefore, it is a widely accepted view that it is best, with most economic time series, to work with differenced data rather than data in levels (Plosser and Schwert, 1978). The consequence of differencing is loss of information on the long-run relationships among variables, which can be handled by estimating an ECM. With this in mind, all the I (1) and all others with inconclusive test results were differenced. Test results on DF tests on the differenced series for all variables are reported in Table 6.1. According to the results obtained, all are stationary processes, or I (0).

6.4.2 Co-integration

Test results for the order of integration of series in section 6.4.1 showed that some of the series are integrated of order one or I (1) while the remaining are I (0). The main objective of this section is to test for the stationarity of the linear relationship of these variables or to determine whether the variables are integrated of order zero, or in short, whether they are co-integrated. If co-integration is confirmed, a non-spurious long-run equilibrium relationship exists. When this is combined with ECM, whose variables are I (0), consistent estimates of both long-run and short-run elasticities is evident.

Two tests, one residual-based, proposed by Engle and Granger (1987) and the second reduced rank procedure of Johansen (1988), were employed to test for co-integration. The residual-based procedure is known as a single-equation approach. It assumes that the variables in the long-run equation are all I (1) and tests whether the error term in equation 1 is I (1) against the alternative that it is I (0). The Johansen reduced-rank approach, on the other hand, is a system approach in the sense that it tests for the existence of a more than one co-integrating relationship. In this study, the constant and the trend variables in the Johansen procedure applied were set unrestricted, meaning that they were not forced to lie in the co-integration space only. The two approaches are used in this study only to support evidence on the long-run equilibrium relationships among variables. Results are reported in Table 6.2. According to Table 6.2, both the residual-based and the Johansen test procedures indicate the existence of co-integrating relationships between planned supply and the variables that predict it. This is the first step in supply-response modelling.

Table 6.2: Co-integration tests for cereals

Equation	Variables	DF Test		Johansen Model	
		Without trend	With trend	Eigenvalue Test	Trace Test
Wheat	WHEATA, WHEATP, D72, D76, DTB82, D82, DTB92	-5.51 (-2.98)*	-5.45 (-3.59)*	1) 19.33 (22.26)* 2) 18.19 (16.28)**	43.94 (39.33)* 24.61 (23.83)*
Maize	MAIZEA, MAIZEP, SORGHUMP, DTB76, D84, D90, DTB93,	-4.75 (-2.98)*	-4.62 (-3.59)*	1) 44.08 (24.35)* 2) 27.87 (18.33)* 3) 12.17 (11.54)*	84.12 (39.33)* 40.03 (23.83)* 12.17 (11.54)*
Sorghum	SORGHUMA, SORGHUMP, MAIZEP, RAINFALL, D72, DTB90, D90, DTB93	-4.73 (-2.98)*	-4.62 (-3.59)*	1) 21.54 (22.26)	45.20 (39.33)* 23.66 (21.23)*
Teff	TEFFA, TEFFP, WHEATP, RAINFALL, DTB74, D74	-6.16 (-2.98)*	-6.02 (-3.59)*	1) 22.26 (22.26)**	41.78 (39.33)*

Note: numbers in brackets are critical values. * significant at 5%; **significant at 10%

6.4.3 Error-Correction Model

After long-run relationships between cultivated area and the variables predicting it are confirmed, ECM is developed. Results are reported in Table 6.3. According to Hallam and Zanoli (1993), a high R^2 in the long-run regression equation is necessary to minimize the effect of small sample bias on the parameter estimates of the co-integrating regression which may otherwise be carried over to the estimates of the error-correction model. The models are chosen on the basis of the following criteria: data coherence, parameter consistency with theory and goodness of fit. According to results from the short-run model (top of table 6.3), planned supply of teff, wheat, maize and sorghum are affected positively by own prices but negatively by prices of substitute goods. Except for maize, whose price elasticity is 0.38, in the short run, both own prices and prices of substitutes of the other crops are insignificant. The insignificant price elasticities for the remaining crops can be attributed to infrastructural factors, namely, technological constraints, credit constraints, poor marketing situations, the existing land tenure system and lack of physical infrastructure.

It has been also found that planned supply is significantly affected by policy changes, which resulted in the leftward or rightward shift of supply. The effect of these policy changes had a pronounced effect on planned supply in 1974, 1976, 1980, 1990 and 1992. Furthermore, planned supply is affected in the short-run by extreme weather changes, which occurred in 1972, 1982, 1984 and 1993. The years 1972, 1984 and 1993 represent severe drought situations, whereas 1982 represents a good harvest year. The error- correction terms in each equation have the required signs. However, the rate of adjustments towards the long-run equilibrium of each crop occurs, with almost 100 per cent correction occurring in the current period. An investigation of this finding is left to other studies as it is beyond the scope of this study.

The long-run supply response model is given in the bottom half of Table 6.3. According to results obtained, own price and the introduction of socialism as the political and economic system of the country, represented by the break variables (i.e. DTB74 and D74), together account for 88 per cent of the variation in planned teff supply. All variables in this equation have the expected signs. Supply of teff is positively affected by its own price, negatively by the price of its substitute (i.e.

wheat), negatively by the introduction of socialist production relations and negatively by the time trend variable. Socialism was the political and economic system of the country between 1974 and 1990. Of these variables, own price, the constant term, DTB74 and DT74 respectively, are significant at the 15, 1, 5 and 1 per cent levels. Table 6.3 further shows that a 10% increase in the producer price of teff caused a 2.8% expansion of cultivated area of teff.

Table 6.3: Error-Correction Model Results on cereals

Variables	Teff	Wheat	Maize	Sorghum
		SHORT RUN		
Constant	-0.15 (-0.57)			-0.56 (-2.17)**
ΔP1	0.14 (0.90)	0.15 (1.15)	0.38 (2.72)**	0.09 (0.71)@
ΔP2	-0.09 (-0.63)	-0.23 (-1.57)	-0.47 (-3.47)**	-0.01 (-0.12)
R	0.08 (0.58)			0.27 (2.16)**
ΔD72		-0.12 (-4.25)***		-0.11 (-1.61)
ΔDTB74	-0.09 (-2.25)**			
ΔD74	-0.23 (-4.19)***			
ΔDTB76			-0.08 (-3.96)**	
ΔD76		-0.17 (-5.88)***		
ΔDTB82		0.12 (4.11)***		
ΔD82		0.13 (3.15)***		
ΔD84			0.12 (3.85)**	
ΔDTB90				-0.14 (-2.01)**
ΔD90			0.09 (3.27)**	-0.08 (-0.85)
ΔDTB92		-0.08 (-3.65)**		-0.07 (-1.46)
ΔD92				
ΔDTB93			-0.15 (-7.32)	
ΔD93				
Error(-1)	-1.18 (-4.52)***	-1.12 (-4.60)***	-1.05 (-4.79)***	-1.11 (-3.50)**

Adjusted R^2	0.58	0.76	0.80	0.32
F	7.10	12.95	17.83	2.53
LONG RUN				
Constant	2.16 (7.49)***	2.22 (113.06)***	1.81 (197.71)***	1.63 (7.28)***
Time	-0.002 (-1.12)			0.005 (1.51)
P1	0.28 (1.53)	0.28 (1.83)	0.51 (2.87)	0.43 (1.41)
P2	-0.13 (-0.89)	-0.30 (-1.70)*	-0.63 (-3.85)**	-0.50 (-1.61)
R	0.06 (0.39)			0.26 (2.44)**
D72		-0.13 (-5.6)***		-0.19 (-4.51)***
DTB74	-0.09 (-2.58)**			
D74	-0.19 (-7.97)***			
DTB76			-0.09 (-2.70)**	
D76		-0.15 (-5.6)***		
DTB82		0.11 (3.31)***		
D82		0.08 (4.48)***		
D84			0.11 (4.97)***	
DTB90				-0.21 (-3.19)**
D90			0.05 (2.53)**	-0.17 (-3.75)**
DTB92		-0.10 (-2.90)**		-0.12 (-2.05)**
DTB93			-0.14 (-4.10)***	
Adjusted R^2	0.88	0.92	0.82	0.78
F	33.0	45.9	2120	13.18

*Note: figures in brackets are t-ratios, P1= is own price elasticity; P2 = cross price elasticity; R= rainfall; D followed by a date represents structural break in that date, DTB followed by a date represents time of break, @ indicates that price data are stationary on levels meaning not differenced. *** = significant at 1%, ** = significant at 5% and * = significant at 10%.*

Own real producer price, real producer price of substitute, D76, DTB82, D82 and DTB92 together accounted for over 92 per cent of the variation in the cultivated area of wheat. A cursory review of the equation for wheat shows that the variables have the expected signs except DTB92. The negative sign on DTB92 could be attributed to the changes in the political and economic systems of the country that allowed farmers to produce crops of their choice and to sell them at market-determined rates. Between 1975 and 1990, farmers used to be forced to produce and sell grain at fixed prices to satisfy fixed-grain quota delivery requirements imposed on them by the Agricultural Marketing Corporation (AMC). The negative sign could therefore be attributed to the diversification or change in the mix of production of crops by farmers.. Similar incidences were witnessed in the mid-1980s when farmers attempted to evade flat grain quota delivery systems by changing their mix of production (Befekadu and Tesfaye, 1990). Many farmers were reported to have started producing oil crops to which the government responded by introducing fixed quota delivery systems and by imposing severe penalties on farmers who transgressed the fixed quota delivery policy. Grain collected used to be rationed at lower prices to urban consumers.

Table 6.4: Long- and short-run price elasticities for cereals

Equations	**Price elasticity coefficients**	
	Long-run	**Short-run**
Teff	0.28****	0.14
Wheat	0.28***	0.15
Maize	0.51***	0.38*
Sorghum	0.43****	0.09

Notes: *significant at 1% level of significance; ** significant at 5% level of significance; *** significant at 10% level of significance; **** significant at 20% level of significance.

Planned supply of wheat is affected positively by own price, negatively by the price of the substitute (i.e. teff), negatively by D72 (i.e. the 1972 drought), negatively by DT76 (i.e. change in policy), positively by DTB82 and D82 (i.e. the 1982 good rain), and negatively by DTB92 (i.e. change of government). It is also shown that these variables are significant at the acceptable levels. Tables 6.3 and 6.4 further show that a 10% increase in the producer price of wheat and teff causes a 2.8% expansion and a 3% decrease in cultivated area of wheat. It is interesting to note that breaks, which represent adverse policy situations and natural calamities, shift supply of wheat by approximately 0.13 to the left.

Own price, price of substitutes (i.e. sorghum), DTB76, D84, D90 and DTB93, account for over 82% of the variation in the cultivated area of maize (Table 6.3). DTB76 and D90 captured the effects of the introduction of socialist policies between 1974 and 1978 on cultivated area of maize, while D90 captured the effect of the removal of many of the constraints that agriculture had been facing, with the exception of land, between 1974 and 1990. All the variables have the expected signs except D84. In addition, all are significant at the 1% and 5% levels of significance. A 10% increase in the producer price of maize results in a 5.1% expansion in the cultivated area of maize (table 6.4). A 10% increase in the price of its substitute, sorghum, causes a 6.3% decrease in the cultivated area of maize. A 10% increase in the magnitude of the occurrence of adverse situations emanating from a change of policies and drought on average cause a 1.1% shift in the supply function of teff to the left.

Own real producer prices, real producer prices of the substitutes (i.e. producer price of maize), rainfall, D72, DTB90, D90 and DTB92 together account for over 78% of the variation in the cultivated area of sorghum (table 6.3). The variable D72 represents the 1972 drought, while DTB90, D90 and DTB92 capture the effects of the 1990 and 1992 change of policies. All the variables, except DTB90, D90 and DTB92, have the expected signs. With the exception of own producer prices and the producer price of the substitute crop, which are significant at the 15% and at the 20% levels respectively, the rest are significant at the 1% and 5% levels. This implies that a 10% increase in the real producer price of sorghum and maize causes a 4.3% expansion and a 5% contraction in the cultivated area of sorghum (Tables 6.3 and 6.4). The reasons for the negative signs of the 1990 and 1992 policy changes on the cultivated area of sorghum could be attributed to their effect on the transfer of resources from non-traded to traded goods by raising the domestic prices of tradables. Studies indicate that farmers in both predominantly cash-crop and non-cash-crop growing areas of the country have started increasingly utilizing their scarce resource, i.e. land, to the production of perennial crops such as coffee, t' chat, and vegetables, such as potatoes and tomatoes, attracted higher prices (Alemu, 1998; Tesfaye, 2002).

The following were some of the major policy changes that were introduced between 1974 and 1980 alone which could have bearing on the responsiveness of cultivated area of cereals to various changes. The effects of these policy changes on planned supply of the crops studied were captured by DTB74, D74, DTB76, D76, DTB90, D90, DTB92 and D92. Attempts are made in the following paragraphs to highlight possible reasons for these changes.

In 1974, land became the property of the state. This unified the age-old disparity in land ownership rights between the northern and the southern parts of the country. In the northern part of the country, in general, communal ownership of land was practised. But in the south, a free hold system was prevalent. In 1976, direct government control of prices and markets were introduced, which followed the establishment of the Agricultural Marketing Corporation (AMC), aimed at linking peasant farms to an urban rationing system. Peasant farmers started to be forced to sell their production quota at fixed prices to AMC. The quota was flat and had the objective of restricting the free-market exchange of grain. Later, the flat quota delivery system was replaced by a fixed quota delivery system in order to force farmers from evading grain quotas by changing their mix of production.

In 1976 and 1977, resettlement and villagization programmes were started. The former has the objective of resettling the unemployed and farmers from densely populated areas in the highlands to increase productivity through the use of under-utilized surplus lands and to provide land to those without it. Many new settlers reportedly abandoned their new homes and returned to their old villages for reasons such as dissociation from ways of life that they were used to and due to fear as their new homes were at the center of political contention. With regard to the villagization programmes, according to Alemayehu (1990), the programme was executed with the intention to serve as a prelude to co-operativization. Like the resettlement programme, the benefit of villagization programme was political and social but not economic (Alemayehu, 1990).

In 1978, producer co-operatives (PC), guided by socialist ideology, were established. This had a goal of facilitating a transition to large-scale farm production in order to achieve the ultimate objective of the socialist state to extract as much resources as possible to finance growth in the non-agricultural sectors. In the same year, input pricing and marketing fell in the hands of government parastatals, namely the Agricultural Input Supply Corporation (AISCO) and the Ethiopian Seed Corporation (ESC). These corporations gave priority in terms of input delivery to producer cooperatives and state farms by marginalizing private peasant farms, which until 1990, accounted for over 90 per cent of the cultivated land and production.

No significant addition to the changes mentioned above was introduced in the 1980s, except the formulation and implementation of the ten-year perspective plan. The plan vowed to speed up the establishment of producer co-operatives. It targeted to increase the number of producer cooperatives from 1147 at the time, when the plan was implemented, to 15, 344 by the end of the plan period. Except for the land policy, which remained unchanged to date, all the other policies that impacted on agriculture between 1974 and 1990 were reformed by the changes in 1990 and 1992 to the political and economic systems of the country.

6.5 CONCLUSIONS AND POLICY IMPLICATIONS

In this chapter, factors that explain long-run and short-run supply response of teff, wheat, maize and sorghum production are studied. It was found that planned supply of these crops is positively affected by own real producer prices and negatively by real producer prices of substitute goods. This occurred in both the short-run and in the long run. These findings rule out the applicability of perverse supply response in Ethiopian agriculture.

Except for maize, short-run price elasticities are not significant for the remaining crops. However, long-run price elasticities are positive and highly significant but inelastic. Long-run elasticities ranged between 0.05 to 0.51, which compared with estimates by Bond (1983) for other Sub-Saharan African countries, is very low. This could be attributed to the severity of structural constraints that Ethiopian farmers are facing. The finding that long-run price elasticities are positive and significant supports the expectation that farmers respond to incentive changes. In addition, the finding that long-run elasticities are positive, significant and greater than short-run elasticities may imply the following: that it takes time before farmers obtain information about price changes due to infrastructural problems, that farmers respond to price changes only when they are convinced that the changes are permanent, that some resources are fixed and take time before they can be mobilized.

Planned supply was also affected by structural breaks, which occurred in 1972, 1974, 1982, 1984, 1990, 1992 and 1993. In 1974, land became the property of the state and various other policy changes, which potentially affected agriculture but that were in line with the socialist principles of production organization, were introduced. In 1990 and 1992, changes in policies from command-based to mixed-based and from mixed-based to market-based policies were introduced. The years 1972, 1982 and 1993 represent changes in weather patterns. Each structural break in its own time affected planned supply by causing an upward or downward shift in the supply curves, depending on their sign. The error correction coefficients indicate that the entire per cent of the adjustment towards long-run equilibrium for food crops is completed in one period.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

This study took as its major goal the study of the responsiveness of Ethiopian agriculture to policy and non-policy related changes. The study had the following objectives: reviewing agricultural policies of Ethiopia, measuring the contribution of agriculture to overall GDP growth, measuring the responsiveness of aggregate agriculture to policy and non-policy related factors and its degree of vulnerability to external events, and measuring the responsiveness of the crop sub-sector.

A summary of the methods, conclusions and recommendations of the study are given in the following three sections.

7.2 MODEL ESTIMATION

A number of estimation techniques were employed to achieve specific objectives of this study. In view of the lack of availability of econometric or statistical packages tailored to achieving two of the specific objectives of this study, two computer programs were written. The first program was helpful to decompose changes in the mean and variances of cereal production into four and ten components respectively while the second was used to date periods of cyclical fluctuations on agricultural GDP.

It is apparent that to comply with basic assumptions of econometric procedures, under normal circumstances, econometric estimation must be preceded by a study of the statistical properties or the data generating processes of the data. This had for long been conducted by applying conventional Augmented Dickey-Fuller (ADF) statistic until the influential article by Perron (1989) for the first time showed the consequence of applying the conventional ADF method on data characterized by a structural break(s). He found that the conventional ADF procedures have the tendency of incorrectly considering a data as a difference stationary process while the true data generating process is in fact a trend stationary process. However, Perron's contribution is severely criticized for assuming structural breaks as known a priori and for suggesting the use of an adjusted ADF procedure in place of the conventional ADF procedure to test for the statistical property of a time series variable without testing for the significance of the assumed break.

In this study, an attempt was made to improve Perron's (1989, 1990) procedure. This was achieved by introducing a two step procedure. In step one, structural breaks were detected and tested for their significance using recursive analysis. And in step two, depending on the result obtained in step one, decision on the use of a model to test for unit root was made.

In each chapter, different methods were employed. In chapter two, literature on agricultural policy of Ethiopia was reviewed. In chapter three, descriptive statistics were applied to compare the performance of agriculture with non-agriculture and a Vector Autoregressive Procedure (VAR) and time varying parameter approaches were combined to measure the contribution of growth in agriculture to growth in other sectors of the economy at stages of economic policy reform. This model was preferred to the input-output model for the mere reason that data needed to conduct this type of analysis are hard to get in Ethiopia. Otherwise, the application of an input-output model could have provided a better picture of the whole strings of contributions that link agriculture with the rest of the economy.

In chapter four, a regression procedure was applied to measure the responsiveness of aggregate agriculture to major policy changes. In addition, the degree of persistence of aggregate agriculture to shocks and the effect of drought on cyclical fluctuation of agricultural GDP were determined by studying the data generating process and by employing a univariate time series procedure respectively. The following is one major weakness of the regression analysis that was applied in this study to measure the responsiveness of aggregate agriculture to policy and non-policy related changes. Policy and non-policy related variables were quantified with the assumption that their effects on aggregate agriculture will be felt immediately in the year in which they are introduced. However, depending on facts on the ground, there may exist a time lag between the date on which a change in a policy is introduced and the date on which its effect is realized.

In chapter five, statistics such as average production, coefficient of variation (CV), the probability of a 5 percent shortfall below trend line and variance decomposition techniques, were applied to identify sources of increased instability in cereal production. In chapter six, an error correction approach was employed to measure the responsiveness of cereal producers to producer prices and major changes in economic policies. This approach is much preferred to the traditional approach i.e. partial adjustment model which is criticized on both theoretical and empirical grounds (McKay, 1998). The main criticisms pointed at an error correction model , which makes use of a time series data are the following. First, long-run elasticity estimates are biased downward due to the belief that farmers respond to price changes only when price changes are perceived to be permanent. Second, price elasticity estimates computed using such models are in general subject to the Lucas critique. The first criticism remains to be the major weakness of time series modeling in general. But an attempt was made to handle the second criticism by introducing dummy variables to capture the effect of the occurrence of policy and non-policy related events.

7.3 SUMMARY OF FINDINGS

Agricultural development polices of Ethiopia that have been implemented since 1957 could be broadly divided into industry-led (between 1960s to 1980s) and agriculture-led (since 1994). The industry-led development strategy had its theoretical roots in the earlier works of Arthur Lewis's two-sector classical growth model, Hirschman's postulate on linkage effects, and Raul Prebisch's secular decline hypothesis. Similarly, the agricultural-led strategy was influenced, to mention a few, by the theoretical works of Johnston and Mellor (1961), Mosher (1960), Mellor (1997) and De Janvry and Sadoulet (1989).

If the industry-led strategy is judged by the objective that it upholds, structural transformation, data indicate that the country is still stumbling in its first stage of economic development. In short, what is commonly known in economic development literature as the Johnston and Mellor environment or structural transformation has not yet been attained. This situation can be attributed to the following. Firstly, little effort was made to develop agriculture because government attention to agriculture was sporadic or did not occur in an organized fashion to tackle rural underdevelopment. Secondly, the very strategy adopted contradicts the experiences of many of the now successful countries. A study of the economic histories of most successful countries reveals that they embarked on structural transformation after they made sure that their agricultural sectors were in good shape. But, in Ethiopia, development planning was started from the second stage—structural transformation.

With regard to the effectiveness of the agriculture-led strategy, its duration has been too short to give any meaningful judgement. However, a review of measures taken after a new economic policy was introduced in 1992 indicated that its effectiveness is being harmed by the following constraints, namely, the existing land policy, structural constraints and poor marketing situations.

The objective regarding the contribution of agriculture to economic growth was discussed at some length in chapter three. Chapter four discussed the responsiveness of aggregate agriculture to major policy and non-policy related changes in general. Chapter five discussed the level of and the causes for significant instabilities in major cereal crops. Chapter six discussed the responsiveness of peasant agriculture to price incentives.

In chapter 3, the performance of agriculture was measured using three indices, namely, its contribution to overall GDP relative to the manufacturing and service sectors, its growth in relation to population, its over-time share from GDP, the ability of the sector to withstand the whims of nature, and its ability to stimulate growth in other sectors of the economy. The following were major findings of the chapter. Firstly, much of the growth in overall GDP during the three periods has been as a result of growth in the manufacturing and the service sectors, i.e. the contribution of agriculture has been very low. Secondly, the agricultural GDP growth rate has been lower than the population growth rate for over four decades implying that the country is food insecure. Thirdly, there is a trend decline in the share of agriculture from GDP, and that this is being offset by an upward trend in services but not in manufacturing. The upward trend in service GDP is not a normal pattern of economic growth as it is the result of expansion in public expenditure but not an increase in expenditure on education, health, communication and the like. Fourthly, the performance of agriculture, as well as its contribution to overall economic growth has been directly linked to an external factor, such as drought. Fifthly, a study on the performance of agriculture in terms of stimulating growth in other sectors of the economy gave the following results. It has been found that the contribution of agriculture to growth in other sectors of the economy has been dependent on the type of economic systems followed and non-economic constraints faced at various levels of economic reform. Growth in agriculture contributed positively to growth in the manufacturing and service sectors before 1975, and its contribution to growth in these sectors has been improving since 1990.

In chapter four, the objective was to measure the responsiveness of aggregate agriculture to policy and non-policy related changes. It was found that major changes in economic systems have had little impact on the slope, as well as intercepts of agricultural GDP series. It was also found that agricultural GDP was a trend stationary process. Therefore, events, which might originate from natural or man-made factors, dissipate in a short period of time with little impact on the long-term performance of agricultural GDP. As part of a continuation to the finding on the responsiveness of aggregate agriculture to policy and non-policy related changes and to the degree of persistence of aggregate agriculture to shocks, an attempt was made to extract cycles from agricultural GDP. The cycles were employed to predict periodicity in agricultural GDP, which were found to coincide with drought years that have occurred in the past.

In chapter five, the objective was to investigate the level and the cause of instability in cereal production. A high level of instability in cereal production has been found. This suggests that there is high level of food insecurity. Results on attempts made to decompose changes in cereal production of consecutive periods indicated that instabilities in cereal production were predominantly caused by instabilities in yield but not in cultivated area. Increased instability in yield was in turn increasingly attributed to weather variability rather than the change to a favourable policy environment and improvements in the techniques of production.

In chapter six, the objective was to measure the responsiveness of peasant agriculture to incentive changes. To this end, supply response was estimated for four cereal crops, namely teff, wheat, maize and sorghum. It was found that farmers responded to incentive changes positively. This suggests that there is no perverse supply response and that farmers respond to incentive changes. It is found that long-run elasticities are positive, significant and greater than short run elasticities, which imply the following. Firstly, it takes time before farmers obtain information about price changes due to infrastructural problems. Second, farmers respond to price changes when they are convinced that the changes are permanent. Thirdly, some resources are fixed and take time before they could be mobilized for production purposes. In addition, it is found that their response is affected by major changes in economic policies.

7.4 CONCLUSIONS AND RECOMMENDATIONS

It is believed that the new development strategy (i.e. the agriculture-led growth strategy) is the right step forward considering the potential of agriculture to grow. However, it is believed that for the strategy to achieve its short-term objective of developing agriculture and its long-term objective of releasing resources needed for growth in other sectors of the economy, the following measures are imperative. Firstly, problems associated with state ownership of land should be harnessed by conducting a study on how the existing land-holding policy should be reformed in a way that can ensure the utilization of arable land to its economically best uses. Presently, land is in state hands i.e. farmers are granted only usufruct rights over land. State ownership of land is blamed, among others, for causing the following: for causing current holding size to be less than one hectare through continuous land redistribution, for putting a check on the application of modern agricultural technologies in production, for causing tenure insecurity, which discourages long-term investments in soil conservation practices. Farmers fear that another round of land distribution would make them end up with little plots. In addition, state ownership of land is criticized for causing expansion of cultivation to areas previously designated as permanent pasture and forests due to population pressure in rural areas. Secondly, it is believed that the effectiveness of the new strategy is compromised by a lack of policy that can ensure the proper functioning of markets. Market liberalization, the new agricultural extension programme and good weather are considered causes of increase in cereal production since 1992 in the high-yielding regions of the country, while farmers operating in low potential areas of the country continue to be food insecure. Low levels of production in low potential areas of the country are attributable to the existing agricultural extension system. The system widely promotes the use of fertilizers and improved seed varieties in potentially high yielding areas of the country.

Increase in cereal production in the high-yielding regions is a major cause for a decrease in cereal prices below cost of production in most areas of the country due to lack of infrastructural facilities and an organized marketing system capable of transporting surplus production over time and space. Lower cereal prices are in turn becoming causes for decline in farm input utilization, and hence are being adversely affecting the proper functioning of the input package programme which is considered a vehicle for the realization of the agriculture-led development strategy. Therefore, it is recommended that market improvements and infrastructural development must be incorporated into the development planning process. In addition, the new extension programme must also consider ways of increasing cereal production in the arid and semi-arid zones of the country.

The performance of agriculture, relative to other sectors, and its responsiveness to incentive changes constitute the other objective of this study. The following were some of the major reasons for the relatively poor performance of agriculture during the three periods studied in chapter two. Drought and lack of infrastructure have been major impediments for agricultural growth during the three periods. Discriminatory policies have been major impediments for agricultural development in the first and the second period. State ownership of land and the failure of the new strategy to go beyond the dissemination of new production technology in the third period were key issues. The finding in chapter three that agriculture contributed favourably to growth in other sectors of the economy in economic systems where agriculture was not discriminated against suggests that the sector must be freed from policy constraints for it to stimulate growth in other sectors of the economy.

The finding in chapter four that the trend in aggregate agriculture, measured by real agricultural GDP, is affected more by the 1983-85 drought rather than by the 1974 nor by the 1992 changes of economic policies from free-market-based to command-based and from command-based to free market based economic systems respectively is attributed to the subsistence nature of production and to problems related to infrastructure. A comparison with the finding in chapter six with crop-level supply-response estimates indicated that the effects of policy changes are high and significant. This is consistent with the theory that growth in aggregate agriculture is dependent on technical change, which is a long-term phenomenon whereas the effect of policy changes on crop-level supply response can be easily felt as a result of the possibility of resource transfer within the crop sub-sector. It is found that short-term and long-term price-elasticity estimates of individual crops are positive and significant, suggesting that agriculture is responsive and that attempts which excessively tax agriculture to develop non-agriculture constrains not only the growth of agriculture but also the growth of the sectors that depend on agriculture. Compared to similar estimates for other Sub-Saharan African countries, the elasticity estimates are small. The results have the implications that macro-policy reforms and efforts that enhance the responsiveness of the sector at various stages should be encouraged and supported.

The finding in chapter four that the trend of real agricultural GDP was significantly affected by the severe drought which occurred between 1983-1985 was attributed to the effect the drought had on the asset base of farm households. Oxen are the most important examples of productive inputs the lack of these assets constrains the productive capacity of farm households. Many households, in the drought-hit areas, fearing that they would eventually lose their livestock due to lack of water and pasture, were reported to have attempted to absorb the risk by selling them or slaughtering them. Lack of oxen in these areas was one of the major production constraints in the aftermath of the drought. A further investigation attempting to decompose changes in cereal production between two consecutive periods which are characterized by opposite economic systems found that yield instability constitute the highest percentage of the instability in total cereal production. Instability in yield was attributed to the weather. Increasing the agricultural research and extension capabilities of the country in order to improve the supply of new drought-resistant crop varieties is believed to mitigate instability in yield because it is believed that cereals grown by using new technologies have lower coefficients of variation than cereals grown by means of traditional technologies.

REFERENCES

ABEBE, H. (1998). The Supply Responsiveness of Peasant Agriculture in Ethiopia: Some Macroeconometric Results from Cereal Production. *Ethiopian Journal of Economics*, vol. 7, No. 2:1-23.

AHMED, R. (1988). Pricing Principles and Public Intervention in Domestic Markets In: Mellor, J.; Ahmed, R. (eds.). *Agricultural Price Policy for Developing Countries*.

ALEMAYEHU, L. (1995). Grain Market reform and food security in Ethiopia, a paper presented at the World Bank Seminar, Washington, D.C.

ALEMAYEHU, L. (1994). Liberalizing Ethiopian Grain Markets. In Harod, G. (Ed.). *New Trends in Ethiopian Studies*, Papers of the 12th International Conference of Ethiopian Studies.

ALEMAYEHU, L. (1990). Villagization: Policies and Prospects. In: Siegfried Pauswing, Fantu Cheru, Stefan Brune and Eshetu Chole (Eds.). *Ethiopia: Rural Development Options*. London, Zed Books Ltd.

ALEMU, Z.G., OOSTHUIZEN, L.K. and VAN SCHALKWYK, HD. (2003a). Is instability in cereal production in Ethiopia caused by policy changes? A paper accepted for presentation at the 25th conference of the International Association of Agricultural Economists.

ALEMU, Z.G., OOSTHUIZEN, L.K. and VAN SCHALKWYK, HD. (2003b). The contribution of Agriculture in the Ethiopian Economy: A time-varying parameter approach, *Agrekcon,* Vol. 42, No. 2:29-48.

ALEMU, Z.G., OOSTHUIZEN, L.K. and VAN SCHALKWYK, HD. (2003c). The effect and persistence of major change in Economic policies on the long-run performance (trend) of Ethiopian Agriculture, *Quarterly Journal of International Agriculture (forthcoming)*.

ALEMU, Z.G., OOSTHUIZEN, L.K. and VAN SCHALKWYK, HD. (2003d). Extracting a cycle from Ethiopian Agriculture, *Eastern Africa Social Science Research Review*, Vol. 19, No. 2 (in print).

ALEMU, Z.G., OOSTHUIZEN, LK and VAN SCHALKWYK, HD. (2003e). Grain Supply Response in Ethiopia: An Error-correction Approach, *Agrekon*, Vol. 42, No. 3 (forthcoming).

ALEMU, Z.G. (2002). How successful the Agricultural Development Led Industrialization Strategy (ADLI) will be by leaving the Existing landholding system intact?" *Economic Focus: Journal of Ethiopian Economic Association*, Vol. 4, No. 4: 16-20.

ALEMU, Z.G., OOSTHUIZEN, L.K. and VAN SCHALKWYK, HD. (2002). Agricultural Development Policies of Ethiopia since 1957, *South African Journal of Economic History*, Vol. 17: 1-25.

ALEMU, Z.G. (1998). *Competition for Scarce land between Food and Cash Crops: The case of Alemaya Woreda, Eastern Oromiya Region of Ethiopia*, A research report submitted to the Research Office, Alemaya University of Agriculture.

ALEMU, Z.G. (1996). Usufruct Rights in Land in Grain Supply Response Analysis: The case of Ethiopia. *Ethiopian Journal of Economics, vol.* V, No. 2: 81-96.

ALEMU, Z.G. (1995). *Supply Response for total Agriculture and Selected Food Crops in Ethiopia*. School of Graduate Studies, Addis Ababa University.

ANTHOLT, C.H. (1998). Agricultural Extension in the Twenty-first Century. In C.K. Eicher and J.M. Staatz (Eds.). *International Agricultural Development*: Baltimore: the Johns Hopkins University Press.

ASFAW, N. and T.S. JAYNE. (1998). Vertical and Special integration of grain markets in Ethiopia. *Grain market research project*, MEDaC, Working Paper 9, Addis Ababa.

ASKARI, H. AND J. CUMMINGS (1976). *Agricultural Supply Response, A survey of the Econometric Evidence*, New York: Praeger.

BALKE, N.S. (1991). Modeling Trends in Macroeconomic Time Series. *Economic Review*, Federal Reserve Bank of Dallas, May 1991: 19-31.

BANERJEE, A., J. DOLADO, J. GLABREATH AND D. HENDRY (1993). Co-integration, Error Correction and the Econometric Analysis of Non-Stationary Data, Oxford: Oxford University Press.

BANERJEE, A., LUMSDAINE, R. and STOCK, J. (1992). Recursive and Sequential Tests of the Unit-root and Trend-Break Hypotheses: Theory and International Evidence. *Journal of Business and Economic Statistics,* American Statistical Association, Vol. 10, No. 3: 271-287.

BEFEKADU, D. and TESFAYE, R. (1990). The Marketing and Pricing of Agricultural Products in Ethiopia. In: Seigfried P., Fantu C., Brune S., and Eshetu C. (Eds.). *Ethiopian Rural Development Options*, London: Zed Books Ltd.

BEVERIDGE, S., AND C.R. NELSON. (1981). A new approach to Decomposition of Economic Time Series into Permanent and Transitory Components with particular attention to Measurement of the 'Business Cycle. *Journal of Monetary Economics*, vol. 7: 151-174.

BEYNON, J.G. (1989). Pricism Versus Structural Adjustment in African Agriculture. *Journal of Agricultural Economics,* vol. 40, No. 3. 323-353.

BINSWANGER, H.P., AND KLAUS, D. (1997). Explaining Agriculture and Agrarian Policies in Developing Countries. *Journal of Economic Literature* vol. 35, No. 4.

BOND, M.E. (1983). Agricultural Response to Prices in Sub-Saharan Africa countries. *IMF staff papers*, 30: 703-726.

BROOKS, K. (1990). Agricultural Reform in the Soviet Union. In: C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the Johns Hopkins University Press.

CAMPBELL, J.Y, AND N.G., MANKIW. (1989). Permanent and Transitory components in Macroeconomic Fluctuations. *The American Journal of Economic Review*, vol. 77: 111-117.

CENTRAL STATISTICAL AUTHORITY (CSA). THE FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA, various issues.

CHAN, K.H., J.C. HAYYA AND J.K. ORD. (1977). A note on Trend Removal methods: The case of Polynomical versus univariate differencing. *Econometrica* 45: 737-744.

CHENERY, H.B. (1979). Structural change and Development policy. New York: Oxford University Press.

CIA WORLD FACT BOOK (2001). Ethiopia Economy. http://www.photius.com/wfb2000/countries/ethiopia/ethiopia_economy.html

CIMMYT (1989). *1987-88 CIMMYT World Wheat Facts and Trends. The Wheat Revolution Revisited: Recent Trends and Future Challenges. Mexico: CIMMYT.*

CORDON, W.M. (1974). *Trade Policy and Economic Welfare.* Oxford: Claredon Press.

de JANVRY, A. AND SADOULET, E. (1989). Investment Strategies to Combat Rural Poverty: A proposal for Latin America. *World Development,* Vol. 17. No. 8.

DEANE, P. (1978). The Evolution of Economic Ideas. New York: Cambridge University Press.

DEJENE, A. (1990). The evolution of rural Development Policies. In Pausewang, Brune S, and Chole (Eds.). *Ethiopia: Rural Development Options*. London: Zed Books Ltd.

DESSALEGN, R. (1999). Revisiting the Land Issue: options for change. *Economic Focus*, Vol. 2, No. 4, Ethiopian Economic Association, Addis Ababa, 1999.

DESSALEGN, R. (1990). Cooperatives, state farms and small holder production. In Pauswang, Fantu, C., Brune S, and Eshetu C. (Eds.). *Ethiopia: Rural Development Options*. London: Zed Books Ltd.

DICKAY, D AND FULLER, W. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association,* Vol. 74: 427-31.

DORNBUSCH, R. (1980). *Open Economy Macroeconomics*. New York: Basic Books.

EICHER, C.K AND STAATZ, J.M. (1990a). Introduction. In C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the Johns Hopkins University Press.

EICHER, C.K. AND BAKER D.C. (1990b). Agricultural Development in Sub-Saharan Africa: A critical Survey. In Lee R. Martin (Eds.). *A survey of Agricultural Economics Literature,* Volume 4. The University of Minnesota press for the American Agricultural Economics Association.

ELLIS, F. (1992). Agricultural Policies in Developing Countries. *Cambridge University Press.*

ENGLE, R.F. AND GRANGER, C.W.J. (1987). Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, Vol. 55: 251-75.

ESHETU, C. (1990). Agriculture and Surplus Extraction. In Pausewang, S, Fantu, C, Brune, S, and Eshetu, C. (Eds.). *Ethiopia: Rural Development Options.* London: Zed Books Ltd.

ETHIOPIAN AGRICULTURAL RESEARCH SYSTEM (EARS) (1997). An Overview of the Agricultural Sector in the Ethiopian Economy. http://falcon.ifs.uni-linz.ac.at/research/masters/fisseha/overview.html

ETHIOPIAN ECONOMIC ASSOCIATION (EEA) (2000). *Annual Report on the Ethiopian Economy.* Befekadu D. and Berhanu N. (Eds.). vol. 1. 1999/2000.. Addis Ababa.

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA (FDRE). (1996a). Transport Sector Memorandum. No. 12/1996. *Negarit Gazette*, Ethiopia.

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA (FDRE). (1996b). A proclamation to further liberalize restrictions on domestic and foreign investment. No. 15/1996. *Negarit Gazette*, Ethiopia.

FEDERAL DEMOCRATIC REPUBLIC OF ETHIOPIA (FDRE). (1997). Rural land administration proclamation of the Federal Government of Ethiopia, proclamation No. 89/1997. *Federal Negarit Gazeta of The Federal Democratic Republic of Ethiopia*, Addis Ababa.

FEI, J.C. AND RAINS, G. (1964). Development of a labor surplus economy. Honeywood, Il: Irwin.

FERNANDO, B.S. (1992). Agricultural Supply Response, how to pass from war to a peace economy: the Ethiopian case, Research Program contracted by the EC to DIAL, Nber R/821.

FOOD and AGRICULTURAL ORGANIZATION (FAO). (2002). FAO Statistical Data Base **http://apps.fao.org/**

FOOD AND AGRICULTURAL ORGANIZATION (FAO) (1997). *Crop and Food Supply Assessment Mission to Ethiopia*, 19 December.

GEBREMESKEL, D.; T. S JAYNE, and J.D SHAFFER. (1997). Market Structure, Conduct and Performance: constraints on performance of Ethiopian Grain Market. *Grain market research Project*, MEDaC, Working paper 8, Addis Ababa.

GOSHU, M. (1995). Agricultural Research and Extension in Ethiopia, In Dejene, A. and Mulat, D. (Eds.): Ethiopian Agriculture: Problems and Transformation, Proceedings of the Fourth Annual Conference on the Ethiopian Economy, Addis Ababa.

GOTTMAN, J.M. (1981). *Time-series analysis, A comparative introduction for social scientists.* Cambridge: Cambridge University Press.

GRANGER, C.W.J and NEWBOLD, P. (1977). *Forecasting Economic Time Series.* Academic Press, A subsidiary of Harcourt Brace Jovanovich Publishers.

GRANGER, C.W.J. (1969). Investigating Causal Relationships by econometric models and cross-spectral methods. *Econometrica*, vol. 37, No.3: 424-439.

GUJARATI, D.N. (1995). *Basic Econometrics.* Third Edition. McGRAW-Hill International edition, economic series.

GUTU, S.Z. (1990). Cereal pulse and oilseed balance sheet analysis for Ethiopia *1979-1989, Institute of Development Studies, University of Sussex, No. 8, BLDSC.*

HALLAM, D. AND ZANOLI, R. (1993). Error Correction Models and Agricultural Supply Response. *European Review of Agricultural Economics,* Vol. 2: 151-166.

HARRIS, R.I.D. (1995). *Using Cointegration Analysis in Econometric Modelling.* London: Prentice Hall.

HAYAMI, Y. and RUTTAN, B. (1985). *Agricultural Development: An International Perspective*, Rev.Ed. Baltimore: Johns Hopkins University Press.

HAZELL, P.B.R. (1984*). Sources of increased instability in Indian and U.S. cereal production,"* American Journal of Agricultural Economics, No. 66: 302-311.

HAZELL, P.B.R. (1985). *Sources of increased variability in world cereal production since the 1960s.* Journal of Agricultural Economics, No. 36, vol. 2:145-159.

HAZELL, P.B.R. (1988a). *Changing patterns of variability in cereal prices and production. In: Mellor, J.; Ahmed, R. (eds.).* Agricultural Price Policy for Developing Countries.

HAZELL, P.B.R. (1988b). *Risk and Uncertainty in Domestic Production and Prices. In: Mellor, J.; Ahmed, R. (Eds.).* Agricultural Price Policy for Developing Countries.

HIRSCHMAN, A.O. (1958), *The Strategy of Economic Development.* New Haven: Yale University Press.

HONDCROFT, L.E. (1984). The Rise and Fall of Community Development, 1950-65: A critical Assessment. In: C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the Johns Hopkins University Press.

IMPERIAL ETHIOPIAN GOVERNMENT (IEG). (1967). *Third five-year Development Plan, 1968-1973.* Addis Ababa.

IMPERIAL ETHIOPIAN GOVERNMENT (IEG). (1962). *Second Five Year Development Plan, 1963-1967.* Addis Ababa.

IMPERIAL ETHIOPIAN GOVERNMENT. (1957). *First Five Year Development Plan*, 1957-1962. Addis Ababa.

INTERNATIONAL MONETARY FUND (IMF). *International Financial Statistics.* Washington D.C.

JAEGER, W. (1991). The Impact of Policy in African Agriculture, An Empirical Investigation. *WB working Paper* No. 147.

JOHANSEN, S. (1988). Statistical Analysis of Co-integrating Vectors. *Journal of Economic Dynamics and Control,* vol. 12:231-254.

JOHNSTON, B.F. and MELLOR, J.W. (1961). The Role of Agriculture in Economic Development. *American Economic Review*, vol. 51, No.4: 566-93.

JOHNSTON, J. and DiNARDO. (1997). Econometric Methods. 4th Edition. McGraw-hill international editions.

KUZNETS, S. (1968). *Towards a theory of Economic Growth with Reflections on the Economic Growth of Nations*. Norton: New York.

KUZNETS, S. (1966). *Modern Economic Development*, Yale University Press, New Haven, Chapter 3.

KUZNETS, S. (1964). Economic Growth and the Contribution of Agriculture: Notes on Measurement. In C. Eicher and L.Witt. (Eds..). *Agriculture in Economic Development*. McGraw-Hill: New York.

LEWIS, W.A. (1954). *Economic Development with unlimited supplies of labour.* Manchester School of Economics and Social Studies, vol. 22, No. 2: 139-91.

LIN, J. (1998). Agricultural Development and Reform in China. In C.K. Eicher and J.M. Staatz (Eds.). *International Agricultural Development*. Baltimore: the Johns Hopkins University Press.

LIN, J.Y., YAO X, and WEN G. J. (1990). China's Agricultural Development: Recent Experience and Policy Issues. In C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the Johns Hopkins University Press.

MADDALA, G.S. (1992). Introduction to Econometrics, second edition, New Jersey: Prentice Hall.

MADDALA, G. S. and KIM, IN-MOO. (1998). *Unit roots cointegration and structural change,* Cambridge University Press.

MCKAY, A.M. AND C. VALLANT (1998). Aggregate Export and Food Crop Supply Response in Tanzania, *CREDIT Research Paper*, No. 4 in the CREDIT Project on infrastructural and Institutional Constraints to Export Promotion, as part of the DFID Trade and Enterprise Research Program (TERP).

MELLOR J.W. (1998). Agriculture on the Road to Industrialization. In C.K. Eicher and J.M. Staatz (Eds.). *International Agricultural Development*. Baltimore: the Johns Hopkins University Press.

MINISTRY OF ECONOMIC DEVELOPMENT AND COOPERATION (MEDAC). (2000). DATA ON MACROECONOMIC INDICATORS.

MINISTRY OF ECONOMIC DEVELOPMENT AND COOPERATION (MEDaC), (1999). *Survey of the Ethiopian Economy, Review of post reform developments* (1992/93-1997/98).

MOSHER, A.T. (1960). *Getting Agriculture Moving*: Essentials for Development and Modernization. New York: Praeger.

MULAT, D., V. KELLY, T.S. JAYNE, ALI SAID, J.C.LEVALLLEE, AND H.CHEN. (1998). Agricultural Market Performance and Determinants of Fertilizer Use in Ethiopia. Working Paper No. 10. Addis Ababa: *Grain Market Research Project*, Ministry of Economic Development and Cooperation.

NELSON, C. AND PLOSSER C. (1982). Trends and Random walks in Macroeconomic Time Series: Some Evidence and Implications, *Journal of Monetary Economics*, Vol. 10: 139-163.

NERLOVE, M. (1979). The Dynamics of Supply: Retrospect and Prospect, *American Journal of Agricultural Economics,* Vol. 61, No. 5:874-888.

NEWBOLD, P; RAYNER, T. AND KELLARD, N. (2000). Long-Run Drift, Co-Movement and Persistence in Real Wheat and Maize Prices, *Journal of Agricultural Economics*, vol. 51, No. 1: 106-121.

NICHOLLS, W.H. (1964). The Place of Agriculture in Economic Development. In: C.K. Eicher and L.Witt. (Eds.). *Agriculture in Economic Development.* New York: McGraw-Hill.

NORTH, D.C. (1994). Economic Performance through time. *American Economic Review* 84, No.3: 359-368.

NORTH, D.C. (1992). *Institutions, Institutional Change and Economic Performance.* New York: Cambridge University press

OFFICE OF THE NATIONAL COUNCIL FOR CENTRAL PLANNING (ONCCP). (1987). *The Three Year Development Plan.* Addis Ababa, Ethiopia.

OFFICE OF THE NATIONAL COUNCIL FOR CENTRAL PLANNING (ONCCP). (1983). *The Ten Year Perspective Plan.* Addis Ababa, Ethiopia.

PAUSEWANG, S. (1990). Meret Le Arrashu. In: Pausewang, S, Fantu C, Brune S, and Eshetu C. (Eds.). *Ethiopia: Rural Development Options*, London: Zed Books Ltd.

PERRON, P. (1990). Testing for a unit root in a time series with changing mean. *Journal of Business and Economic Statistics*, vol. 8: 153-162.

PERRON, P. (1989). The Great Crash, the oil shock and the unit root hypothesis. *Econometrica*, vol. 57: 1361-1401.

PERSARAN, M.H. and PERSARAN, B. (1997). *Working with Microfit 4.0, Interactive Econometric Analysis*. Oxford University Press.

PICKETT, J. (1991). *Economic Development in Ethiopia: Agriculture, the market and the state.* Development Center Studies of the organization for development co-operation and development, Paris.

PLOSSER, C. AND SCHWERT, G. (1978). Money, Income and Sunspots: Measuring Economic Relationships and the Effects of differencing, *Journal of Monetary Economics,* Vol. 4.

PREBISCH, RAUL. (1959). Commercial Policy in the Underdeveloped Countries. *American Economic Review* 64 (May): 251-75.

PROVISIONAL MILITARY ADMINSTRATION COUNCIL (PMAC). (1978). Proclamation No. 138/1978 Providing for the Establishment of Co-operative Societies, *Negarit Gazette*, Addis Ababa.

PROVISIONAL MILITARY GOVERNMENT OF SOCIALIST ETHIOPIA (PMGE) (1976). Proclamation No. 108/1976, Negarit Gazette.

RUTTAN, V.W. (1998). Models of Agricultural Development. In C.K. Eicher and J.M. Staatz (Eds.). *International Agricultural Development*. Baltimore: the Johns Hopkins University Press.

SCANDIZZO P. L. (1998). Growth, trade and agriculture: An investigative survey. FAO *Economic and Social Development Paper* 143, Rome.

SCHIMMELPFENNIG, D., THIRTLE, C., VAN ZYL, I. (1996). Crop level supply response in South African Agriculture: an error-correction approach. *Agrekon,* Vol. 35, No 3: 111-122.

SCHUH, E.D. (1999). Agriculture and Economic Development. *Chicago Policy Review*, v.3, no.1, Special Edition 1999:.57-65.

SCHUH, E.D (1990). The new macroeconomics of Food and Agricultural Policy. In C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the John Hopkins University Press.

SIMKINS P. S. (1992). Do real business cycle models really exhibit business cycle behavior? *Journal of Monetary Economics* 33: 381-404.

SINGH, A.J. and BYERLEE, D. (1990). Relative variability in wheat yields across countries and over time, *Journal of Agricultural Economics*: 21-32.

STAATZ, J.M AND EICHER, C.K. (1998). Agricultural Development Ideas in Historical Perspective. In C.K. Eicher and J.M. Staatz (Eds). *International Agricultural Development*. Baltimore: the John Hopkins University Press.

STAATZ, J.M. AND EICHER, C.K. (1990). Agricultural Development Ideas in Historical Perspective. In C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World*. Baltimore: the Johns Hopkins Univesity Press.

STERN, N. (1996). Growth Theories Old and New: and the role of agriculture in economic development. *FAO Economic Social Development Paper* No. 136. Rome.

STOCK, J.H AND WATSON, M.W. (1988). Variable Trends in Economic Time Series. *Journal of Economic Perspectives* Vol. 2, No.3: 147-174.

SUTCLIFFE, J.P. (1995). Soil Conservation and Land Tenure in Highland Ethiopia. Special issue on Land rights and Access to land in Post-Derg Ethiopia. *Ethiopian Journal of Development Research*, 17:63-80.

TANG, A. M. (1990). A Critical Appraisal of the Chinese Model of Development. In: C.K. Eicher and J.M. Staatz (Eds.). *Agricultural Development in the Third World.* Baltimore: the Johns Hopkins University Press.

TEFERI, A. (1995). Land redistribution and interhousehold relations: the case of two communities in Northern Ethiopia. *Ethiopian Journal of Development Research*, vol. 17, 23- 40.

TESFAYE, L. (2002). *Market Incentives, Peasant Farmers' Response and a policy dilemma: A case study on Expansion of Chat Production as a cash crop in the Eastern Ethiopian Highlands*. Unpublished research report.

TIMMER, C. (1998). The Agricultural Transformation. In C.K. Eicher and J.M. Staatz. (Eds.), *International Agricultural Development*. Baltimore: the John Hopkins University Press.

TIMMER, C. (1990). The Agricultural Transformation. In C.K. Eicher and J.M. Staatz. (Eds.). *Agricultural Development in the Third World*. Baltimore: The Johns Hopkins University Press.

TIMMER, C.P; FALCON, W.P, PEARSON, S. R. (1983). *Food Policy Analysis.* Baltimore: Johns Hopkins University Press.

TOWNSEND, R. (1997). *Policy Distortions and Agricultural Performance in the South African Economy.* Development Bank of Southern Africa Development Information Business Unit, Discussion Paper No 138.

TOWNSEND, R. and THIRTLE, C. (1994). Dynamic acreage response: an error-correction model for maize and tobacco in Zimbabwe, *International Association of Agricultural Economics*. Occasional Paper no. 7.

TRANSITIONAL GOVERNMENT OF ETHIOPIA (TGE) (1994). A proclamation to create the Ethiopian Privatization Agency, No 2/1994. *Negarit Gazette*, Addis Ababa.

TRANSITIONAL GOVERNMENT OF ETHIOPIA (TGE) (1992). A proclamation to provide for the encouragement, expansion, and coordination of investment, No. 15/1992. *Negarit Gazette*, Addis Ababa.

TRIPP R., ANADAJAYASEKERA P., BYERLEE D. AND HARRINGTON L. (1990). Farming Systems Research Revisited. In C.K. Eicher and J.M. Staatz. (Eds.). Agricultural Development in the Third World. Baltimore: the Johns Hopkins University Press.

WEBB, P., VON BRAUN, J. and YOHANNES, Y. (1992). Famine in Ethiopia: Policy Implications of Coping Failure at National and Household Levels. *IFPRI, Research report* 92.

WOLDAY, A. (2001). *Agricultural Input and Output marketing in remote areas: Ethiopia.* A study submitted to the policy analysis unit in Harare, FAO.

WOLDAY, A. (1999). Maize Marketing in Ethiopia: Liberalization and Market Integration Issues. *Ethiopian Journal of Development Research*, vol. 21, No. 1, April 1999.

WORLD BANK (1987). Ethiopia: An export action program. Division EA2NE, Report No. 6432-ET, Washington DC: World Bank.

YOHANNES, A. (2002). Sequences of Financial Sector Reform in Ethiopia 1992/93-2000/01. *Economic Focus, Bulletin of the Ethiopian Economic Association (EEA)*, Vol. 4 No. 4: 3-5.

APPENDIX A: Break down of service GDP during the socialist era

YEAR	DSTSRV	OSERV	PUBAD	EDUCAT	HEALTH	TRANCO
1970	1292.94	1635.17	616.4	194.3	65.6	376.39
1971	1349.51	1737.48	671.8	200.1	68.6	390.51
1972	1387.05	1882.33	724.6	206.9	72	418.71
1973	1391.63	1896.8	743.1	203.8	74.8	433.66
1974	1404.56	1966.51	791.7	210.1	78.7	471.21
1975	1453.03	2042.87	822	212.5	81.8	530.1
1976	1671.66	2178.54	852	220.2	87.1	536.24
1977	1727.98	2332.96	932.9	228.4	88.1	570.94
1978	1633.42	2504.08	1053.4	243	91.8	596.26
1979	1705.83	2647.63	1147.5	248.9	94.1	587.95
1980	1304.92	2494.33	985.7	271.3	90.8	544.09
1981	1272.14	2363.72	842	278.5	100	623.62
1982	1555.13	2713.74	1096.1	271.1	114.7	667.69
1983	1605.98	2963.29	1213.7	278.2	136.8	705.75
1984	1757.39	3190.5	1327.8	287.9	146.5	729.6
1985	1930.79	3377.3	1391.5	298	154	799.2
1986	2084.15	3611	1483.4	318.3	160.1	884.8
1987	1554.8	2713.7	1096.1	271.1	114.7	NA
1988	1650.9	2963.3	1213.7	278.2	136.8	NA
1989	1757.3	3190.5	1327.8	287.9	146.5	NA
1990	1914.7	3377.3	1391.5	298	154	NA
1991	2093.7	3581.7	1454.1	318.3	160.1	NA

Source: International Financial Statistics

DSTSRV = Distribution services, OSERV = Other service, PUBAD = Public Administration, TRANCO = Transport and Communication.

Note that figures are in millions of Birr

APPENDIX B: Major Macroeconomic indicators

YEAR	POP	CONSN	GOVREV	GOVEXP	DOMFINANCE	FORFINCE	MONEY
1963	21.59	2118	NA	NA	NA	NA	260
1964	21.88	2321	268.1	345.8	7.4	17.9	303
1965	22.17	2588	294.5	388.8	11.1		350
1966	22.5	2658	322.8	468.6	0.5	34	378
1967	22.9	2787	355.1	477.7	6	9.7	372
1968	23.4	2969	357.7	503.8	29.3	6.1	400
1969	24	3188	390.4	506.6	11.7	-0.4	455
1970	24.6	3519	426.8	550.4	26.7	27.3	453
1971	25.3	3782	466	603.8	13	39.8	437
1972	25.9	3720	494.1	647.9	20.3	44.1	491
1973	26.2	3797	561	678.6	-0.7	39.8	619
1974	26.8	4244	619.7	733	8.1	46.9	754
1975	27.5	4428	710.4	985.4	146.1	98.3	942
1976	28.2	4618	777.9	1144.5	203.8	104.2	953
1977	35.9	5461	1013.7	1320	131	86.8	1179
1978	36.8	5885	1184.3	1664.1	338	73.7	1378
1979	37.6	6544	1410.1	1690.5	85.6	170.8	1572
1980	38.8	6795	1597.1	1994.9	229.3	150.5	1568
1981	39.6	6851	1791.7	2136.3	206	130.5	1720
1982	40.4	9149	1865.3	2377.4	10	474.9	1892
1983	41.2	9858	2158.4	3159.2	948	421	2142
1984	42.7	9047	2283.2	2874.5	411.8	208.5	2309
1985	44.3	10661	2266	3150.3	441.8	328.7	2702
1986	45.7	10261	2730.4	3540.5	371.5	470.2	3273
1987	44.2	11036	2847.8	3604.1	414.9	326.8	3341
1988	45.5	10396	3432.3	4161.5	360.7	402	3722
1989	46.9	11281	3882	4785.7	436.8	601.6	4322
1990	48.4	12258	3103.9	4832.3	1266.2	495.9	5273
1991	50	15369	2680	4421.1	1191.6	420.8	6199

1992	51.6	18059	2208	3708.1	NA	NA	7142
1993	53.2	22209	3206.6	5090.1	NA	NA	7450
1994	54.9	23748	3842.6	7663.1	NA	NA	9027
1995	54.7	27942	5839.2	NA	NA	NA	9280
1996	56.4	31291	6817.3	NA	NA	NA	9114
1997	58.1	32831	7877.4	NA	NA	NA	9883
1998	59.9	35472	8400.2	NA	NA	NA	9146

Source: Ministry of Economic Development & Cooperation, International Financial Statistics

Pop = population, CONS = Consumption, GOVREV = Government Revenue, GOVEXP = Government Expenditure DOMFNCE = Domestic Finance, FORFNCE = Foreign Finance.

APPENDIX C: Food Gap in rural areas

Year	**Rural Population**	**Cereal Production**	**Food Availability per person**	**Food Deficit Per Person Per year**
1961-1975	26	4.6	142	83
1975-1991	38	5.3	113	112
1992-1996	47	6.3	106	119

Source: Author's computation based on FAO data

APPENDIX D: Computer Program written to decompose changes in variance in to ten component parts

```
for t=1:35; a11=[]'; a12=[]'; y11=[]'; y12=[]'; a21=[]'; a22=[]';
   y21=[]'; y22=[]'; prod11=[]'; prod12=[]'; prod21=[]';
   prod22=[]';
end
   covy11a11=cov(y11,a11); covy21a21=cov(y21,a21);
   covy11y21=cov(y11,y21); cova11a21=cov(a11,a21);
   covy12a12=cov(y12,a12);covy22a22=cov(y22,a22);
   covy12y22=cov(y12,y22); cova12a22=cov(a12,a22);
   covy12a22=cov(y12,a22);covy11a21=cov(y11,a21);
   covprod1=cov(prod11,prod21); covprod2=cov(prod12,prod22);
   covprodiff=covprod2-covprod1; covprodiff1=covprodiff(1,2);
   CYVC=((mean(a11)*mean(a21))*(cov(y12,y22)-cov(y11,y21)));
      CYVC1=CYVC(1,2); CAVC=((mean(y11)*mean(y21))*(cov(a12,a22)-
   cov(a11,a21)));
   CAVC1=CAVC(1,2);CAYC=(mean(a11)*mean(y21)*(cov(y12,a22)-
   cov(y11,a21)))+(mean(y11)*mean(a21)*(cov(a12,y22)-cov(a11,y21)))-
   (cov(a11,y11)+(cov(a12,y12)-cov(a11,y11)))*(cov(a22,y22)-
   cov(a21,y21))-(cov(a21,y21)*(cov(a12,y12)-cov(a11,y11)));
      CAYC1=CAYC(1,2); CMY=mean(a11)*(mean(y22)-
   mean(y21))*cov(y11,a21)+mean(a21)*(mean(y12)-
   mean(y11))*cov(a11,y21)+(mean(y11)*(mean(y22)-
   mean(y21))+mean(y21)*(mean(y12)-mean(y11))+(mean(y12)-
   mean(y11))*(mean(y22)-mean(y21)))*cov(a11,a21);
      CMY1=CMY(1,2); CMA=mean(y11)*(mean(a22)-
   mean(a21))*cov(a11,y21)+mean(y21)*(mean(a12)-
   mean(a11))*cov(y11,a21)+(mean(a11)*(mean(a22)-
   mean(a21))+mean(a21)*(mean(a12)-mean(a11))+(mean(a12)-
   mean(a11))*(mean(a22)-mean(a21)))*cov(y11,y21);
      CMA1=CMA(1,2); IMYMA=(mean(a12)-mean(a11))*(mean(y22)-
   mean(y21))*cov(y11,a21)+(mean(y12)-mean(y11))*(mean(a22)-
   mean(a21))*cov(a11,y21);IMYMA1=IMYMA(1,2);
      IMAY=(mean(a11)*(mean(a22)-mean(a21))+mean(a21)*(mean(a12)-
   mean(a11))+(mean(a12)-mean(a11))*(mean(a22)-
   mean(a21)))*(cov(y12,y22)-cov(y11,y21)); IMAY1=IMAY(1,2);
      IMYAV=(mean(y11)*(mean(y22)-mean(y21))+mean(y21)*(mean(y12)-
   mean(y11))+(mean(y12)-mean(y11)))*(cov(a12,a22)-cov(a11,a21));
      IMYAV1=IMYAV(1,2); IMAYYCOV=(mean(y21)*(mean(a12)-
   mean(a11))+mean(a11)*(mean(y22)-mean(y21))*(mean(y22)-
   mean(y21)))*(cov(y12,a22)-cov(y11,a21))+(mean(y11)*(mean(a22)-
   mean(a21))+mean(a21)*(mean(y12)-mean(y11))+(mean(y12)-
   mean(y11))*(mean(a22)-mean(a21)))*(cov(a12,y22)-cov(a11,y21));
      IMAYYCOV1=IMAYYCOV(1,2);
   TOTALCOMP=(CYVC1+CAVC1+CAYC1+CMY1+CMA1+IMYMA1+IMAY1+IMYAV1+IMAYYC
   OV1); Residual=(covprodiff1-TOTALCOMP);
end
```

APPENDIX E: Percentage points of the Asymptotic Distribution of t_α in Model C Time Break Relative to Total Sample Size: λ

λ =	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
1%	-4.38	-4.65	-4.78	-4.81	-4.90	-4.88	-4.75	-4.70	-4.41
2.5%	-4.01	-4.32	-4.46	-4.48	-4.53	-4.49	-4.44	-4.31	-4.10
5%	-3.75	-3.99	-4.17	-4.22	-4.24	-4.24	-4.18	-4.04	-3.80
10%	-3.45	-3.66	-3.87	-3.95	-3.96	-3.95	-3.86	-3.69	-3.46
90%	-1.44	-1.60	-1.78	-1.91	-1.96	-1.93	-1.81	-1.63	-1.44
95%	-1.11	-1.27	-1.46	-1.62	-1.69	-1.63	-1.47	-1.29	-1.12
98%	-0.28	-0.98	-1.15	-1.35	-1.43	-1.37	-1.17	-1.04	-0.80
99%	-0.45	-0.67	-0.81	-1.04	-1.07	-1.08	-0.79	-0.64	-0.50

Source: Perron (1989) "The Great Crash, The Oil Price Shock, And The Unit Root Hypothesis". Econometrica, Vol. 57, No. 6 (November, 1989), 1361-1401

APPENDIX F: Initial Estimation Result

$$y = 4.07 + 0.02x + 0.01D_1 - 0.67D_2 - 1.16D_3 - 0.01D_4 + 0.02D_5 + 0.03D_6 + u.$$

(123) (3.98) (0.105) (-3.97) (-2.23) (-0.73) (2.07) (1.84)

Adjusted R^2 =0.86. Numbers in brackets are t-ratios. DW= 2.37

APPENDIX G: AREA

Year	Wheat	Barley	Maize	Oats	Millet	Sorghum	Teff	Cereals T.
1961	912000	935000	755000	10000	290000	1000000	1980000	5882000
1962	919000	950000	769000	10000	290000	1022000	2133000	6093000
1963	928000	967500	772200	10000	290000	1046000	2100000	6113700
1964	920800	970000	790500	10000	293000	1063800	2108000	6156100
1965	962300	981500	800400	10000	293200	1071200	2110000	6228600
1966	988600	990000	812100	10000	296300	1081700	2111600	6290300
1967	1008400	950000	820200	10000	297800	1129500	2132700	6348600
1968	1028600	930000	828400	10000	299300	1174000	2154000	6424300
1969	1049200	940000	837700	10000	300800	1186600	2175500	6499800
1970	1070300	950000	847100	10000	302300	1203200	2197300	6580200
1971	1091600	950000	863600	10000	303800	1233500	2217800	6670300
1972	1113400	950000	882100	11000	306800	926700	2239500	6429500
1973	806000	928000	871000	12000	200000	800000	1665000	5282000
1974	816000	940000	882000	13000	202000	812000	1686000	5351000
1975	765100	762000	749100	14000	205600	751100	1217600	4464500
1976	536800	545400	732700	15000	378400	777600	1440400	4426300
1977	548400	711000	672600	15000	199000	746900	1337100	4230000
1978	492800	797800	849400	15500	232300	763000	1304000	4454800
1979	511300	836800	910100	15500	238300	726400	1392600	4631000
1980	536190	909830	870780	6700	215870	1026290	1513340	5079000
1981	552200	828760	730950	35200	232870	967700	1364140	4711820
1982	684910	810350	652470	79400	226490	844260	1331550	4629430
1983	714010	908000	819670	56920	225150	905650	1399830	5029230
1984	625610	796310	820890	26190	215310	913610	1317940	4715860
1985	660220	828130	946670	37160	229350	768060	1345090	4814680
1986	778360	926630	865000	38910	228250	858060	1296240	4991450
1987	668820	902290	1048210	41100	140730	851420	1298330	4950900
1988	657830	1056720	1095250	52890	156490	782240	1253390	5054810
1989	647630	958470	1021100	42520	133230	627070	1461240	4891260
1990	605070	912140	1277790	42430	154770	738250	1226960	4957410
1991	556750	724060	1154340	44970	167680	517150	1279060	4444010
1992	519500	743130	999190	40460	152090	461270	1368330	4356060
1993	578230	578790	838450	29290	176030	448210	1385930	4034930
1994	746810	934140	1242740	33800	250670	753990	1425140	5387290
1995	826840	1140580	1464080	45720	230390	919830	1899070	6526510
1996	959450	1059960	1880580	63730	273120	1331600	2162890	7731330
1997	846000	897360	1718270	62040	292180	1443410	2238890	7498150
1998	831770	897200	1449300	55400	290580	981710	1806920	6312880
1999	1030000	1050000	1650000	59000	446680	1040000	2150000	7425680

Source: FAO Agricultural Data Base

APPENDIX H: PRODUCTION DATA FOR CEREAL CROPS

Year	Barley	Maize	Oats	Millet	Sorghum	Teff
1961	748000	727000	5000	140000	793000	1140000
1962	760000	739000	5000	140000	810000	1170000
1963	774000	695000	5000	140000	829000	1200000
1964	786000	766800	5000	145100	853300	1243700
1965	805000	788400	5000	146600	867700	1255500
1966	822000	812100	5000	146600	887000	1267000
1967	800000	826600	5000	148100	922100	1285500
1968	780000	853000	5000	150900	800000	1304300
1969	800000	880400	5000	152400	1007300	1323300
1970	815000	909000	5000	153900	1036800	1342600
1971	830000	939000	5000	155400	1101800	1362200
1972	830000	970500	6000	158400	943400	1382000
1973	761000	888400	7000	120000	750000	1198800
1974	752000	882000	8000	121200	749100	1180200
1975	624850	840840	9000	156680	630520	847920
1976	537000	1370550	10000	378800	875540	1003710
1977	894560	947810	10000	172380	755680	994480
1978	689940	929080	12000	207150	707900	1022380
1979	931300	1372370	13400	198700	1054520	1142080
1980	1050820	1524080	6670	214611	1643180	1426420
1981	1075130	948249	46448	204393	1410830	1312100
1982	935507	1199550	65430	197180	1206500	1082730
1983	1168340	1602950	62254	240071	1356380	1371670
1984	804345	1532950	22245	199357	1201630	1090240
1985	842184	1087800	27445	187384	507220	912221
1986	775,257	913859	31497	189892	904548	968714
1987	780210	996999	36353	120328	969736	1042980
1988	778,763	1268870	49534	165854	909889	1000030
1989	799936	1018160	47663	112190	849224	1217730
1990	798,757	1063040	48693	152455	972805	1046140
1991	785878	820585	63950	221860	694662	1813870
1992	798,467	792182	40133	128344	564929	1184550
1993	578230	787484	36251	135251	628309	1356090
1994	746810	875417	36672	176658	702612	1254620
1995	826840	985831	43587	154084	1140710	1342730
1996	959450	1124950	83810	243657	1807700	1792620
1997	846000	953017	66710	296200	2040390	2037170
1998	831770	982700	56100	259559	1083230	1328730
1999	1030000	970000	55000	381486	1340000	1670000

Source: FAO Agricultural Data Base

APPENDIX I: PRODUCER PRICE

Year	Wheat	Barley	Maize	Oats	Millet	Sorghum	Teff
1966	218	153	161	122	187	187	234
1967	205	139	134	115	160	160	209
1968	203	113	112	114	112	112	200
1969	215	136	121	120	145	145	216
1970	263	196	186	148	223	223	275
1971	237	176	168	133	185	185	237
1972	188	121	114	105	136	136	189
1973	233	170	160	130	180	180	233
1974	253	196	171	142	209	209	253
1975	247	180	164	138	219	219	263
1976	284	210	190	159	223	223	334
1977	290	237	222	162	232	232	390
1978	340	270	260	190	270	270	410
1979	340	270	260	220	160	320	410
1980	340	270	260	230	160	340	410
1981	340	270	260	250	160	350	410
1982	340	270	160	300	160	220	410
1983	475	379	304	400	370	376	514
1984	872	659	579	750	551	805	805
1985	955	781	716	820	767	839	839
1986	617	498	507	530	565	542	542
1987	532	437	387	460	470	423	687
1988	583	490	404	515	489	493	698
1989	614	521	456	552	538	512	719
1990	620	515	420	540	510	485	733
1991	905	735	610	810	610	750	1020
1992	1095	905	710	800	810	790	1270
1993	1,100	930	750	850	830	830	1,300
1994	1,200	980	800	900	880	880	1,400

Source: FAO Agricultural Data Base

DECLARATION

I declare that the thesis hereby submitted by me for the Ph.D. degree at the University of the Free State is my own independent work and has not previously been submitted by me at another university/faculty. I furthermore cede copyright of the thesis in favour of the University of the Free State.

NAME: Zerihun Gudeta Alemu

SINGATURE:

DATE: MAY 19, 2003

PLACE: University of The Free State