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FOOD SECURITY IN ZAMBIA: AN ECONOMETRIC ANALYSIS OF THE MAIZE MARKET

presented by

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# FOOD SECURITY IN ZAMBIA: AN ECONOMETRIC ANALYSIS OF THE MAIZE MARKET

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## ABSTRACT

## FOOD SECURITY IN ZAMBIA: AN ECONOMETRIC ANALYSIS OF THE MAIZE MARKET

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This study has specified and estimated an econometric model of the maize market using time series data to determine the current and possible future conditions of prices, production and consumption of maize in Zambia. Maize is the main staple food crop in the entire country, a source of income for over half of the population that produce it, and it is the second largest contributor to GDP after copper.

Separate equations are specified for production, consumption and prices of maize using the OLS estimator. Equations that pass statistical and economic tests are combined to form a recursive simultaneous equation model.

The model predicts that domestic maize production and total demand for maize will grow at an average annual rate of 7.77% and 3.29%, respectively, over the period 1991-2000. However, domestic production will be insufficient to meet the demand. Maize will be imported to meet excess demand if no corrective measures are taken.

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## ABBREVIATIONS

| | |
|---|---|
| ARMB | Agricultural Rural Marketing Board |
| CCS | Cooperative Credit Scheme |
| CCU | Copperbelt Province Cooperative Union |
| CPCMU | Central Province Cooperative Marketing Union |
| ECU | Eastern Province Cooperative Union |
| EDP | Emergency Development Plan |
| FAO | Food and Agricultural Organization |
| FEMAC | Foreign Exchange Management Committee |
| FNDP | Fourth National Development Plan |
| GDP | Gross Domestic Product |
| GMB | Grain Marketing Board |
| ILO | International Labor Organization |
| IMF | International Monetary Fund |
| K | Kwacha (Zambian Currency) |
| KG | Kilogram |
| KM | Kilometer |
| LCU | Luapula Province Cooperative Union |
| LPCU | Lusaka Province Cooperative Union |
| NAMBoard | National Agricultural Marketing Board |
| NCDP | National Commission for Development planning |
| NCU | Northern Province Cooperative Union |
| NERP | New Economic Recovery Program |
| NWCU | North-Western Province Cooperative Union |
| OLS | Ordinary Least Squares |
| PCU | Provincial Cooperative Union |
| SNDP | Second National Development Plan |
| SPCMU | Southern Province Cooperative Marketing Union |
| TDP | Transitional Development Plan |
| TNDP | Third National Development Plan |
| WPCMU | Western Province Cooperative Marketing Union |
| ZCF | Zambia Cooperative Federation |
| ZEGA | Zambia Export Growers Association |

# 1. INTRODUCTION

## 1.1 Background

### 1.1.1 The Importance of Maize in Zambia

Various crops are grown in Zambia, including maize, soya beans, sunflower, groundnuts, cotton, tobacco, rice, beans, millet, wheat and cassava. The main staple food crop for the whole country is maize. In the urban areas, maize is supplemented, to a lesser extent, with wheat flour, bread and rice. In the rural areas, maize is supplemented with traditional food crops - sorghum, millet and cassava. The whole agricultural sector is dominated by maize in Zambia. Of all the food and non-food crops that are grown, maize accounts for about 70% of total area under cultivation and contributes about 90% to total food production in Zambia. It is produced throughout the country by more than half of the population (Chenoweth and McKenzie, 1992) and it is also the main source of income for most of the households in the rural areas.

Maize is consumed in both rural and urban areas. In 1980, average cereal consumption per capita was estimated at 172 kg of which 62% (106.64 kg) was derived from maize while the rest was accounted for by cassava, millet, sorghum, wheat and rice (Republic of Zambia, 1990). The same study revealed that with the decrease in the production of traditional food crops over the years and the decontrol of prices for all foods other than maize mealie meal in the 1980s, per capita consumption of maize is even higher now. The decontrol of prices for other food staffs apart from maize has left maize mealie meal

relatively cheaper and more affordable than other cereals like wheat and rice. This has also been influenced by the general economic position of the population which has continued to worsen starting as far back as in the 1970s as reflected by the real per capita gross domestic product (GDP).

The importance and strategic position of maize has also been recognized by the government. Since the colonial period, the government has intervened in the maize subsector mainly for socio-political reasons. The main aim of government controls of maize marketing has been to ensure the supply of cheap food to the vocal urban population. Uniform and pan-seasonal maize producer prices have been fixed by the government without considering regional differences. The marketing and processing of maize, as well as maize meal distribution have been government controlled. The marketing spread has also been determined by the government, which has been setting uniform prices paid and received by maize millers, and uniform consumer prices for all maize processed products. Actually, maize production and marketing have been promoted by the government to an extent that maize is the second most important economic commodity after copper, in terms of domestic revenue.

However, with the gradual removal of maize subsidies, hence maize support production and marketing support programs, maize production and marketing may become too expensive in some parts of the country. In such areas, production of alternative crops such as sorghum and millet may have to be encouraged if they are suitable. The importance of sorghum in the country is reviewed below.

### 1.1.2 The Importance of Sorghum in Zambia

Although the amount of sorghum produced in Zambia is very little relative to the amount of maize produced (less than 5%), sorghum and other traditional food crops are still important staple food crops for some rural households that grow maize mainly as a cash crop. Sorghum is the main food crop among traditional food crops. Because sorghum and millet are not retailed and consumed in urban areas as a staple food, over 99% of sorghum produced in the country is retained for consumption in rural areas. For households that produce traditional food crops, maize is retained for consumption only as a supplement to those traditional food crops. Moreover, in drought-prone areas where maize cannot be produced, sorghum and millet, which are more drought resistant than maize, are the main food crops produced.

The Republic of Zambia (1990) revealed that between 1982/83 and 1988/89, sorghum took up the second largest area under cultivation after maize in Lusaka, Copperbelt and North-Western Provinces while it took up the third largest area under cultivation in Western Province. All these provinces are maize deficit areas. Therefore, there is a possibility that if policies encouraged the production of suitable crops other than maize and considering the decline in maize support programs, sorghum production might stand a good chance in these provinces where it is already produced.

## 1.2 Problem Statement

Generally, food production in Zambia has been increasing since independence in 1964, as shown in Table 1.1, which shows Zambia's food production indices for the period 1963-1988. The food production increase since the late 1970s has been quite erratic. This can partly be attributed to the weather conditions that characterized the period, particularly in

Table 1.1

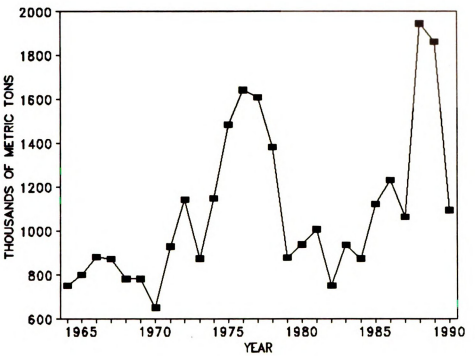
Zambia: Food Production Indices, 1963-1988
(1979-1981 = 100)

| Year | Indices |
|---|---|
| 1963 | 0.65 |
| 1964 | 0.65 |
| 1965 | 0.73 |
| 1966 | 0.84 |
| 1967 | 0.89 |
| 1968 | 0.80 |
| 1969 | 0.87 |
| 1970 | 0.86 |
| 1971 | 0.96 |
| 1972 | 0.98 |
| 1973 | 0.96 |
| 1974 | 1.09 |
| 1975 | 1.13 |
| 1976 | 1.21 |
| 1977 | 1.17 |
| 1978 | 1.10 |
| 1979 | 0.97 |
| 1980 | 1.02 |
| 1981 | 1.00 |
| 1982 | 1.98 |
| 1983 | 1.03 |
| 1984 | 1.04 |
| 1985 | 1.15 |
| 1986 | 1.13 |
| 1987 | 1.14 |
| 1988 | 1.26 |

Source: FAO Production Yearbook 1988 Vol. 42 for data from 1963-1968; 1980 vol. 34 for data from 1969-76; and 1974 vol. 28.1 for data from 1977 to 1988.

Note: Data from 1963-1968 was given as indices with 1961-65 as base years while data from 1969-76 was given as indices with 1969-1971 as base years. The author converted them to indices with 1979-1981 as base year to tally with data for the period 1977 to 1988.

**Figure 1.1. Maize Production in Zambia: 1964-1990**




the 1980s. The fluctuating increase in total food production is also reflected in the production of maize during the same period, as shown in Figure 1.1.

However, this increase in food production has not been enough to meet the demand. Food production has been increasing at a lower rate than population. Excess food demand has been met by imports, mostly in the form of cereals. Imports of non-essential foodstuffs have been restricted by government policy. Some of the problems in the maize subsector that need to be looked into include excessive transaction costs, producer prices, high levels of government subsidies, heavy transportation bottlenecks, lack of credit, insufficient storage facilities and other market infrastructure, high grain losses, late delivery of inputs, imperfect

information, technological implementation problems, lack of spare parts for machinery and trucks, and limited access to both domestic and international trade.

Therefore, there is need to increase food production further and have an efficient food system. To have adequate maize production and an efficient food marketing and distribution system, there is need to have proper future commodity pricing, production and consumption information for planning purposes by all the groups involved in the food system. Hence the importance of understanding how the maize market operates and to forecast prices and quantities of maize.

The information from forecasting can assist several users: farmers in their production and marketing decisions; marketing agencies and intermediaries as they assess production prospects for the season for their resource allocation purposes; consumers in determining their consumption patterns; lending institutions; and the government in setting agricultural priorities and other agricultural programs like price support programs.

A well-coordinated marketing system for both inputs and outputs is of vital importance if food self-sufficiency is to be obtained. It is important because about 50% of the population resides in urban areas and depends on the food market system for the supply of their daily food needs. This is in addition to the need for farmers to have efficient produce marketing and timely distribution of farm inputs.

A well-coordinated food system is also required for the attainment of food security which goes beyond increased production and food self-sufficiency. Valdes and Siamwala (1981) define food security as

> the ability of food deficit countries, or regions or households within these countries, to meet target consumption levels on a year-to-year basis. (p.2).

Therefore, it is possible to have both national food self-sufficiency (adequate food production) and hunger in some areas of the country.

Timmer et al. (1983) argue that hunger is caused by restricted choices of basic food quantities available to individual consumers, resulting mainly from inefficient and uncoordinated food systems. They further argue that this hunger problem is embedded in the set of processes of the food system starting from the point of commodity production (farm), through the transformation of these commodities into food in the marketing sector, to selling of food to consumers to satisfy nutritional and social needs. The actual functioning of this food system frequently leaves many poor people inadequately fed because of their employment and income status, the prices they pay for food and other goods and services, and their ability to move in search of better opportunities. Hence, solving the problem of hunger involves expanding the available choices, which are a function of incomes, food prices, food supplies, and consumer knowledge.

## 1.3 Objectives of the Study

The main objective of the study is to carry out an econometric analysis of the maize subsector to determine the current and possible future maize demand and supply conditions. This objective is three-fold. First, the study will give a descriptive and diagnostic analysis of the major institutional, policy, environmental and economic factors and relations that characterize the agricultural sector and the maize subsector in particular. This will show how the Zambian maize subsector's performance is a function of the institutional and policy environment within which it operates. This will also provide a background for the economic formulation of the supply and demand behavioral equations for the maize econometric model.

Second, the study will carry out a maize market analysis which will involve the specification and estimation of an econometric model of supply and demand for maize. Then predictions of maize prices and quantities will be made to the year 2000. Lastly, results of the regression model will be used to calculate supply and demand elasticities.

## 1.4 Data Collection

The 1964-1990 time series data used in this study are secondary data. Some of the data were collected from the documents published by the Central Statistical Office and other government ministries of the Republic of Zambia. The rest of the data are from the Food and Agricultural Organization (FAO) and from some books written about Zambia which report data obtained from Zambian government documents. Specific sources of data are given in Appendix B.

The rainfall figures are national averages which have been computed from rainfall levels at stations from the various parts of the country as reported in the government publications consulted. They may or may not be representative of the true population mean value, even when the sample is large.

It is worth pointing out that various sources of country-data show big differences in the same variables. For Zambia, the data on area harvested of maize, yield, production, exports, imports and domestic consumption from the United States Department of Agriculture (USDA) and from FAO showed big differences. However, both sources have almost the same data as those from Zambia for the period 1980 to 1990 for which period data on the latter could be found.

Although both FAO and USDA have almost the same data as those from Zambia for the 1980s, FAO data, and not USDA data, were selected for use in this study for two

reasons. First, an inquiry into the sources of data from the USDA revealed that the USDA obtains some of its country-data from FAO among other sources, while FAO is said to be collecting its data from the respective country governments. Second, FAO has its data broken-down into various types of demand for maize and maize wasted in Zambia unlike USDA which just reports domestic consumption of maize.

## 1.5 Organization of the Study

This study is organized into six chapters. Following this introduction (Chapter 1), Chapter 2 gives an overview of Zambia's general and specific agricultural policies and the post-independence sectoral and economic performance of the economy. In Chapter 3, the maize subsector is discussed with regard to production, marketing, consumption and pricing. Chapter 4 discusses the methodology used in estimating the maize supply, demand and price behavioral equations. Chapter 5 presents empirical findings from the econometric model of the study. Finally, in Chapter 6, a summary, conclusions, and policy implications of the study, as well as further research recommendations, are given.

## 2. THE ZAMBIA ECONOMY

This chapter gives an overview of Zambia's economy with particular emphasis on the agricultural sector. The first part gives an overview of the pre-colonial period. The second part provides a descriptive and diagnostic analysis of the post-independence development plans undertaken by the Zambian government and the resulting sectoral and overall performance of the economy. Performance is measured by the achievement of the targets set, and the relative performance of the sectors of the economy. This is followed by the discussion on specific agricultural policies.

### 2.1 Colonial Period

The British colonial rule in Zambia was such that the economy was overwhelmingly geared towards the export of copper with agriculture and manufacturing left severely underdeveloped (Clark and Allison, 1989; Bhagavan, 1978). The Federal government had a policy of confining the manufacturing and industrial base to Zimbabwe (then Southern Rhodesia). Large sums of revenue that accrued from the copper exports in Zambia (then Northern Rhodesia) were drained out of the territory and used to underpin industrial development in Zimbabwe (Ceary, 1989; Kaunga et al., 1983). The few industrial activities and commercial agriculture were concentrated along the railway line which ran through the Southern, Central and Copperbelt provinces of Zambia.

Agricultural production, particularly peasant production of traditional food crops such as sorghum, millet and cassava and other simple commodities, was irreparably damaged, and peasant society totally destabilized by the phenomenon of labor migration from rural to urban areas, induced by the colonial regime. As a result, great regional

imbalances arose between the rural and urban areas. These regional imbalances and the heavy dependence of Zambia's economy on the copper industry, whose export earnings have fluctuated and declined so much since early 1970s as a result of world copper price instability, became a great concern of the government upon independence in 1964. Upon independence, the Zambian government's policies emphasized the diversification of the economy, with particular emphasis on the development of the agricultural sector on which the rural areas heavily rely for their income and other social and economic needs.

## 2.2 Post-Independence Period

At Independence in 1964, Zambia inherited a highly dualistic economy. The modern sector, mainly owned by foreigners, was dominated by the copper industry and by large-scale commercial agriculture. The rest of the economy consisted mainly of rural small-holder farmers with very few productive links to the modern sector. The difference in the two sectors of the economy were also reflected in their high income disparities in favor of the modern sector. Therefore, since independence, the Zambian government has undertaken objectives and policies that would help develop the rural sector so as to raise the standard of living of the rural population and to narrow the rural-urban gap and to reduce the economy's dependence on copper. The major policies and objectives that have been undertaken by the government and the performance of the economy in general and the agricultural sector in particular are discussed below.

### 2.2.1 Transitional Development Plan: 1965-1966

The first post-independence plan was the Emergency Development Plan (EDP). It was a prelude to the 18 months Transitional Development plan (TDP) which ran from

January 1965 to June 1966. The TDP was meant for bridging the period of transition before a main development plan could be formulated. It covered a period of change from the rudimentary planning presented by the colonial public expenditure programs to the initiation of full resource programming, which the government wanted to introduce (Chileshe, 1986). It had two categories of projects: those carried over for completion and new ones whose starting period was dependent on the progress made in those carried over. Low priority was allocated to agriculture and the rural sector (Chileshe, 1986). The agricultural sector was neglected because Zambia was "born" at a time when revenues from the copper industry were plentiful enough to comfortably cushion the economy.

### 2.2.2 First National Development Plan: 1966-1970

In 1966, the First National Development plan was launched and it covered the period 1966-1970. Its emphasis was to establish a broad social and economic infrastructure as quickly as possible, before any direct agricultural production could be emphasized. The Plan's main objectives were to diversify the economy so as to eliminate over-dependence on the copper industry; to increase employment; to improve per capita monetary output; to maintain reasonable price stability; to minimize the inherited economic imbalance between the urban and rural sectors; to raise the general levels of education and develop a wide range of specific technical, administrative, executive, professional and management skills of the population; to provide more and better living accommodation and other social welfare needs; and to develop new communications, sources of energy, transport and other economic infrastructure which constitute the basic framework for real economic growth and development.

During this period, agriculture was not taken seriously and was not in practice considered to be complementary to the development of the industrial sector in Zambia. This is depicted in the sectoral concentration of the public investment funds, as shown in Table 2.1. A large proportion of public expenditure was allocated to the transport and infrastructure sectors which accounted for 38.9% of the total public sector investment of K563.7 million. Agriculture, industry and mining, and social infrastructure absorbed about 12.2%, 21.4% and 18.1%, respectively. Forestry, game, fisheries and research together were allocated the least (3.2%) despite the importance of research to a country's development process. These public sector investment funds (563.7 million) accounted for about 65% of the total national investment funds (K858.6 million), indicating the lower importance attached to the private sector.

The justification for the lower priority given to agriculture relative to the other major sectors of the economy was mainly the "time lags and bottlenecks, absent from other sectors" but present in the agricultural sector (First National Development Plan, p. 22). Another factor cited that prohibited a rapid expansion of the agricultural sector was the need to spend considerable sums of money on programs such as economic infrastructure and training which would be fruitful only after 1970. However, the agricultural sector also benefitted from the planned investment that was channelled into provision of economic infrastructure in the rural areas, including provision of basic water supplies, access roads and major conservation works.

The report on the "Second National Convention on Rural Development, Incomes, Wages and Prices in Zambia" (1970) provides the first major assessment by the government of the policies that were described in the First National Development Plan. This convention was held in December 1969. President Kaunda pointed out that the past government

Table 2.1

Zambia: Planned Public Investment, 1966-1970

| | | Million Kwacha | Percent |
|---|---|---|---|
| I. | Infrastructure and Transport | | |
| | Housing and Construction | 86.3 | |
| | Roads | 69.8 | |
| | Railways | 19.5 | |
| | Aerodromes | 15.1 | |
| | Telecommunications | 12.9 | |
| | Meteorology | 0.7 | |
| | Supporting Services | 11.3 | |
| | | 215.7 | 38.3 |
| II | Agriculture and Lands | | |
| | Crops and Livestock | 69.0 | 12.2 |
| | Forestry | 2.7 | |
| | Game and Fisheries | 6.6 | |
| | Research | 5.6 | |
| | Other | 3.2 | |
| | | 87.0 | 15.4 |
| III | Industry and Mining | | |
| | Industrial development | 50.1 | |
| | Mines | 12.1 | |
| | Tourism | 5.5 | |
| | Electricity | 53.4 | |
| | | 121.0 | 21.4 |
| IV | Social infrastructure | | |
| | Health | 18.5 | |
| | Education | 79.5 | |
| | Labor and Social Welfare | 4.1 | |
| | | 102.1 | 18.1 |
| V | Other | | |
| | Office of the President | 29.5 | |
| | Secretary to the Cabinet | 1.1 | |
| | Office of National Development and Planning | 1.2 | |
| | Foreign Affairs | 0.6 | |
| | Justice | 0.8 | |
| | National Assembly | 0.5 | |
| | Home Affairs | 3.1 | |
| | Finance | 1.0 | |
| | | 37.9 | 6.7 |
| | Total | 563.7 | 100.0 |

Source: Zambia, Office of National Development and Planning. First National Development Plan 1966-1970, July, 1966, p. 12, converted from pounds to Kwacha.

policies were inconsistent with the philosophy of Humanism, which is based on the equality of all men and the dignity of even the most impoverished individual. He expressed concern and dissatisfaction with the widening rural/urban gap and with the fact that government policies as at that date had benefitted the 'urbanites' while they affected only a small minority of the population in the rural areas. He also criticized the poor performance of the cooperative movement and the bias toward capital-intensive methods of production at the expense of the labor-intensive production methods.

Overall, the performance of the economy during the First National Development Plan was quite satisfactory, mostly due to higher copper prices that prevailed at that time. The introductory part of the Second National Development Plan (SNDP) reports that between 1965 and 1970, nominal GDP increased by 83% with an average annual growth rate of 10.6% (Second National Development Plan (SNDP), 1971). This growth rate compared favorably with the planned increase of 11.7% per annum in the First National Development Plan. Over the period 1964-1970, gross fixed capital formation grew at an average annual rate of 21% while the planned rate was 20% per annum. As a percentage of GDP, investment rose from about 16% in 1964 to about 28% in 1970. Resources (external and internal) made available during the period exceeded the amounts planned by 43%; recurrent expenditure exceeded the target by 21%; and real capital expenditure was close to the amount budgeted for. Therefore, on the whole, the resource and expenditure targets of First National Development Plan were more than met (SNDP, pp. 2-4).

Although the overall performance of the economy was good between 1965 and 1970, that of the agricultural sector was not satisfactory. The poor performance is reflected in the amount by which the Plan targets had been missed and by the relative performance of the other sectors. While the target annual growth rate was 9%, the actual rate of growth was

only 3.3% per annum, and out of the K88.4 million planned capital expenditure for the rural sector, only 76% was actually spent (SNDP, p. 4). The 1970 targets for marketed production for individual commodities in the First National Development Plan were not met except for raw sugar, dressed poultry, and eggs (SNDP, p. 14). Even this sugar was produced on an industrial estate, not in the rural areas. The SNDP also pointed out that during the First National Development Plan, greater problems were experienced with communal agricultural cooperatives than with family farm cooperatives and that in the future, emphasis should be put on the latter.

### 2.2.3 Second National Development Plan: 1972-1976

The Second National Development Plan (SNDP) was designed to carry further the process of economic and social growth started during the First National Development Plan period. It laid major emphasis on rural development - "the expansion of agricultural production as a top priority" (SNDP, p. 33) - both to reduce the level of income disparity between urban and rural areas and to diversify the economic base. The SNDP sought to fulfill a number of objectives which included the creation of new employment and income opportunities; the improvement of infrastructural services to complement rural employment creation and counteract rural-urban migration; the increase in the contribution of the agricultural sector to the GDP; the reduction in the growing dependence on imported commodities; the achievement of staple food self-sufficiency; and the emphasis to improve rural nutrition by increasing the production of protein foods in the rural areas for local consumption (SNDP p. 61).

To achieve these objectives, the government was required to coordinate and emphasize policies that favored balanced and accelerated rural development and encouraged

self-reliance. For instance, it was required to ensure and maintain fair prices for agricultural products, inputs, and consumer goods. In addition, it had to improve input supply, credit facilities, extension services, storage facilities, marketing and processing services to agriculture, forestry, and fisheries. There was also policy redirection through the promotion and development of long-term family farms, and use of more labor-intensive techniques and the shift of emphasis from large-scale state production to private sector production.

Two new major policies were introduced in the SNDP: the setting up of regional production priorities, and the formation of Intensive Development Zones (IDZ's). However, both policies were not implemented. The policy of regional production priorities was hindered by the movement toward uniform regional crop pricing which began in 1971/72 such that by 1974/75 season, all regional price differentials were eliminated. This was because it was supposed to be based on considerations of local demand and supply and comparative costs. On the other hand, in 1975, a decision was taken against the implementation of the IDZ's because it was discovered they were not going to be as feasible as they were planned for.

Despite the proposal that the agricultural sector would be given top priority, the planned allocation of investment gave several other objectives just as high a priority in the SNDP. The other objectives given almost the same priority included expansion and diversification of industry and improvement of social and economic infrastructure. As in the First National Development Plan period (1966-1970), the agricultural sector was not expected to grow at a higher rate, relative to the growth rates of the other major sectors. During the SNDP period, the projected average annual growth rate of the agricultural sector (5.3% for subsistence agriculture and 5.9% for commercial agriculture) at constant 1969

prices was lower than that of the manufacturing and mining sectors (14.7% and 6.1%, respectively) (SNDP, p.40).

Table 2.2 shows the allocation of the investment funds between the public sector and the private sector, and partly reflects the importance attached to each economic sector. Data in Table 2.2 show that the public sector again utilized nearly 65% of total sectoral investment funds in the SNDP. On a sector basis, public investment in transport and communications infrastructure continued to receive top priority. Allocations to most sectors, including the agricultural (rural) sector declined.

Both the overall performance of the economy and the performance of the agricultural sector was not satisfactory during the SNDP period. Between 1965 and 1970 (approximate period of the First National Development Plan) and at constant 1965 prices, GDP grew at an annual average rate of 2% while during the SNDP, the average annual growth rate of GDP was 3.4% at constant 1965 prices - as against the target growth rate of 7.4% (Third National Development Plan (TNDP), 1979, p.1). Although the GDP annual average growth rate was higher during the latter plan than during the former, the latter growth rate was still lower than the target.

Despite the major objective of the SNDP being that of diversifying the economy, hardly any development took place in this direction. At constant 1965 prices, the contribution of the mining sector to the total GDP decreased from 24% in 1971 to 23.2% in 1976. The agricultural sector's contribution of 14.2% to GDP in 1976 was almost the same as that of 1971. However, there was a significant development in the crop subsector but its growth impact was canceled by the shortfalls in the livestock subsector. The average annual contribution of the manufacturing sector to GDP in 1976 was marginally above that of 1971; the share of construction in the GDP almost remained constant; while the shares of

Table 2.2

Zambia: SNDP Planned Investment by Economic Sector, 1972-1976

Million Kwacha

| Activity | Public Sector | Public % | Private Sector | Private % | Total |
|---|---|---|---|---|---|
| Rural Sector | 122.5 | 9.6 | 30.9 | 4.4 | 152.5 |
| Mining | 41.0 | 3.2 | 361.0* | 52.7 | 402.0 |
| Manufacturing | 107.0 | 8.4 | 146.0 | 21.8 | 253.0 |
| Construction | - | 0.0 | 63.0 | 9.8 | 63.0 |
| Power | 198.8 | 15.6 | - | 0.0 | 198.8 |
| Trade | 45.0 | 3.4 | 10.0 | 1.5 | 55.0 |
| Transport and Communications | 369.3 | 29.1 | 5.4 | 0.8 | 374.7 |
| Tourism | 15.5 | 1.2 | 10.0 | 1.5 | 25.0 |
| Housing, etc. | 146.0 | 11.5 | 54.0 | 7.9 | 200.0 |
| Education | 114.5 | 9.0 | 3.0 | 0.4 | 40.0 |
| Health | 37.0 | 2.0 | 3.0 | 0.4 | 40.0 |
| Others | 74.9 | 5.9 | - | 0.0 | 74.9 |
| Total | 1271.0 | 100.0 | 685.4 | 100.0 | 1956.4 |

Source: Compiled from data given in Tables 1.1 to 3.2 of Total Investment Outlay in the Second National Development Plan, 1972-1976, Ministry of Development Planning and National Guidance, Lusaka, Zambia.

* Mainly investments of the subsidiaries of MINDECO which are 51% owned by the government.

transport, communication, storage, and wholesale and retail sectors in the total GDP declined, particularly in the last years of the plan. Therefore, overall, "the SNDP failed to bring about any diversification in the country's economic structure." (TNDP, pp. 3-4).

The uneven and inadequate growth performance of the economy during the period of the SNDP was attributed to a number of both endogenous and exogenous factors that characterized the period. The endogenous factors included the pattern of investment, the import of highly capital-intensive technology, and other factors. For the pattern of investment, (i) about half of the total expenditures was on maintenance and replacement of already existing fixed investment which did not result in any net addition to the capital stock thereby reducing fixed assets; (ii) the proportion of investment absorbed by the economic and social infrastructure and services (that is, sectors that are not directly productive) was also high as shown in Table 2.2; (iii) the investment was also biased towards the adoption of highly capital-intensive technology which was against the need to utilize the country's domestic raw materials and unsuited to Zambia's resource endowment which warranted less capital-intensive techniques; and (iv) the weaknesses in the implementation of the plan at both the central and provincial levels, lack of properly appraised projects for absorbing capital funds, shortages of skilled man-power and managerial capacity, and policy shortcomings such as pricing of products unrelated to economic costs (TNDP, pp. 2-3).

The domestic economic difficulties were compounded by exogenous factors such as the collapse of the copper prices on the world market, the negative effect of weather conditions on crop harvests, the impact of world inflation and recession, the fuel crisis, the break-up of the international monetary system, and the disruption of supply routes caused by the Rhodesian border closure and the Angolan civil war and the consequential re-routing of Zambian distribution channels (TNDP, foreword and p.1).

2.2.4 Third National Development Plan: 1979-1983

The TNDP was also formulated based on the lessons learnt from the past performance of the economy. It called for a major shift in the investment pattern in favor of three productive sectors namely agriculture, industry and mining. Again, rural development was emphasized through the need to expand the agricultural sector to attain both self-sufficiency in staple foods and to promote exports, through the promotion of rural reconstruction centers, school production units, ranches and state farms. In addition, the TNDP recognized the importance of maintaining the prominence of village regrouping schemes and model-village projects in the rural areas.

The Plan supportive policies and strategies for the achievement of rural development included the provision of complementary social and economic services and amenities such as water supply, electrification, feeder roads, housing and educational and health facilities. These were in addition to ensuring that producer prices were based on economic costs; ensuring timely collection of the agricultural produce; and investment in production and marketing programs that would ensure provision of adequate and timely agricultural inputs and services such as credit, fertilizers, implements, seeds, and storage and extension.

Table 2.3 shows the planned expenditure of the investment funds for the TNDP period whose total was K3,354 million. According to the TNDP, the private sector was only supposed to utilize about 9% of the total investment funds. The agricultural sector had the third largest allocation of the total investment funds (about 15%), with the second largest allocation given to the transport and communications sector (about 19%) and the first largest allocation accruing to the mining sector (about 20%). Out of K673 million allocated to the mining sector, K580 million (over 86%) was allocated to the copper industry.

Table 2.3

Zambia: TNDP Planned Sectoral Investment, 1979-1983

Million Kwacha

| Sectors | Govt Budget | Parastatals Internal Resources | Parastatals External Resources | Private Sector | Total |
|---|---|---|---|---|---|
| Agriculture | 440.0 | 10 | - | 55 | 502.0 |
| Mining | 13.0 | 450 | 180 | 30 | 673.0 |
| Manufacturing | 60.0 | 240 | 120 | 30 | 450.0 |
| Power | 50.0 | 140 | - | - | 190.0 |
| Transport and Comm.(excluding roads) | 220.0 | 170 | 230 | 20 | 640.0 |
| Public Works (including roads) | 155.0 | - | - | - | 155.0 |
| Commerce | 10.0 | 28 | - | 20 | 58.0 |
| Housing & real estate | 95.0 | 23 | - | 125 | 243.0 |
| Education | 106.0 | - | - | - | 106.0 |
| Health | 43.0 | - | - | - | 43.0 |
| Tourism, National Parks & Wild life | 10.0 | 24 | - | 20 | 54.0 |
| Information and broadcasting | 30.0 | - | - | - | 30.0 |
| Youth and Sports | 4.2 | - | - | - | 4.2 |
| Scientific Research | 6.0 | - | - | - | 6.0 |
| General Admin. | 46.8 | - | - | - | 46.8 |
| Provinces | 150.0 | - | - | - | 150.0 |
| Total | 1439.0 | 1085 | 530 | 300 | 3354.0 |

Source: Republic of Zambia, Third national Development Plan: 1979-1983, National Commission for Development Planning, Lusaka, p.37.

The allocation to the agricultural sector did not increase much from the percentage allocation in the SNDP (12%).

The performance of the economy during the TNDP period was not satisfactory, as reflected in all macro-economic indicators such as GDP; Government Budget; balance of payments; general price and employment levels. Real GDP grew by 1% throughout the Plan period or by an average of 0.2% per annum, compared to the projected growth in real GDP of 4.8% per annum (Fourth National Development percent Plan (FNDP), 1989, p. 2). The only positive growth rate in real GDP occurred in 1981 when there was 6.2% growth. But this was followed by negative GDP growth rates of 2.8%, 2.0% and 0.4% in 1982, 1983 and 1984, respectively. Moreover, the share of gross fixed capital formation in real GDP expenditure during the TNDP period averaged 14.3% as against a target of 29%. In contrast, the share of private and government consumption taken together was 79.7% as against the planned target of 71%, while domestic savings remained short of planned targets since the government did not raise savings for the whole period under review (FNDP, 1989, p. 2). Failure to achieve the projected real GDP growth rate resulted in the failure to achieve the projected growth in per capita incomes of 1.5% over the Plan period. Aggravated by a higher growth rate of population, per capita income declined by 12.1% during the period 1980 to 1984 (FNDP, 1989, p. 2). Inflation and terms of trade were also negatively affected during the Plan period. Inflation increased from 12% in 1980 to 19.4% in 1983. Using 1979 as the base year, the terms of trade index declined from 59.74 in 1980 to 26.77 in 1983.

With this poor performance of the TNDP, the government embarked on another strategy for the period 1983 to 1987 which tried to incorporate the mistakes learned from the past.

2.2.5 Restructuring in the Midst of Crisis: 1983-1987

The planned reforms for the period 1983-1987 are laid out in a government document entitled "Restructuring in the Midst of Crisis". It also provides measures of how to restructure the economy, reduce Zambia's heavy dependence on the mining sector and accelerate the country's social and economic development. The document discusses the poor performance of the agricultural sector since independence. At the time of writing this document, there had been no substantial improvement in livestock and crop production; per capita crop production had been declining since mid-1970s; the agricultural sector had failed to make a significant contribution towards raising incomes in the rural areas. Hence, regional-income disparities continued between the rural and urban areas.

The document attributes the poor performance of the agricultural sector to several factors, of which inappropriate or ineffective government policies are a part. These inappropriate policies include the pan-territorial and pan-seasonal (uniform) pricing system, which discouraged the development of crops according to regional comparative advantage and thus discouraged the production of traditional crops like sorghum, cassava and millet; the changing terms of trade against the agricultural sector that reduced the real producer prices; the inadequate producer incentives in the late 1960s and the 1970s; the limiting of marketing functions to government parastatals only that bred inefficiencies in the marketing system due to lack of competition and resulted in increasing budgetary subsidies, which in turn weakened the capital expenditure program; the inadequate research and technical services, especially in the traditional sector; the inefficient and inadequate supply of farming inputs (like fertilizer, seeds, credit, and farm implements) because of the shortage of foreign exchange; and insufficient budgetary allocations to the agricultural sector - for example, while the operating base and personnel of the Ministry of Agriculture and Water

Development (MAWD) had grown substantially, its operating expenses for materials and services did not increase in relative proportions. The result was only a marginal increase in output.

In the "Restructuring in the Midst of Crisis" document, the government identified long-, medium- and short-term objectives which would promote small-holder agriculture. As a long run strategy, institutional changes and proper and adequate investment allocation for agriculture were sought. To provide incentives for economically efficient farming at all levels, it was prescribed that the government should improve producer price setting. The medium-term strategy called for the government to eliminate subsidies, streamline and improve marketing and input delivery, and to increase credit availability. In the short-run, the government would expand commercial agriculture by providing more of the imported inputs that were scarce, like fertilizer, farm machinery, spare parts and agro-chemicals, to increase production. The government also undertook some adjustment programs prescribed by the IMF and World Bank.

However, the economic problems continued in the economy. The growth in the real GDP was close to nil and little diversification took place. As a result, real GDP per capita declined by 0.1%, 0.6% and 3.7% in 1985, 1986 and 1987, respectively. The share of gross fixed capital formation in real GDP expenditure between 1985 and 1987 dropped from 14.3% to 8.6% per annum. In 1987, it further dropped by 7.8% (FNDP, 1989, p.2). This indicates that there was a contraction in the general performance of the economy. Inflation continued to be on the rise and terms of trade continued to decline. Inflation increased from 19.4% in 1983 to 53% in 1986 and dropped to 45% in 1987 with 1975 as the base year. Agriculture, which was supposed to have the greatest potential for growth, continued to lag

behind its potential due to lack of effective and sufficient incentives as well as bad weather conditions during the 1980s.

### 2.2.6 New Economic Recovery Program

In response to the worsening economic crisis and in need to restore stability and create a conducive environment for investment and planning, the government decided to abandon the IMF/World Bank sponsored programs. It launched its own New Economic Recovery Program (NERP) in May, 1987. The NERP had three interrelated goals:

> (a) to reactivate the economy on the basis of maximizing the use of own resources;
> (b) to change the consumption pattern from import dependence to reliance on domestically produced goods, and services; and
> (c) to rationalize the use of foreign exchange as a strategic resource. (FNDP, 1989, p. 6)

On the basis of the NERP, the Interim National Development Plan (INDP) was drawn-up covering a period of eighteen months, starting July 1987. The program had notable sectoral and overall performance achievement (FNDP, 1989, p. 22-3). GDP grew by 6.3% at constant 1977 prices and per capita income growth rate was positive for the first time since 1981. The agricultural sector grew by 6.4% over the previous year's level. Although the mining sector's growth rate was below the target, the sector grew by 2.7% in 1988 and contributed about 9% to GDP. The manufacturing sector recorded good performance in the pulp and paper products subsectors, textiles and clothing and food, beverages and tobacco subsectors. The index of industrial production of the pulp and paper products subsector increased from 204% in 1987 to 322.2% in 1988 while that of the textiles and clothing subsector increased from 115.7% in 1987 to 200% in 1988. The food, beverages and tobacco sub-sector's index increased from 95.1% in 1987 to 115.7% in 1988.

To continue with the implementation of the NERP, the government launched the Fourth National Development Plan (FNDP) in 1989 covering the period 1989-1993.

### 2.2.6.1 Fourth National Development Plan: 1989-1993

The present policy orientations for economic development are outlined in the Fourth National Development Plan (FNDP). The FNDP is the first broad medium-term program in the implementation of the country's New Economic Recovery Program. The theme of the program is "growth from own resources", which incorporates the idea of self-reliance in all aspects. The major agricultural-related objectives of the FNDP are to improve agricultural productivity and increase production for export; to achieve food self-sufficiency; to promote import-substitution; to diversify the economy so as to reduce economic dependence on revenues from copper; to streamline the marketing system so as to improve input and output marketing; and to improve the standard of living of the rural population through increased employment creation and income generation. Increased production at minimum costs is envisaged in the short-run while providing medium- and long-term facilities to consolidate economic growth and development.

However, minimum costs of production can only be achieved through efficiency in agricultural production and marketing. The FNDP is meant to bring about this efficiency through various strategies. The overall strategy is to provide price and non-price incentives as well as provide the necessary support services. Seasonal and regional pricing is envisaged in order to encourage comparative advantage and on-farm storage. The existing price incentives, foreign exchange retention scheme and tax incentives are expected to increase production, food availability and employment opportunities. The need to provide sufficient credit is recognized, although this is in conflict with a credit squeeze aimed at controlling

money supply in the economy. The plan also emphasizes the need to mobilize funds for the Irrigation Revolving Fund, the need to maximize the use of electricity in rural areas and to strengthen the irrigation branch in the Ministry of Agriculture. This is to hedge against bad weather which characterized the country in the last decade, and has contributed to the poor performance of the agricultural sector particularly in the 1980s.

The plan also incorporates nutrition and population issues into the agricultural development strategy. With regard to nutrition, the aim is to provide enough staple food-stuffs, fruit and vegetables and protein and energy rich products. Improvement of staple food accessibility by all consumers has also been emphasized through the improvement and expansion of the local production, processing, preservation, storage, and distribution system.

A break-down of resource allocation in the FNDP is given in Table 2.4. Out of a total of K26,102.6 million, the mining sector has the largest share in investment allocation (K7492.9 million), compared to manufacturing and trade and agriculture and water development sectors which have been allocated K4,946.6 million and K3,152.7 million, respectively. The new emphasis in the mining sector is on the expansion of the mining sector to some minerals other than copper, while the manufacturing and trade sector is trying to promote import substitution and shift consumption from imported to domestically produced goods and services. Therefore, the agricultural sector is considered the least among the major economic sectors of the economy, although most of the Zambian population still depends on it for a living.

## 2.3 Overall Economic Performance and Development

Table 2.5 gives a summary of some macroeconomic indicators for the period 1960-1988. It shows that from 1960 to 1963 (years before independence), the average annual

Table 2.4

Zambia: FNDP Planned Sectoral Investment, 1989-1993

| Sectors | Million Kwacha | | | |
|---|---|---|---|---|
| | Govt Budget | Parastatal Organizations | Private Sector | Total |
| Agric. & Water Devt. | 505.4 | 1639.4 | 1008.9 | 3152.7 |
| Land & Natural Resources | 141.6 | 490.1 | 283.1 | 884.8 |
| Mining | 515.3 | 5061.0 | 1916.6 | 7492.9 |
| Manufacturing & Trade | 791.5 | 2572.2 | 1582.9 | 4946.6 |
| Tourism | 118.5 | 385.1 | 237.0 | 740.6 |
| Energy | 179.6 | 583.7 | 359.2 | 1122.5 |
| Transport & Comm. | 348.1 | 1131.4 | 696.2 | 2175.7 |
| Construction & Housing | 203.6 | 661.6 | 407.2 | 1272.4 |
| Education | 736.8 | 138.2 | 46.1 | 921.1 |
| Health | 689.4 | 129.3 | 43.1 | 861.8 |
| Mass Communications | 320.3 | 60.1 | 20.0 | 400.4 |
| Employment & Social Devt. | 611.2 | 114.6 | 38.2 | 764.0 |
| Govt. Admin. | 1336.1 | - | - | 1336.1 |
| Total | 6497.4 | 12966.7 | 6638.5 | 26102.6 |

Source: Republic of Zambia, New Economic Recovery Program: Fourth National Development Plan, 1989-1993, Volumes I and II, National Commission for Development Planning, Lusaka, p.38.

Table 2.5

Zambia: Macroeconomic Indicators, 1960-1988

| Year | (Million K) Real GDP[a] | (000 K) Real GDP Per Capita | Percentage Share in GDP of Investment[b] | Savings[c] | Imports | Exports |
|---|---|---|---|---|---|---|
| 1960 | 3775 | 1.198 | 23.63 | 32.94 | 40.10 | 58.00 |
| 1961 | 3759 | 1.165 | 24.38 | 40.64 | 43.10 | 58.13 |
| 1962 | 3748 | 1.131 | 22.69 | 23.19 | 45.89 | 58.10 |
| 1963 | 3818 | 1.094 | 17.86 | 21.90 | 40.24 | 58.10 |
| 1964 | 4328 | 1.233 | 11.35 | 32.47 | 31.08 | 65.14 |
| 1965 | 5598 | 1.547 | 24.47 | 48.66 | 36.99 | 52.46 |
| 1966 | 5367 | 1.442 | 28.89 | 38.21 | 39.50 | 53.77 |
| 1967 | 5629 | 1.468 | 30.83 | 36.36 | 43.47 | 49.63 |
| 1968 | 5772 | 1.461 | 32.39 | 27.97 | 44.26 | 51.41 |
| 1969 | 5946 | 1.466 | 18.11 | 21.54 | 32.42 | 65.68 |
| 1970 | 6157 | 1.470 | 26.66 | 26.91 | 38.64 | 56.19 |
| 1971 | 6271 | 1.455 | 28.82 | 28.24 | 39.12 | 56.89 |
| 1972 | 6642 | 1.498 | 31.16 | 29.51 | 39.40 | 37.53 |
| 1973 | 6657 | 1.459 | 29.23 | 30.23 | 21.81 | 46.64 |
| 1974 | 7098 | 1.512 | 36.65 | 29.61 | 26.85 | 37.93 |
| 1975 | 6913 | 1.428 | 40.56 | 17.69 | 37.78 | 32.91 |
| 1976 | 7209 | 1.443 | 23.81 | 18.46 | 24.74 | 39.66 |
| 1977 | 6872 | 1.332 | 24.67 | 11.23 | 26.69 | 35.65 |
| 1978 | 6905 | 1.294 | 23.86 | 16.35 | 21.90 | 30.52 |
| 1979 | 6700 | 1.212 | 14.14 | 34.06 | 22.33 | 40.98 |
| 1980 | 6901 | 1.203 | 22.88 | 24.67 | 45.40 | 21.38 |
| 1981 | 7321 | 1.227 | 19.94 | 15.93 | 41.15 | 28.64 |
| 1982 | 7119 | 1.146 | 16.77 | 17.25 | 36.61 | 27.62 |
| 1983 | 6980 | 1.079 | 13.75 | 20.66 | 31.79 | 30.64 |
| 1984 | 6955 | 1.033 | 14.68 | 22.67 | 32.83 | 36.65 |
| 1985 | 7072 | 1.009 | 14.90 | 18.32 | 38.22 | 38.74 |
| 1986 | 7111 | 0.977 | 23.81 | 15.91 | 45.64 | 45.59 |
| 1987 | 7098 | 0.939 | 13.74 | 13.00 | 38.73 | 41.85 |
| 1988 | 6894 | 0.887 | 11.37 | 23.68 | 26.87 | 34.20 |
| Average Annual Growth Rate: 1960-1963 | | | | | | |
| | 0.28% | -2.31% | -7.86% | -15.34% | -0.25% | 0.04% |
| Average Annual Growth Rate: 1964-1974 | | | | | | |
| | 4.79% | 2.40% | 0.38% | 0.23% | -6.38% | -3.26% |
| Average Annual Growth Rate: 1975-1988 | | | | | | |
| | -0.27% | -4.23% | -15.05% | -7.60% | -4.0% | -4.85% |

Notes:

[a] Real GDP is derived by deflating GDP in current prices dy the deflator (1985 = 100)

[b] Investment is defined as Gross Fixed Capital Formation plus Change in Stocks

[c] Savings is derived as a residual (GDP-consumption)

Source: Republic of Zambia, Monthly Digest of Statistics, various issues.

Republic of Zambia, National Accounts Statistics Bulletin, No. 2, Central Statistics Office, Lusaka, 1988.

Republic of Zambia, Zambia in Figures, 1991, Central Statistics Office, Lusaka, 1991.

growth rate of real GDP was 0.28% while the real per capita GDP had a decreasing growth rate of -2.31%. After independence in 1964 and before the world copper prices started to fluctuate in 1974, average real GDP growth rate increased to 4.79% while that of average real per capita GDP improved tremendously to 2.4%. However, both the real GDP and the real GDP per capita average growth rates became negative during the period between 1975 and 1988, although the nominal growth rate was positive.

The percentages of sectoral contributions to total GDP for selected years are given in Table 2.6, which shows that the contribution of the mining sector to total GDP has been decreasing over time. In 1970, the mining sector contributed about 34% to total GDP while in 1989 it only contributed about 7.8% at constant (1977) prices. On the other hand, the GDP shares of the other sectors of the economy have been increasing. The contribution of the agricultural sector to GDP rose from 10.8% in 1970 to 19.1% in 1989 at constant (1977) prices.

However, this increase in earnings, particularly in the agricultural sector, has not been at a rate fast enough to beat the rate at which population has been increasing. For instance, the agricultural sector currently contributes less than 20% to the GDP and has recorded an annual growth rate of just about 2.4% in recent years on the average while the population growth rate has been over 3% (Central Statistical Office, 1990).

The contribution of the agricultural products to total exports has never been more than 5% and has declined to less than 2% since 1978. Agricultural imports have far exceeded agricultural exports over the years. For instance, according to the Quarterly Agricultural Statistics Bulletin, Vol. IV, March/June, 1975, agricultural exports were only worth K9.63 million and K 5.5 million while agricultural imports were worth K29.3 million and K60.7 million for the years 1965 and 1972 respectively.

Table 2.6

Zambia: Percentage Distribution of GDP by Kind of Economic Activity at Constant 1977 Prices

| Economic Activity | 1970 | 1977 | 1980 | 1985 | 1989* |
|---|---|---|---|---|---|
| Total GDP (%) | 100 | 100 | 100 | 100 | 100 |
| Total GDP value (1977 prices) | 304 | 344 | 425 | | |
| Agric., Forestry & Fishing | 11 | 16 | 15 | 17 | 19 |
| Mining & Quarrying | 34 | 12 | 10 | 9 | 8 |
| Manufacturing | 10 | 18 | 19 | 21 | 25 |
| Electricity, Gas & Water | 2 | 3 | 3 | 4 | 2 |
| Construction | 7 | 6 | 5 | 4 | 3 |
| Wholesale & Retail Trade | 9 | 10 | 10 | 9 | 8 |
| Hotels & Restaurants | 1 | 2 | 2 | 3 | 2 |
| Transport, Comm. & Storage | 4 | 7 | 6 | 5 | 5 |
| Financial Institutions & Insurance | 2 | 4 | 3 | 3 | 2 |
| Real Estate & Business Service | 3 | 6 | 7 | 9 | 9 |
| Community, Social & Personal Services | 14 | 17 | 17 | 17 | 17 |
| Import Duties | 3 | 3 | 2 | 1 | 1 |
| Less imputed Banking Service Charges | 1 | 1 | 1 | 1 | 1 |

* Preliminary estimate likely to undergo revisions

Sources: Republic of Zambia, Central Statistical Office, Monthly digest of Statistics, (Lusaka: Central Statistical Office), various issues.

Republic of Zambia, Economic Report, (Lusaka: Ministry of Finance and Development Planning and National Commission for Development Planning), various issues.

Note: Figures are rounded off to the nearest whole number.

The poor performance of the Zambian economy in general and the agricultural sector in particular can be attributed to a number of factors. A major turning point in the Zambian economy came in 1975 as copper prices on the world market started to decline while domestic copper production was declining too.

After the 1965 Unilateral Declaration of Independence (UDI) of Southern Rhodesia, Zambia introduced sanctions (through import controls) against Zimbabwe (then Southern Rhodesia). Since Zambia is a land-locked country, the import controls meant the need for more export earnings. However, since export earnings were declining, import controls had to adjust to the former.

The economic difficulties resulting from cutbacks in exports, imports, and revenues were aggravated by the effects of droughts on agricultural production. Moreover, the poor plan performance is partly attributed to inconsistencies in objectives and lack of effective coordination between the various organs of the Party and Government responsible for policy formulation and implementation (ILO,1977, p.265; Chileshe, 1986, pp.74-77). The combination of these problems, plus such problems as shortage of technical and managerial skills, world and national inflation, the oil crisis, the collapse of the International Monetary System, etc., resulted in a huge financial and economic crisis.

## 2.4 Specific Agricultural Policies

### 2.4.1 Pricing Policy

Up to 1971, there were regional producer price differences that mainly reflected transport cost differentials. However, during the 1972/73 marketing season, the government introduced the policy of uniform pricing for all controlled products. At that time, controlled products included maize, maize meal, groundnuts, different types of beans, cowpeas,

sunnhemp, sunflower seeds, sorghum, soya beans and seed cotton. Uniform prices were set annually on the basis of a number of often conflicting criteria, namely cost of production, fair return to producers, fairness to consumers, import-export parity, food security, and political acceptability. Fairness to consumers and political acceptability had been the overriding considerations (Jansen, 1988), since the pricing system was influenced by the desire to provide cheap food for the benefit of the vocal urban population.

The pricing policy was modified slightly in 1982. Some consumer items were decontrolled. Consumer items such as mealie meal, wheat products, sugar, etc. were still controlled. The government continued to control all producer prices of major commodities, fertilizer selling prices as well as tractor hire charges. In 1985, producer prices of most agricultural crops were decontrolled and in June of 1989, all producer prices were decontrolled apart from that of maize. However, the government still sets floor prices of major agricultural crops as a way of giving farmers a strong negotiating base for their crops.

The policy of uniform pricing has been the subject of considerable criticism from both local and international organizations. The policy has resulted in inefficient allocation of resources. It has encouraged the production of maize at the expense of traditional crops such as cassava, millet and sorghum. The neglect of traditional crops has contributed to food insecurity, especially in areas that are prone to droughts, since it provides no incentives for on-farm storage. The policy has made it unprofitable to store crops on farms and has encouraged farmers to sell crops immediately after harvest. Thus, the policy has overtaxed the buying, transport and storage facilities of government marketing agencies.

Finally, in 1991, the maize producer price was decontrolled. Now, the government just sets the floor price for maize. This move was meant to attract private traders and other parastatal organizations into maize marketing to make it more efficient and to relieve the

government of the high subsidy expenses it was incurring in maize marketing. However, while the producer price of maize is decontrolled, the government continues to set a uniform retail price of maize mealie meal. This has been unattractive to private traders since the whole business is unprofitable. Maize mealie meal retail prices are set at too low a level to allow private traders to recover their handling and transportation costs and make a profit. As a result, Zambia Cooperative Federation (ZCF) and its designated affiliates have continued to monopolize maize marketing.

The government has not encouraged the production of traditional staple food crops (sorghum, cassava and millet) to the same extent as it has for maize. This is partly reflected in the fact that the government never used to set prices or market some of the traditional crops until the 1970s for millet and the late 1980s for cassava.

### 2.4.2 Marketing Policy

Parastatal marketing organizations have always existed in Zambia, and, until recently, they monopolized commodity marketing and input distribution. Since the pre-colonial period, maize marketing has been the sole responsibility of the grain marketing boards and their agents. Details about this will be discussed in chapter three. Since the decontrol of some commodities, some commodity specific organizations have been formed to render output marketing and input distribution services for the respective commodities. For instance, the Lint Company (Lintco) is responsible for the cotton subsector while the Zambia Coffee Company (ZCC) is responsible for coffee. In the case of seed and fruit and vegetable, there is the Zambia Seed Company (ZamSeed) and the Zambia Horticultural Company (ZamHort), respectively. Other commodity-specific marketing organizations include the Zambia Pork Products (ZAPP) for pork and pork products; the Zambia Cold

Storage Board (ZCSB) for beef and beef products, the Dairy Produce Board (DPB) for milk and milk products; and the National Tobacco Company/Tobacco Board of Zambia (NATCO/TBZ) for tobacco. Private traders have also been involved in the marketing and processing of many commodities such as beef, milk and milk products, fruit and vegetables, wheat, soybeans, etc.

### 2.4.3 Subsidy Policy

In general, subsidies are meant to integrate an economy and to foster a balance among various sectors (Timmer et al., 1983). In Zambia, priority in the allocation of subsidies was meant to be given to the rural sector and to industries which increase their use of local resources in the production process.

Between 1965 and 1975, investigations into the actual beneficiaries of subsidies revealed little evidence to support this purpose of subsidies (Chileshe, 1986). Most subsidies have been and still are used to support certain public institutions which could not survive commercially. Many subsidies were used to compensate for price increases and for the losses incurred by public enterprises, resulting into a fast rise in subsidies. Subsidies increased from K 4 million in 1965 to K 16 million in 1966, to K24.1 million in 1967 and to K 34 million in 1974. In 1967, the government admitted in the SNDP that subsidies were no longer acting as anticipated and that the continuous losses made by the subsidized public enterprises showed that

> subsidies of any type, whether on maize or any other commodity, not only result in a misdirection of resources, but are also apt to put a premium on inefficiency unless they are given after careful scrutiny of the various factors going into the cost of production of commodities concerned. (SNDP, p.7).

Subsidies were also used to establish and to prop up many of the country's cooperative societies. Many cooperatives were led by groups of misguided office bearers

who under normal circumstances would not have been permitted to run such enterprises. There was also lack of supervision by the central government authorities. As a result, many cooperative societies wasted resources. Therefore, the fact that a greater proportion of the Zambian population lives in rural areas and derives its subsistence therefrom was not a good economic reason for subsidizing cooperative societies on a country-wide basis.

There have also been commodity subsidies. Before the introduction of uniform producer prices in 1972/73 season, the government subsidized crop marketing in areas where it wanted to increase crop production, and when the marketing board could not cover its costs. But with the introduction of uniform prices, the subsidy situation worsened. The marketing agencies involved in handling commodities (particularly maize) and inputs have continuously and increasingly been subsidized to cover their handling, transportation, storage and management overhead costs. Maize subsidies will be discussed in chapter 3.

### 2.4.4 Trade Policy

Trade policy has also had a great impact on the food and agricultural sector. One of the main objectives in the agricultural sector has been export diversification. Under the 50% foreign exchange retention scheme introduced in 1984, exporters of non-traditional products were allowed to retain 50% of their export earnings in foreign currency for use in acquiring necessary inputs for their operations, thereby providing incentives for export production. Currently, some non-traditional exporters are allowed to retain 100% of their earnings, in special cases.

Other non-price incentives for expanding production, processing and marketing are provided in the Investment Act of 1986 and various government statutory instruments. These include concessional tax rates for agricultural income; 100 percent write-off of capital

cost of farm implements and machinery within two years; tax rebates; foreign exchange retention allowances for producers marketing at least 5,000 bags of maize; and removal of duties on agricultural machinery and most agricultural inputs. For example, tax rates on farming incomes were reduced from 80% to 25% in 1981 and to 15% in 1982 (Jansen, 1988, p. 48). However, the beneficiaries of these incentives are mostly emergent (medium-scale) and commercial farmers who constitute only about 9% of total farmers in Zambia. Moreover, these strategies are not intended to promote traditional crops like sorghum.

Export activities are also supported under the Export Development Act of 1985. This Act led to the establishment of the Export Council of Zambia, whose functions are to formulate and approve national export promotion policies, and the establishment of the Export Board of Zambia, whose main responsibilities are to develop and promote exports and give assistance to exporters. In addition to the two institutions, the government established the Zambia Export and Import (EXIM) Bank in 1987 to provide financial resources for trade to the non-traditional export sector.

Apart from government institutions, a group of commercial farmers have formed the Zambia Export Growers Association (ZEGA). The ZEGA was formed in 1984 to act as an agent in the export of fruits and vegetables. ZEGA coordinates, identifies markets, ensures quality control, etc. for exports on behalf of its members. The association is also used as a negotiating forum on issues such as air freight space and charges as well as any other issues affecting the export growers as a result of government policies.

Besides activities towards export promotion and expansion, the government has also maintained its food security concerns. It is government policy that there should be no exports of major food stuffs until self-sufficiency has been achieved. Other food stuffs can

be exported but only with government approval. International trade in maize has always been and continues to be done by marketing boards (ZCF).

Zambia is ideally placed to export maize to Zaire, Malawi and Mozambique. However, in 1989/90 and in 1990/91 when there was supposed to be relatively good maize exports, these markets were not utilized to the extent they could have been. This could have been because ZCF has not yet fully understood the intricacies of international trade. Moreover, Subramanyan (1990) shows that the system itself has defects. Although only ZCF is allowed to export maize, maize is generally the property of the Provincial Cooperative Unions (PCUs). Therefore, ZCF is supposed to pay the PCUs first and then export maize. But what usually happens is that the ZCF just exports and promises to reimburse the PCUs later. However, even after receiving the export payment, ZCF does not pay the PCUs right away. Hence, the PCUs have to bear the interest charges on money held in maize stocks, thus worsening their already poor financial position.

### 2.4.5 Exchange Rate Policy

Like marketing and pricing policies, the exchange rate policy has gone through changes over the last few years. Prior to October 1985, the government followed a system of fixed exchange rates. The system of weekly auctions was then introduced and lasted until May, 1987. During the fixed exchange rate system, the country's currency was overvalued. This meant that imported goods were cheaper than those produced locally, suppressing demand for locally produced goods. The overvalued currency also made exports more expensive on the international market, hence less competitive.

During the auction system, the kwacha was devalued significantly within a short period of time. The immediate effect was a general increase in prices, especially for

imported inputs. The agricultural sector depends on imported inputs such as fertilizers, machinery and chemicals. The increase in prices of these imported inputs as a result of devaluation made the auction system counter productive. Exports became cheaper and more competitive on the international market. This opportunity was not fully exploited, however, due to government export restrictions on major agricultural commodities for self-sufficiency reasons. In addition, the agricultural sector did not benefit much from the auction system partly due to low liquidity levels and the inability of most farmers to compete in the auction. Furthermore, the general increase in prices due to the auction system had great adverse effects on the poorer sections of the population. The end result was that the auction system failed to benefit either the sectors considered as priority sectors by the government, and the poor, whose standard of living the government had wanted to improve.

For the above reasons, the government decided to discontinue the auction system, and reverted to a fixed exchange rate system. A Foreign Exchange Management Committee (FEMAC) was established to prioritize the country's scarce foreign exchange resource allocation. FEMAC allocates foreign exchange every two weeks. Several government departments are represented in FEMAC. These include Ministries of Finance and NCDP, Agriculture, Commerce and Industry, and Cooperatives. Some government departments and agencies like the Department of Customs, Bank of Zambia, Prices and Incomes Commission and representatives from commercial banks are also represented. Currently, the central bank has a two-tier exchange rate system under which there is one exchange rate for its dealings with the government and another exchange rate for its day-to-day dealings with customers other than the government.

2.4.6 Research and Extension Policy

Research and extension policies are intended to provide suitable technological packages and extension services to farmers. However, available technological packages remain largely unsuited to the needs of small-holders in general and subsistence farmers in particular. Very little attention has been given to traditional subsistence crops like cassava, sorghum and millet. The extension services have not also provided advice on practical ways of increasing productivity within the constraints imposed by labor, managerial skills, and capital resources at the disposal of farmers. Because extension services have been geared to commercial farmers mainly along the line of rail, there is little, if any, technical advice that extension staff can convey with confidence to small-holders. Since maize is produced mostly by small-scale farmers, if maize production has to increase, there is need to improve extension services to these farmers so as to narrow or even eliminate the gap between them and commercial farmers.

2.4.7 Credit Policy

Although almost all farmers, including small-holder farmers, use their own resources to purchase some of the inputs for agricultural production, credit provided for crop inputs is the major type of farm credit in Zambia. For instance, the maize subsector study of 1990 done by the Zambian government reported that in 1983/84, 93% of all funds loaned by lenders were short-term credit, of which 83% was for crop inputs (Republic of Zambia, 1990).

Commercial farmers get credit for agricultural inputs from commercial banks since they have collateral. For small-scale farmers who lack the collateral needed to obtain credit from banks, the two main sources of seasonal loans are the Cooperative Credit Scheme

(CCS) and Lima Bank. The CCS is operated by the ZCF Finance Services Division, which assumed responsibility for the Rural Cooperative Agricultural Credit Scheme (RCACS) in 1986. For the RCACS to take off, the government provided ZCF with a grant of K60 million as a revolving fund for credit provision. This enabled the cooperative movement to acquire a substantial credit organization at no cost to its members.

Despite the sources of credit for commercial as well as small-scale farmers, their loanable amounts have not been large enough to meet the demand. Table 2.7 below shows the number of applicants and the approved loans for the period 1979/80 to 1983/84. The Table shows that during these seasons, the number of short-term loans approved far exceeded the number of applications. Only 41.5% of the short-term loan applications were approved in the 1981/82 season. According to the same study, the number of applicants was only a small fraction of the total number of maize producers.

The credit system faces several problems: high nominal interest rates and negative real interest rates due to the high inflation rate; delays in the repayment of loans for seeds

Table 2.7

Zambia: Number of Short-term Loan Applicants and Approved Loans, 1979/80-1983/84

| Season | No. of Applicants | No. of Loans Approved | % Approved |
|---|---|---|---|
| 1979/80 | 31773 | 21428 | 67.4 |
| 1980/81 | 50127 | 22302 | 44.5 |
| 1981/82 | 51315 | 21281 | 41.5 |
| 1982/83 | 45639 | 22856 | 50.1 |
| 1983/84 | 34931 | 20278 | 58.1 |

Source: Republic of Zambia, Evaluation of the Performance of Zambia.s Maize Subsector, 1990, p. 65

and fertilizers due to delays in paying farmers for their maize; inadequate credit facilities for small scale farmers; low loan recovery rates; and inadequate training for staff of lending institutions.

## 2.5 Summary

As a background to the analysis of the maize subsector in Zambia, sectoral and overall economic performance of the national economy is reviewed, with particular emphasis on agriculture. Each national development plan that has been employed by the Zambian government since independence in 1964 is discussed with specific concentration on the allocation of public funds. This is done to partly show the priorities of the government in its development strategies over time, especially as the government has been concerned with reducing the dependence on copper and expanding agricultural production.

The general feature of Zambian development planning has been the gap between policies, plans and actions. Sectoral and overall performance has fallen short of the set targets. Although the development plans have emphasized prioritizing agricultural development, in reality, not much attention has been paid to the development of the agricultural sector. The mining industry has continued to be the highest priority where fund allocation is concerned. As a result, the real GDP per capita has been declining since the late 1970s. However, some of the objectives of the agricultural sector in the FNDP, such as the removal of the subsidies, the liberalization of the marketing system for all crops, etc., are moving on the right track, although the liberalization of maize marketing is not yet operational because the government still controls the maize mealie meal retail prices.

Specific agricultural policies that affect the maize subsector are also discussed. These reflect how most of the policies have been benefitting commercial farmers at the

expense of small-scale farmers. Since maize is mostly produced by small-scale farmers while sorghum is solely produced by small-scale farmers, these farmers have not benefitted much from these agricultural policies.

# 3. THE MAIZE SUBSECTOR IN ZAMBIA

To be able to specify behavioral relationships required to analyze a subsector, there is a need to understand the operations of the subsector in question and how it is affected by the environment and institutions within which it operates. This chapter gives a descriptive and diagnostic analysis of the production and marketing activities in the maize subsector.

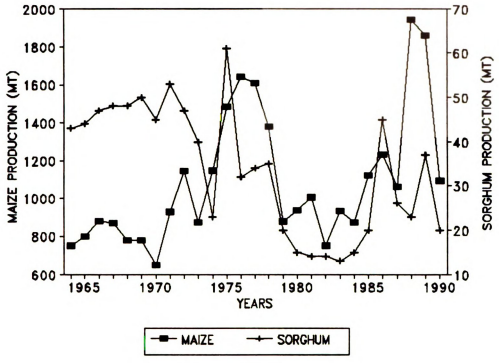
## 3.1 Maize Supply Analysis

### 3.1.1 Trend in Maize Production

There are three categories of farmers in Zambia: small-scale, medium-scale and commercial farmers. Maize is produced throughout the country by all categories of farmers. Commercial farmers represent only about 1% of the total farmers yet they contribute about 30% to total maize production. Medium-scale farmers constitute about 8% of total farmers and they contribute about 35% to total maize production. The remaining 35% of maize production accounted for by small-scale farmers who constitute about 91% of total farmers in Zambia.

Maize production and marketing has been heavily supported by the government at the expense of the traditional food crops. This is partly reflected in the quantities of maize and sorghum produced over time. Figure 3.1 shows that from 1964 to about 1975, the quantity of sorghum produced was roughly 5% that of maize. Since 1975, sorghum production has dropped to about 1% of total maize production. However, it should be noted that the sorghum production figures are likely to be underestimated considering the low profile sorghum is given and that there is no concrete time series data available on it

**Figure 3.1 Maize and Sorghum Production in Zambia: 1964-1990**




within the country. The only data that is reported on sorghum is the marketed output which would also not be representative of production since most of it is consumed within the areas where it is produced.

There have been fluctuations in the quantity of maize produced throughout the period under study. In the 1960s, maize production was relatively low because the government had not yet started promoting its production and marketing. During that period, the policy was more oriented toward the building of infrastructure in readiness for agricultural take-off than toward direct agricultural production. In the early 1970s, maize production increased substantially. This increase can partly be attributed to an increase in the maize producer price. However, in the late 1970s, there was a drastic decrease in maize

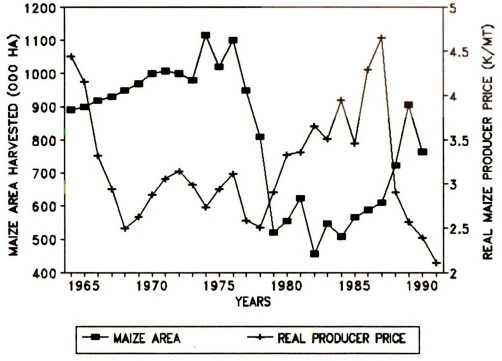
production. Although maize production started to pick-up in the 1980s, for the most part of the 1980s this increase in maize production was erratic, partly due to bad weather conditions.

Over the years, especially since the 1970s, the government has taken notable steps towards encouraging maize production by revising nominal producer prices upwards. However, the producer prices have not been significant enough to stimulate increased production. The real producer prices have been low particularly in the 1980s resulting in a decrease in maize production by commercial farmers who switched to the production of the other cash crops whose prices were more attractive. Small-scale farmers, who have lesser opportunity to switch to other commodities continue to increase maize production while decreasing the production of traditional food crops like sorghum, millet and cassava. This has been so because the government, through the Provincial Cooperative Unions (PCUs), gives some farmers maize seed and fertilizer on credit relatively easily under its maize promotion strategy. However, the amount of these inputs issued on credit is limited by the availability of government funds and are not enough to meet the demand.

#### 3.1.1.1 Trend in Area Harvested of Maize

The increase in maize production in the mid-1970s and in the 1980s can partly be attributed to an increase in the areas harvested of maize, as shown in Figure 3.2. Although area harvested of maize has also been fluctuating like maize production, the cycles are less pronounced in the case of the former. However, the drastic decrease in maize production in the late 1970s and early 1980s is very much reflected in the decrease in the area harvested of maize during that same period. These fluctuations in maize area can partly

**Figure 3.2 Zambia: Relationship between Area Harvested of Maize and the Real Producer Price of Maize, 1964-1990**




be attributed to the weather that characterized the period. The rains came later than usual so that farmers could not plant much of the land with maize considering its gestation period.

Figure 3.2 shows that the area harvested of maize increased from 0.89 million hectares in 1964 to 1.1 million hectares in 1976. It then dropped to 0.95 million hectares in 1977 to about half a million hectares in 1982. However, it increased again from 0.547 million hectares in 1983 to about 0.905 million hectares in 1989, but dropped again in 1990 to 0.764 million hectares. Figure 3.2 shows a big unexplained drop in the area harvested of maize in the late 1970s. On the overall, area harvested of maize constitutes about 70% of the total area under cultivation in the country.

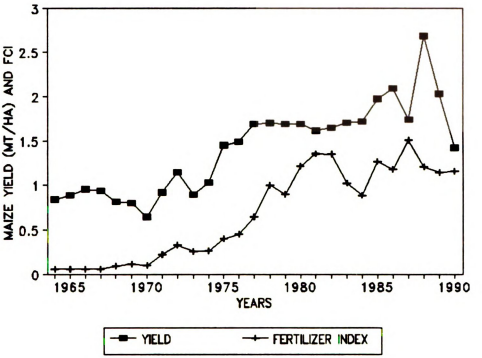
Figure 3.2 also shows some responsiveness of farmers to real producer prices of maize in some years particularly between 1968 and 1973 and between 1976 and the early 1980s. Although there is a positive relationship between the area harvested of maize and the real producer price of maize, a distinct trend is absent. Thus the real maize producer price would not be expected to be a significant determinant of the area harvested of maize in the econometric model, although the sign is expected to conform to economic theory.

3.1.1.2 Trend in Maize Yield

Average maize yield has generally been increasing over time, as shown in Figure 3.3. This increase in maize yield can partly be explained by the increase in the use of commercial fertilizer and hybrid maize seed which is believed to have a higher yield rate than the traditional maize seed. Currently, there are about ten hybrid maize seed varieties utilized in Zambia. Moreover, about 70% of the total fertilizer sold in the country is used in maize production (Republic of Zambia, 1990, p.54).

The maize yield response to the fertilizer consumption index (see its calculation in Appendix C) is shown in Figure 3.3, which shows that there is a causal relationship between maize yield and fertilizer consumption. Although hybrid seed and commercial fertilizer are used in maize production, there have been problems of accessibility and delivery of these inputs to farmers in terms of timing, quantities and suitability of different varieties to the ecological conditions of various places. For instance, there have been times when the maize area has increased proportionately more than the increase in fertilizer use in maize production as was the case in the 1980s (Republic of Zambia, 1990). This implied that average fertilizer application rates decreased thereby reducing the chances of having better maize yields. This was mainly due to the increased proportion of maize produced by small-

**Figure 3.3 Zambia: Relationship Between Fertilizer Consumption Index and Maize Yield, 1964-1990**




scale farmers who have little access to fertilizer relative to commercial farmers. The same study reported that commercial farmers who are in a better position to buy and store large quantities of fertilizers base their decisions regarding fertilizer type and application levels mainly on the analysis of potential profits. This is not the case with most of the small-scale farmers who have little cash available for fertilizer purchases even if the yield response potential is good.

### 3.1.2 Net Imports of Maize

Although maize production can generally be said to have been increasing, the population growth rate has been faster than that of maize production. This can partly be

explained by the fact that there has been migration from the rural areas, where most of the maize is produced, to the urban areas. Domestic maize production has not been sufficient to meet the increased demand for maize, particularly in the late 1970s and in the 1980s. As a result, Zambia has been a net importer of maize over the years.

### 3.2 Maize Marketing.

Parastatal marketing organizations have always existed in Zambia, and, until recently, they monopolized commodity marketing and input distribution due to various government controls and policies. Food-grains marketing has been one area that has been subjected to extensive controls by the government for a long time. The controls were instituted by the colonial administration in the 1930s and were inherited by the post-colonial administration at independence in 1964. Since 1964, the government has experimented with a number of marketing arrangements for controlled agricultural products.

Upon independence in 1964, two statutory marketing agencies, namely the Grain Marketing Board (GMB) and the Agricultural Rural Marketing Board (ARMB), were established and given the responsibility of marketing agricultural produce. These two marketing boards lasted up to 1969. The GMB was initially responsible for marketing certain controlled agricultural crop products and residual crop products along the railway line. Later on, its operations expanded to include the distribution of farm inputs such as seeds and fertilizer. Controlled products were products which producers were obliged to sell only to the GMB or its appointed agents. Residual crop products were products which were not necessarily supposed to be sold to the Board, but could be delivered to the Board if the farmer so wished. Being one of the controlled products, maize produced along the railway line was marketed by GMB which lasted from 1964 to 1969.

The ARMB was responsible for marketing crops in "nonviable" areas. A nonviable area was an area which had agricultural potential but in which the value of the surplus agricultural produce was insufficient to cover the transportation and handling costs and where markets were unduly depressed (Dodge, 1977 p. 82). It was the Minister of Agriculture's responsibility to declare an area nonviable. The ARMB had the monopoly over marketing of certain commodities and the provision of general marketing services in all the areas that were declared nonviable. Maize and sorghum were among other crops that were marketed by ARMB. The ARMB also used to distribute seeds, fertilizer, and other agricultural requisites. Some subsidies were given to the ARMB to allow it to provide producer price incentives in the nonviable areas, although this was envisaged as a temporary measure.

In September 1969, the GMB and the ARMB were merged to form the National Agricultural Marketing Board (NAMBoard). NAMBoard was established primarily to function as the government's marketing agency; to implement the country's major food policy; and to ensure a guaranteed market for maize, sorghum, and other controlled crops. Therefore, upon formation, NAMBoard had a monopoly in the purchase, sale, import, export, and storage of maize; in ensuring availability of marketing outlets for the maize surplus regions; in ensuring adequate and equitable maize supply in deficit regions; in the marketing of other controlled crops including sorghum; and in the procurement and distribution of fertilizers. However, in 1972, the government decontrolled the marketing of some crops including sorghum, but not maize. That is, while maize continued to be marketed solely by NAMBoard, sorghum became a "residual" crop that could be marketed by private traders too. The government continued to set floor prices for decontrolled crops, thereby assuring farmers a minimum price they could receive for their crops.

Later on, NAMBoard's functions increased to include the marketing of some additional crops and distributing other inputs like seeds, chemicals and implements, throughout the country. Increased responsibilities made NAMBoard inefficient. Additional inefficiencies resulted from insufficient marketing funds for controlled crops, particularly maize, since both the NAMBoard buying and selling prices of various commodities were determined by the government. These prices were inadequate to cover handling and transportation costs and allowed for no profit margin at all. As a result, NAMBoard became heavily dependent on subsidies from the government for its maize marketing operations. Delays in the disbursement of these subsidies to NAMBoard impaired its ability to meet financial obligations to third parties, and to procure and distribute inputs and outputs in a timely manner.

The increased and insupportable responsibilities given to NAMBoard necessitated the formation of the Provincial Cooperative Unions (PCUs) in 1981 as one of the government's measures to improve maize marketing. During the co-existence of NAMBoard and PCUs, the government kept on shifting the marketing responsibilities between the two institutions. Immediately after the PCUs were formed, they took over the responsibilities of rural fertilizer procurement and distribution, and intra-provincial maize marketing from NAMBoard. Inter-provincial maize marketing still remained the responsibility of NAMBoard. However, in 1985, all marketing responsibilities were returned to NAMBoard due to increased inefficiency and financial mismanagement by PCUs. Instead, PCUs only acted as agents of NAMBoard in the crop and input marketing process and the former received a commission for rendering their marketing services.

In 1987, marketing arrangements changed again. The NAMBoard was given the sole responsibility to buy maize only along the line of rail, to coordinate inter-provincial maize

marketing, to carry out maize international trade, and to continue with the distribution of the agricultural inputs. The PCUs concentrated on intra-provincial crop marketing in the rural areas. This arrangement did not last long either. In 1988, NAMBoard was directed to buy maize only for national reserves at designated places where there were silos for storage. That is, it was again the responsibility of the PCUs to do all intra-provincial maize and other crop marketing.

As inefficiencies continued even under the different marketing arrangements, the government dissolved NAMBoard in June, 1989. The food-grain marketing function of NAMBoard at that time was transferred to the Zambia Cooperative Federation (ZCF). The PCUs continued with their intra-provincial maize marketing, acting as buyers of the last resort for the other decontrolled crops, and seed and fertilizer distribution. ZCF is responsible for coordinating inter-provincial maize marketing and the importing and exporting of maize.

In 1991, the government liberalized maize marketing to allow participation by private traders. Unfortunately, private traders have not started marketing maize yet because they have found it to be unprofitable since the government still provides a ceiling on how much private traders can charge when selling maize by continuing to set the maize mealie meal retail price.

### 3.3 Marketed and Retained Maize

Out of the total maize produced, only about half is marketed through the official marketing organizations. Small-scale maize producers based in rural areas where there are no large-scale maize processing plants and where maize meal processed in urban areas is not readily available, retain some maize for own consumption. They then sell the remaining

maize output to official marketing organizations. Therefore, the marketed output depends on how much maize the rural people decide to retain, which in turn depends on the availability of other food crops produced and consumed in the rural areas such as sorghum, millet and cassava. The amount of maize retained has been increasing over time. The inefficiencies in the distribution system for maize meal, the decreasing production of some traditional food crops and the increase in rural population over time are some of the explanatory factors for the increase in the maize retention rate for food security reasons at household level. Maize bought by official marketing organizations is resold to milling companies in the urban areas where it is processed into mealie meal for domestic consumption and for other uses.

### 3.4 Transportation for Maize Marketed Output

Zambia has a fairly good trunk road system although it is in need of repairs in many places. However, the rural road system, which is the responsibility of District Councils, is still poor. Repair work is hampered by lack of earth moving equipment and lack of cash. No system has yet been developed to tax farmers to generate revenue for the construction and maintenance of rural roads. This is a big problem in crop marketing since private truckers shun areas where roads are bad.

Maize is transported from farms to PCUs depots on ox-carts, tractor trailers or hired trucks by individual farmers. From depots to storage facilities, maize is transported by transporters on contract with the cooperative unions. The introduction of uniform producer prices (1972) for the whole country and throughout the marketing season, and the determination of the transport rates for maize marketing have made it difficult for PCUs to contract enough transporters. These policies have made maize haulage by private

transporters unprofitable. Moreover, most of the trucks available in Zambia are 30-ton trucks owned by private traders and engaged in long distance maize haulage in areas with good roads. What PCUs need for maize haulage in the interior parts of rural areas where roads are bad are lightweight trucks that can cover short distances. The government and individual PCUs have only a few of these trucks. However, in January, 1990, ZCF bought 110 lightweight trucks specifically for maize haulage.

The shortage of spare parts for the existing fleet of vehicles is yet another problem which has resulted from the foreign exchange problem tied to the overall economic situation. There is also heavy reliance on road use in maize haulage. The short supply of locomotives and wagons has given way to a minimum use of the railway system. This transport problem delays getting stocks first from rural buying depots to safe storage, and then from safe storage to consumption areas. It also results in some maize loss since maize gets soaked by rain.

### 3.5 Storage for Maize

The maize that is retained is stored by individual households in their own small granaries. The marketed output is stored by marketing organizations. For marketed output, there is currently a national grain storage capacity of approximately 12.5 million 90-kg bags as shown in Table 3.1. Out of this capacity, only about 5 million bags worth of storage is of reasonable quality (sheds and silos). The rest is in the form of "hardstanding" which is supposed to consist of a concrete platform on which maize is put and then covered with tarpaulins.

Table 3.1

Zambia: 1988 Grain Storage Capacity by Type and Provincial Cooperative Union

Millions of 90-kg Bags

| Coop. Union | Existing | | | | Additional Requirement | | | |
|---|---|---|---|---|---|---|---|---|
| | Silos | Sheds | Hard Standings | Total | Silos | Sheds | Hard Standings | Total |
| CPCU | 0.5 | 0.444 | 1.8 | 2.744 | 0.2 | 0.55 | - | 0.75 |
| CCU | 0.41 | 0.331 | 1.179 | 1.919 | - | 0.05 | - | 0.05 |
| ECU | - | 0.71 | 0.413 | 1.123 | 0.2 | 0.75 | 0.55 | 1.5 |
| LCU | - | 0.057 | 0.174 | 0.232 | - | 0.1 | - | 0.1 |
| LPCU | 0.16 | 0.555 | 0.824 | 1.539 | - | 0.05 | - | 0.05 |
| NCU | - | 0.278 | 0.398 | 0.675 | 0.2 | 0.35 | - | 0.55 |
| NWCU | - | 0.106 | 0.072 | 0.178 | - | 0.04 | - | 0.04 |
| SPCMU | 0.16 | 0.888 | 2.641 | 3.689 | 0.2 | 0.4 | - | 0.6 |
| WPCMU | - | 0.255 | 0.236 | 0.491 | - | 0.1 | - | 0.1 |
| Total | 1.23 | 3.624 | 7.735 | 12.589 | 0.8 | 2.39 | 0.55 | 3.74 |

Source: Republic of Zambia, Ministry of Cooperatives, Department of Marketing, Logistics and Marketing Information Center, 1990.

The "hardstanding" storage does not lend itself to effective fumigation and if tarpaulins are of poor quality there is further damage to crops. Despite the disadvantages of "hardstanding" storage, it is used in many places due to transport problems and lack of money. In fact, some of it has a base built of wooden poles, instead of concrete, which easily rot. Yet in some places, maize stocks have been kept in these wooden-base "hardstanding" storage facilities for even two years or more although it is only good enough for a maximum of three months. As of 1988, there was a short-fall of about 4 million 90-kg bags of grain storage capacity.

This storage problem has led to great losses resulting from rain damage, rodents, other storage pests, and improper use of grain bags. Furthermore, a shortage of storage facilities has partly contributed to giving up the grading of maize by marketing organizations

upon buying it since grading entails storing according to grades, thus calling for extra storage facilities. However, the government set aside some K750 million of which K400 million is foreign exchange, for the construction of 75 storage sheds in 1990 (Ministry of Agriculture, 1990).

### 3.6 Maize Processing

Most of the food crops are processed before reaching the final consumer. Bagachwa (1991) discusses the various types of grain (including maize) processing in Tanzania, which are almost the same as those in Zambia. The two types of maize mealie meal processed by commercial milling plants in urban areas in Zambia are breakfast and roller mealie meal. Breakfast is the finest of the two since all the maize husks are removed before milling. The Republic of Zambia (1990) study indicates that from 100 kg of maize, roughly 63 kg of breakfast meal or 92 kg of roller meal can be obtained. The milling of maize is currently carried out mostly by parastatal millers following the nationalization of almost all the major milling companies after the 1986 mealie meal riots on the Copperbelt.

Most of these milling parastatals are concentrated along the old line of rail provinces especially Lusaka and the Copperbelt. About 71.5% of total urban population is concentrated in these areas. These provinces are also the major maize deficit provinces and most of the maize consumed is brought in from the surplus provinces.

The milling plants have a number of problems. Most of them were installed a long time ago and therefore require rehabilitation. This is compounded by lack of foreign exchange to bring in spare parts, which is also partly the reason why the milling plants do not operate at full capacity. For instance, during the period April to June 1987, the milling companies operated at about 57% capacity (FNDP). The capacity under-utilization of maize

milling plants is also attributed to insufficient supply of maize to milling plants at times. This is aggravated by inadequate storage facilities at milling plants. A number of major mills have storage facilities for only 2 to 3 weeks supply of maize. The rigid pricing system does not give millers incentives to invest in storage facilities.

In rural areas, most households rely on laborious, time consuming and often back-breaking staple food processing facilities available at household level. Usually, hard maize varieties are wet-processed. This method entails removing husks on maize grains usually by pounding and soaking the grains for a varying period of 2 to 5 days. Soaking allows for grains to be softened before pounding and sieving. The major disadvantage of this method of processing maize is the significant loss of nutrients through leaching when the grains are soaked. However, fermentation leaves some flavors which contribute to characteristic taste and palatability of the processed product (Siandwazi, 1990).

Mechanized processing of maize in rural areas, usually hybrid maize whose grains are soft, is done using hammermills and handmills. The availability of hammermills increases maize retention by farmers and reduces maize mealie meal importation from urban areas. Maize retention has also increased with the rise in maize meal prices over time and the erratic maize meal distribution system.

The hammermills are also not without problems. As of 1989, about 30% of all hammermills in the country were non-operational due to lack of spare parts and skilled manpower at the local level to maintain them (Ministry of Cooperatives, Department of Marketing, 1990). Moreover, mechanized maize processing facilities (hammermills) are not well distributed and women are still subjected to walking long distances to a nearby hammermill. The levy that women have to pay for processing maize through these mechanized processing technologies is not uniform from one region to another or within the

same area. However, the total number of hammermills that are reported to be in the country may be underestimated in that usually only those that are distributed through the PCUs are considered, not those owned by private individuals.

## 3.7 Maize Retailing

The principal retailers of maize meal in urban areas are state-owned retail outlets. There is a government rule that millers should deliver 80% of the total maize meal to state-owned shops which are based in Lusaka and Copperbelt provinces. Private traders just retail the remaining 20% and they have to obtain a special permit to be able to do that. The government's intention of using these measures has been to guard against malpractice like smuggling and exploitative pricing.

Table 3.2 shows the number of stores that were retailing maize mealie meal in Zambia in 1990. It shows that the number of private traders retailing maize meal far exceeded the number of state-owned shops, despite the former's small share in the total amount of maize meal retailed.

In rural areas, because households retain maize for own consumption, they rarely depend on the market for maize mealie meal supplies. If some households run out of their retained maize stocks and traditional food crops, which is mainly around November/December, that is when they buy maize meal from retail shops, if it is available. This seasonality of the trade in maize mealie meal in the rural areas and the diversity in the allocation of licenses for maize retailing to private traders at district level make it difficult to keep track of this trade. Usually, distributors shun the distribution of maize mealie meal to rural areas because it is too expensive and unprofitable given the uniform

Table 3.2

Zambia: Number of Stores Retailing Maize Mealie Meal by Province in 1990

| Province | State Shops | Private Shops |
|---|---|---|
| Lusaka | 18 | 63 |
| Copperbelt | 18 | 103 |
| Southern | - | 42 |
| Western | - | 16 |
| Eastern | - | 35 |
| Luapula | - | 52 |
| Northern | - | 26 |
| Central | - | 23 |
| Total | 36 | 360 |

Source: Republic of Zambia, Evaluation of the Performance of Zambia's Maize Subsector, 1990, p. 151.

national government fixed and controlled prices and margins. Therefore, maize mealie meal sales in rural areas are negligible and they are part of the 20% stocks of maize meal retailed by private traders.

## 3.8 Maize Consumption Analysis

The staple food crops in Zambia are maize, rice, wheat, sorghum, millet, and cassava. While the first three crops are grown both as cash crops as well as food crops, the other crops are grown only for subsistence purposes. Out of these, maize contributes about 95% to total staple food consumption in the country.

**Figure 3.4 Zambia: Relationship Between Per Capita Maize Consumption and Per Capita Maize Production, 1964-1990**

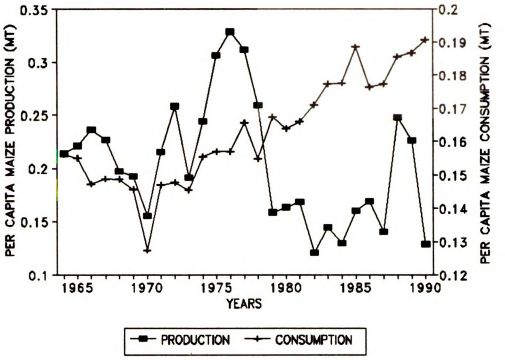


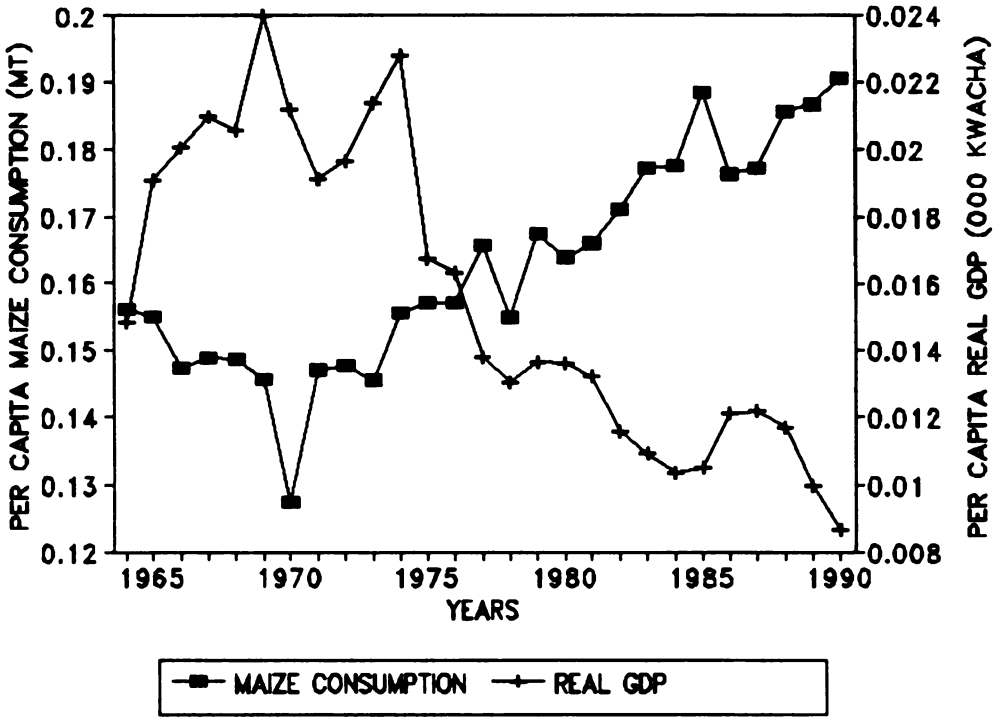

Figure 3.4 shows the relationship between per capita maize consumption and per capita maize production. It depicts that generally per capita maize production was higher than per capita maize consumption in the 1960s and 1970s such that maize exports were greater than maize imports. Moreover, during that same period, the production of traditional food crops was still high relative to that of maize. This implies that more of the traditional food crops were being consumed in rural areas thereby reducing the overall per capita maize consumption relative to per capita maize production. However, with the decrease in per capita maize production starting in the late 1970s, per capita maize consumption has since been higher than per capita maize production, generally, resulting in substantial maize imports in the 1980s.

3.8.1 Relationship between Maize Consumption and Real GDP

The relationship between per capita maize consumption and per capita real GDP is given in Figure 3.5. According to economic theory, consumption of a normal commodity is positively related to income. However, Figure 3.5 shows that while per capita real GDP has been decreasing over time, per capita maize consumption has been increasing. A possible conclusion from this result, based on economic literature, would be that maize is an inferior commodity in Zambia. Rubey (1992) cited two studies done by Cadiz (1984) and Van Zyl (1986), both using country-wide data in South Africa, which found white maize meal had a negative income elasticity of demand -0.38 and -0.30, respectively, and therefore was an "inferior" good. However, Rubey (1992) also reported the findings of the study done by Elliott (1991) using consumption data that only included black consumers in South Africa which has called the two earlier results into question. He reports that Elliott (1991) is reported to have found that white maize meal was a "normal" good since it had an income elasticity of demand of 0.06 for the urban population and 0.20 for the rural population. Since about 94% of total maize consumption is accounted for by the black population in South Africa (Rubey, 1992), it is possible that the negative income elasticities of demand found by Cadiz (1984) and Van Zyl (1986) were influenced by the income differences between whites and blacks in that country. The difference could also be due to the data sets used in their analyses.

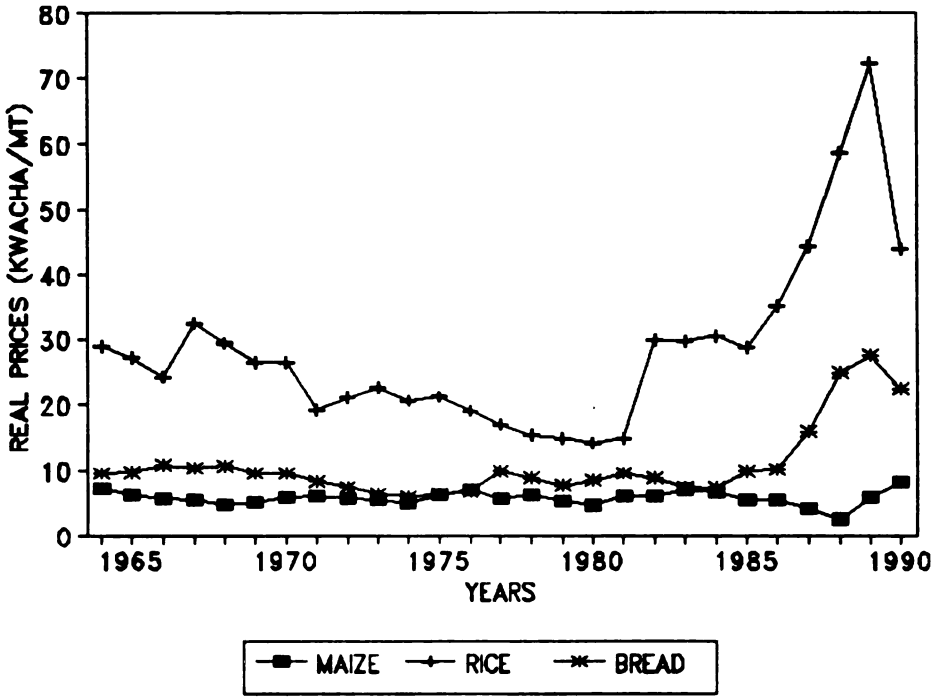
Another study done by Jayne and Chisvo (1991) in Zimbabwe showed a positive relationship between the maize demanded by millers for processing it into commercial meal from the Grain Marketing Board (GMB). Therefore, maize is not an "inferior" good in Zimbabwe. The study reports that the demand for maize by millers from the GMB is essentially a derived demand for maize meal by consumers.

**Figure 3.5 Zambia: Relationship Between Per Capita Maize Consumption and Per Capita Real GDP, 1964-1990**




Based on the findings of these studies from Zimbabwe and South Africa where maize is also the main staple food crop for the majority of the population, it is possible that maize may not be an inferior good in Zambia. Although the negative relationship between per capita real GDP and per capita maize consumption was found in this study, with a relatively large urbanized population relative to the other Sub-Saharan countries, Zambia's per capita GDP may not be representative of the incomes of people across the country. Therefore, further investigations are required to determine the income levels of different categories of people both between and within rural and urban areas before a conclusion can be made whether maize is an inferior good or not in Zambia.

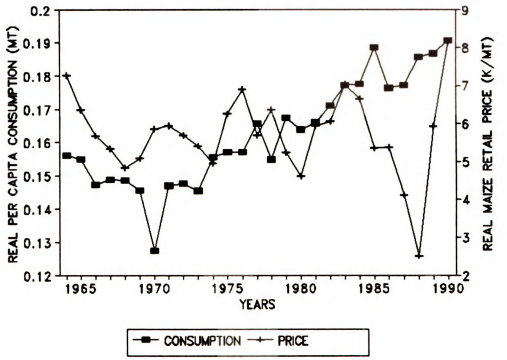
**Figure 3.6** Zambia: Comparison of Real Retail Prices of Maize, Rice and Bread, 1964-1990




The relationship between per capita maize consumption and per capita real GDP may be influenced by the pricing system in the Zambian situation. The other major staple food stuffs are wheat (bread) and rice. The prices for these commodities are not uniform for the whole country. They are more variable from time to time within a given year and they are decontrolled. However, the price of maize meal is uniform throughout the country. It is fixed and controlled by the government and it does not change as often as the changes in the prices of rice and bread.

Therefore, maize meal has always been cheaper than the other staple food crops, as shown in Figure 3.6. As such, as the economic situation worsens from time to time, as rural people's food consumption patterns change from consumption of traditional food crops to

**Figure 3.7 Zambia: Relationship Between Per Capita Maize Consumption and Maize Mealie Meal Retail Price, 1964-1990**




maize consumption (Republic of Zambia, 1990), and as rice and bread become more unaffordable by the urban population, most people have generally tended to reduce the consumption of other staple food stuffs like rice, bread and sorghum and increase maize consumption.

3.8.2 Maize Consumption and Real Maize Retail Price

Economic theory stipulates that consumption of a commodity is negatively related to its own price. The relationship between per capita domestic maize consumption and real maize retail price is given in Figure 3.7 above, which shows that there have been more fluctuations in the real maize retail price than in per capita domestic maize consumption.

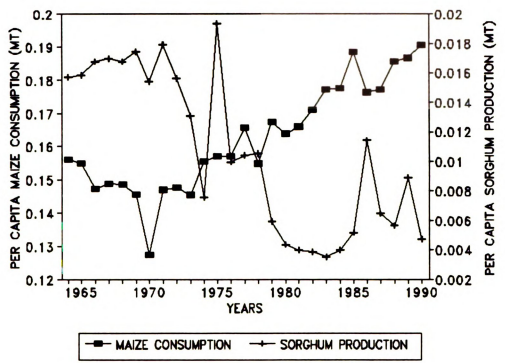
This indicates that although there is some negative relationship between these two variables, their correlation is not very strong. Thus, one would expect the real maize meal retail price not to be a significant determinant of domestic maize consumption. One of the explanations for this could be the lack of readily affordable substitutes for maize meal as explained in the previous section such that most people have no choice but to consume maize meal.

### 3.8.3 Per Capita Maize Consumption and Sorghum Production

The relationship between per capita domestic maize consumption and per capita sorghum production is given in Figure 3.8, which depicts a negative relationship between the two variables. While per capita sorghum production has been decreasing, per capita domestic maize consumption has been increasing since people have been substituting sorghum for maize.

This decrease in the production and hence in the consumption of sorghum in rural areas which implies an increase in maize consumption can partly be attributed to changes in the food consumption pattern (Republic of Zambia, 1990). The same study reported that nutritional surveys for the country suggest that there has been a gradual change taking place in the pattern of food consumption in rural areas with maize being more widely consumed throughout the country. The study also mentioned that the decontrol of prices of all foods except for maize mealie meal in the 1980s has resulted in increased dependence on maize in urban areas where cassava, millet and sorghum are not consumed. Hence, in both urban and rural areas, there has been an increase in maize consumption which is reflected in Figure 3.8. Therefore, it would be interesting to disaggregate rural and urban maize consumption to see the changes in the pattern, although this is beyond the scope of this study.

**Figure 3.8 Relationship between Per Capita Maize Consumption and Per Capita Sorghum Production, 1964-1990**

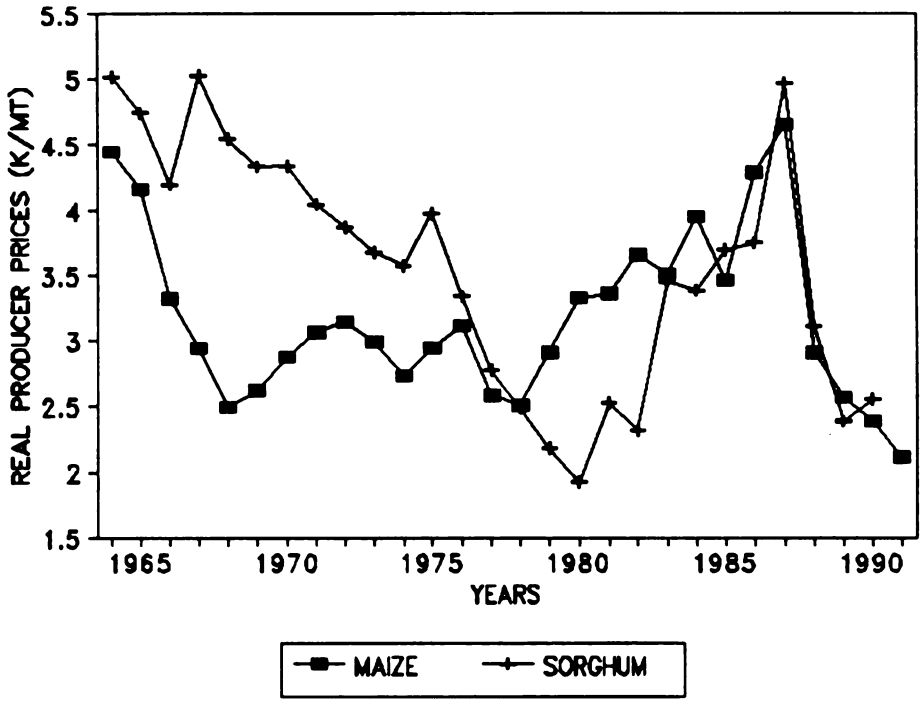



3.9 Maize Price Analysis

3.9.1 Real Maize Producer Price

The decreasing world copper prices since the mid-1970s made the government realize the need for promoting agricultural production. However, in promoting agricultural production, particularly that of staple food crops, the government has biased its policies towards maize production and marketing. Some of this bias in policies against traditional food crops and in favor of maize is reflected in Figure 3.9, which shows the trend in real maize and sorghum producer prices. It shows that the sorghum real producer price was higher than that of maize only between 1964 and 1975 before the government started

**Figure 3.9 Zambia: Comparison of Maize and Sorghum Real Producer Prices, 1964-1990**




promoting maize production. Since 1975, the government has been fixing the maize producer price at almost the same level as that of sorghum, in addition to rendering a readily available market for maize but not for sorghum. This increase in maize price at the expense of that of sorghum partly explains the decrease in sorghum production over time. One of the reasons for maize production and marketing promotion by the government is that in government circles, food self-sufficiency is considered to be equivalent to increased maize production.

Table 3.3 gives the annual percentage change in the producer price from the previous year for major crops grown in Zambia. It is observed that out of the staple food crops (maize, wheat, rice, sorghum, millet and cassava), millet and sorghum almost never had any price revisions from 1976 to 1982. The wheat and rice producer prices also did not

Table 3.3

Zambia: Percentage Changes in Producer Prices from the Previous Year's Price for Selected Crops

| YEAR | CSVA | MLET | SBEAN | WHEAT | RICE | SFLWER | GNUT | CTON | SGHUM | TBCCO | MAIZE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1976 | 27 | 0 | 29 | 0 | 20 | 19 | 47 | 33 | 0 | 15 | 26 |
| 1977 | 60 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 |
| 1978 | 47 | 0 | 26 | 25 | 0 | 35 | 14 | 15 | 0 | 32 | 8 |
| 1979 | 28 | 0 | 16 | 0 | 11 | 1 | 12 | 0 | 0 | 4 | 32 |
| 1980 | -16 | 0 | 28 | 0 | 13 | 20 | 9 | 0 | 0 | 4 | 30 |
| 1981 | -14 | 0 | 13 | 30 | 3 | 7 | 32 | 0 | 50 | 5 | 15 |
| 1982 | 22 | 0 | 16 | 23 | 51 | 18 | 4 | 2 | 0 | 45 | 19 |
| 1983 | 0 | 383 | 7 | 12 | 43 | 4 | 15 | 11 | 78 | 13 | 14 |
| 1984 | 33 | 2 | 16 | 19 | 0 | 0 | 30 | 12 | 17 | 4 | 34 |
| 1985 | 50 | 29 | 16 | 6 | 0 | 30 | 28 | 16 | 44 | 23 | 16 |
| 1986 | 100 | 48 | 84 | 91 | 39 | 50 | 43 | 25 | 59 | 48 | 94 |
| 1987 | 17 | 64 | 32 | 28 | 49 | 67 | 23 | 90 | 73 | 22 | 42 |
| 1988 | 43 | 74 | 47 | 71 | 34 | 29 | 79 | 88 | 3 | 124 | 3 |
| 1989 | 40 | 24 | 29 | 19 | 233 | 80 | 16 | 20 | 36 | 3 | 56 |
| 1990 | 129 | 120 | 106 | 116 | 58 | 85 | 103 | 169 | 161 | 317 | 127 |

Source: Calculated from data obtained from

Republic of Zambia, Ministry of Agriculture and Water Development; Ministry of Cooperatives, and Central Statistics Office

FAO "Agrostat" data on the diskette

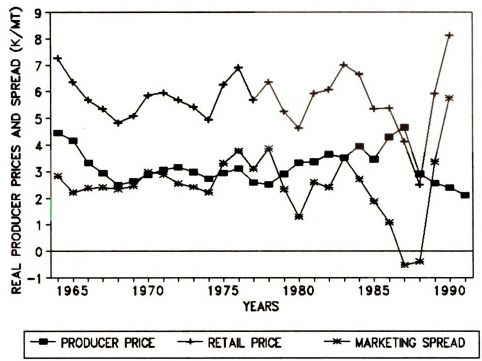
change as much as the maize and cassava prices did. However, while the government used to set floor producer prices for most of the staple food crops, it just started setting those of millet and cassava in 1979 and 1986, respectively. This, plus the lack of assured market for the two crops as with sorghum did not encourage cassava and millet production. Therefore, out of the staple food crops, even the price incentive for the early part of the period was only given to maize.

### 3.9.2 Maize Marketing Margin Analysis

A marketing margin (or marketing spread) is the difference between the farm price and the consumer price of a commodity. Timmer et al. (1983) argue that large marketing margins can occur for two reasons: either high real marketing costs cause consumer prices to be much higher than farm prices or monopolistic elements in the marketing system earn excess profits. They also give two approaches (direct and indirect) that can be used to determine whether there are excess profits and serious inefficiency in food crop marketing or whether wide margins are due to high real costs. The direct approach analyses marketing costs by looking at marketing functions (transportation, storage, processing, etc) whose combined costs constitute the marketing margin.

The indirect approach entails price analysis to determine market efficiency. The latter approach involves statistical comparisons of pairs of price series that should be connected by marketing. However, due to lack of costs and returns to marketing agents on the various marketing functions, and due to lack of prices at different levels of the marketing system, only the farm and retail prices of maize will be used to analyze the maize marketing margin in this study.

**Figure 3.10 Zambia: Comparison of Real Maize Producer and Retail prices, 1964-1990**




The real maize producer price, the real maize mealie meal retail price, and the marketing spread are given in Figure 3.10. A high marketing spread implies high marketing (transportation, storage, processing, etc.) costs. Zambia has a wide marketing spread for maize because of high maize transportation and handling costs. Figure 3.10 shows that in the late 1970s, the real maize marketing margin (marketing spread) was even higher than the real maize producer price.

It can also be inferred from the same Figure that generally the higher the real maize producer price, the higher the real maize mealie meal retail price. However, the ratio of the two prices varies from time to time with the highest ratios reflected in the 1980s. This indicates that for the most part of the 1980s, the marketing spread was relatively small, such that it was even negative in 1987 and 1988.

The relatively lower values of the marketing spread for the most part of the 1980s are not necessarily a reflection of improved efficiency in maize marketing in the Zambian situation. This is because the government was spending a lot of money subsidizing maize marketing such that actual maize transportation and handling costs were not reflected in the retail price of maize. This is depicted in Figure 3.11 in the next section which shows how the maize marketing spread has been moving together with the maize subsidies. The higher the maize subsidy the lower the maize marketing spread. The maize marketing spread increased tremendously in 1989 and 1990 because the government embarked on a maize subsidy-reduction program. The details of this will be discussed in the next section.

Table 3.4 shows the ratio of the maize producer price to the maize meal retail price. The higher the ratio, the smaller the maize marketing spread. It also confirms that the smallest maize marketing margin was in the 1980s when the maize subsidies reached the highest level. However, from 1989 onwards, the ratio started to decline tremendously because of the gradual removal of maize subsidies since that year.

## 3.10 Maize Subsidy Analysis

Maize-related subsidies have been of various forms, the main ones being:

(a) a marketing subsidy on commercial fertilizer;

(b) a price differential subsidy on imported fertilizers;

(c) a marketing subsidy to Provincial Cooperative Unions (PCUs) to cover transportation and handling costs incurred in intra-provincial maize marketing;

(d) a marketing subsidy on inter-provincial maize marketing; and

(e) provision of maize meal coupons to selected groups of urban consumers.

Table 3.4

Zambia: Ratio of Nominal Maize Producer Price to the Maize Mealie Meal Retail Price, 1964-1991

| Year | Producer Price | Retail Price | Price Ratio |
|---|---|---|---|
| 1964 | 41.44 | 67.60 | 0.61 |
| 1965 | 41.33 | 63.20 | 0.65 |
| 1966 | 36.89 | 63.20 | 0.58 |
| 1967 | 34.44 | 62.40 | 0.55 |
| 1968 | 32.22 | 62.40 | 0.52 |
| 1969 | 35.56 | 68.80 | 0.52 |
| 1970 | 38.89 | 79.20 | 0.49 |
| 1971 | 44.44 | 86.40 | 0.51 |
| 1972 | 47.78 | 86.40 | 0.55 |
| 1973 | 47.78 | 86.40 | 0.55 |
| 1974 | 47.78 | 86.40 | 0.55 |
| 1975 | 55.56 | 118.00 | 0.47 |
| 1976 | 70.00 | 155.00 | 0.45 |
| 1977 | 70.00 | 154.00 | 0.45 |
| 1978 | 75.56 | 192.00 | 0.39 |
| 1979 | 100.00 | 180.00 | 0.56 |
| 1980 | 130.00 | 180.00 | 0.72 |
| 1981 | 150.00 | 265.20 | 0.57 |
| 1982 | 177.78 | 294.40 | 0.60 |
| 1983 | 203.33 | 407.20 | 0.50 |
| 1984 | 272.22 | 459.00 | 0.59 |
| 1985 | 314.67 | 486.00 | 0.65 |
| 1986 | 611.11 | 766.00 | 0.80 |
| 1987 | 866.67 | 766.00 | 1.13 |
| 1988 | 888.89 | 766.00 | 1.16 |
| 1989 | 1388.89 | 3206.60 | 0.43 |
| 1990 | 3157.78 | 10760.00 | 0.29 |
| 1991 | 5555.56 | 21520.00 | 0.26 |

Source: Republic of Zambia, Ministry of Agriculture and Water Development and Ministry of Cooperatives, Prices and Incomes Commission and Central Statistics Office.

Maize marketing subsidies began increasing at a faster rate after the introduction of the uniform prices for maize in 1972. Table 3.5 shows the maize and fertilizer subsidies in nominal terms and as a percentage of the total government budget for the period 1980 to 1990. It shows that the share of maize subsidies in the total government budget rose from 9.3% in 1980 to 16.9% of the total government budget in 1988 in nominal terms. The fertilizer subsidy was 3.6% of the budget in 1980, 5.7% in 1982, and 3.9% in 1990.

Figure 3.11 gives the relationship between real maize subsidies and the real maize marketing margin. These huge subsidies resulted partly from the inefficiencies of the marketing organizations and partly from the pricing policy. The pricing policy did not allow marketing agencies to have any profit margins. For instance, from 1985 to 1988, the nominal maize into-mill price of a 90-kg bag of maize remained at K35 while the producer price of the same bag was changing from year to year. In some years, both the producer price and the into-mill price of maize were set at the same level. Such into-mill prices never reflected the transportation and handling costs of maize. Worse-still, the maize producer price was even higher than the maize into-mill price in 1986, 1987 and 1988. The transportation and handling costs of maize and the other parts of the price differential were paid for by the government as part of maize subsidies. In 1987 and 1988, the marketing margin was even negative.

All these huge maize marketing subsidies, particularly in the 1980s were meant to ensure provision of cheap, affordable maize mealie meal to the vocal urban population as the economic situation was increasingly worsening. These maize subsidies have been utilized mostly by the urban population at the expense of the rural population which rarely consumes maize meal processed in urban areas to which maize marketing subsidies apply. In turn, this

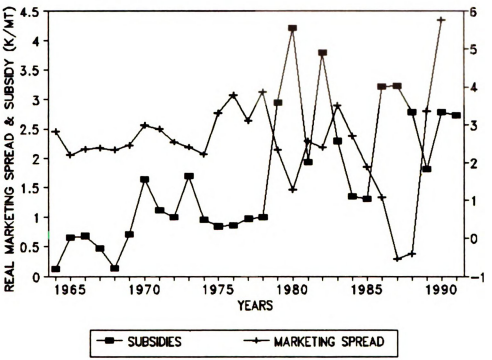
Table 3.5

Zambia: Nominal Maize and Fertilizer Subsidies as a Percentage of the Government Budget

| | Million Kwacha | | | | | |
|---|---|---|---|---|---|---|
| | | | Maize Subsidies | | Fertilizer Subsidies | |
| Year | Govt. Budget | Govt. Budget Deficit | Amount | % of Govt Budget | Amount | % of Govt Budget |
| 1980 | 1657.6 | 568 | 154.00 | 9.3 | 60.0 | 3.6 |
| 1981 | 1388.6 | 450 | 87.10 | 6.3 | 48.5 | 3.5 |
| 1982 | 1643.2 | 668 | 138.00 | 8.4 | 84.6 | 5.7 |
| 1983 | 1475.9 | 327 | 124.70 | 8.4 | 19.9 | 1.3 |
| 1984 | 1484.6 | 414 | 81.60 | 5.5 | 20.1 | 1.4 |
| 1985 | 2184.3 | 1073 | 134.00 | 6.1 | n/a | n/a |
| 1986 | 5383.6 | 1026 | 565.00 | 10.5 | n/a | n/a |
| 1987 | 5837.5 | 2147 | 638.40 | 10.9 | 205.9 | 3.5 |
| 1988 | 8359.3 | 1531 | 1413.00 | 16.9 | 205.9 | 2.5 |
| 1989 | 9838.0 | 3699 | 1585.60 | 16.1 | 357.0 | 3.6 |
| 1990 | 24503.3 | 2801 | 2193.73 | 13.7 | 950.0 | 3.9 |

Source: Republic of Zambia, Evaluation of the Performance of Zambia's Maize Subsector, Tables II.2 and II.5, 1990, Lusaka.

**Figure 3.11 Zambia: Comparison of Real Maize Marketing Margin and Real Maize Subsidies, 1964-1990**




kind of marketing arrangement and pricing policy has contributed and continues to contribute to the poor performance of marketing agencies.

However, according to the current national development plan (FNDP), one of the objectives of the government is to get rid of all maize and fertilizer subsidies by 1993. To begin the process of removing maize marketing subsidies, the government raised the into-mill price of maize in 1989 so that the system could pay for part of the intra-provincial transport and handling costs. In the 1988/89 marketing season, farmers sold maize at K125 per 90-kg bag and millers bought the same bag at K160, allowing a marketing margin of K35.00.

Table 3.6 shows a 1988/89 marketing season's break-down of the intra-provincial maize marketing subsidies paid by the government for maize marketed by each PCU. Out of the total transportation and handling cost incurred by each cooperative union per bag, the marketing system paid K35 per bag while the government paid the remaining amount. That is, the government was able to reduce its intra-provincial maize marketing subsidies by K35 per 90-kg bag of maize. The intra-provincial maize marketing subsidies amounted to about K510 million in 1989. This reflected the decrease in maize subsidies as a percentage of the total government budget in 1989, as shown in Table 3.5 above.

A closer scrutiny of the composition of the handling and transportation cost per 90-kg bag of maize reveals that transport costs accounted for about 74% of the total cost (see Table 3.7). Since transportation cost is the major component of total maize marketing costs, any strategies aimed at reducing marketing costs in the medium-term should propose ways and means of reducing such costs. One way to do this is to reduce the movement of grain from producing areas to either centrally located safe storage or consumption areas by locating storage and milling plants in maize producing areas. This could substantially reduce the burden on government treasury as far as maize handling and transportation cost subsidies are concerned.

Another move in the direction of removing maize marketing subsidies came in the 1990/91 marketing season when the government got rid of all intra-provincial maize marketing subsidies. The minimum transportation and handling cost per 90-kg bag of maize during the same season was K158 since the buying price paid to farmers was K284 while the selling price to millers was K442 per bag.

Table 3.6

Zambia: 1988/89 Season Intra-Provincial Maize Handling and Transportation Costs and Subsidies by Provincial Cooperative Union

| | (Kwacha per 90-Kg Bag) | | | | | |
|---|---|---|---|---|---|---|
| Coop. Union | H & T Costs | Producer Price | Into-Mill Price | Subsidy | Quantity Marketed (90-kg bags) | Total Subsidy Paid |
| CPCMU | 68 | 125 | 160 | 33 | 4494680 | 148324440 |
| CCU | 68 | 125 | 160 | 33 | 483947 | 15970251 |
| ECU | 68 | 125 | 160 | 33 | 2470675 | 81532275 |
| LCU | 97 | 125 | 160 | 62 | 386601 | 23969262 |
| LPCU | 68 | 125 | 160 | 33 | 465596 | 15364668 |
| NCU | 85 | 125 | 160 | 50 | 1451029 | 72551450 |
| NWCU | 117 | 125 | 160 | 82 | 159561 | 13084002 |
| SPCMU | 68 | 125 | 160 | 33 | 3352818 | 110642994 |
| WPCMU | 140 | 125 | 160 | 105 | 285255 | 29951775 |
| Total | | | | | 13550162 | 509951376 |

Source: Republic of Zambia, Ministry of Cooperatives, Department of Marketing, Logistics and Information Center, Lusaka, 1990.

Table 3.7

Zambia: 1988/89 Percentage Composition of Total Handling and Transportation Cost of a 90-kg Bag of Maize

| Item | Handling and Transportation Cost |
|---|---|
| Transport | 74.0% |
| Salaries | 7.0% |
| Bank Interest | 9.0% |
| Bank Charges | 0.7% |
| Weight Loss | 4.0% |
| Profit Margin | 5.0% |
| Fumigation | 0.3% |
| Total | 100.0% |

Source: Republic of Zambia, Ministry of Cooperatives, Department of Marketing, Logistics and Information Center, Lusaka, 1990.

The pinch of the removal of these subsidies has really been felt by the population through dramatic increases in maize mealie meal prices. The price of a 25-kg bag of breakfast maize meal has increased from K20.00 in December 1988 to K114.00 in 1989 to K269.00 in June 1990 and to about K990 in December 1991.

The other aspect which merits attention is the inter-provincial transfer of maize and other crops from surplus regions to deficit regions. The government has continued to subsidize inter-provincial maize transportation costs. The subsidy is based on the formula: distance x transport rate x total quantity moved. The transport rates, fixed by the government for crop marketing, are given in Table 3.8 for selected years.

These transport rates are fixed in consultation with transporters and are the same throughout the country. As a result, some rural areas are shunned by transporters because

Table 3.8

Zambia: Government Gazetted Transport Rates for Maize Haulage, 1984-1990

| | (Kwacha per ton per Kilometer) | | | | | | |
|---|---|---|---|---|---|---|---|
| Distance | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
| 1 - 50 km | 0.25 | 0.70 | 0.80 | 0.91 | 1.45 | 4.00 | 7.20 |
| 51 - 100 km | 0.20 | 0.65 | 0.70 | 0.80 | 1.20 | 3.30 | 5.94 |
| 101 - 200 km | 0.15 | 0.41 | 0.55 | 0.63 | 1.00 | 2.80 | 5.04 |
| 200 - Above | 0.10 | 0.30 | 0.45 | 0.51 | 0.80 | 2.60 | 4.85 |

Source: Republic of Zambia, Ministry of Cooperatives, Department of Marketing, Logistics and Information Center, Lusaka, 1990.

University of Zambia, Institute of African Studies, Draft Report of "Rice Production, Processing and Distribution in Zambia: Analysis of Problems and Prospects", Lusaka, 1990.

they have bad roads. Hence, some crops remain uncollected and get soaked by the rains. Given the structure of these rates, the inter-provincial maize transportation subsidies have been very enormous too. For instance, during the 1988/89 season, it is estimated that about 6.5 million 90-kg bags of maize were moved from the surplus provinces of Southern, Eastern, Central and Northern to the major deficit provinces of Lusaka and Copperbelt. Some maize was also moved to Luapula, North-Western and Western provinces which are also deficit provinces. During the same season, the cost of a ton of maize transported from Kasama to Ndola, over a distance of 759 km, was about K1,973.40. Thus the transport cost was about K177.62 per 90-kg bag of maize, which was higher than the producer price of K125.00 per 90-kg bag for the same season.

To reduce the inter-provincial transportation costs, it is prudent to encourage production near consumption areas. This can be achieved through regionally differentiated

pricing intended to regionalize crop production based on economic and agro-climatic conditions of each region. The guiding principle in crop promotion and production should be regional comparative advantage, especially for maize.

The other maize-related subsidy was the maize meal consumption subsidy. Any type of food subsidy is aimed at providing food to economically weaker groups of the population at a lower price in the absence of a more direct intervention. But what the general subsidy did instead was to create opportunities whereby a substantial proportion of the benefits accrued to households that were economically better off.

In the 1980s, the government embarked on measures to modify and improve the general consumer subsidy. In 1986, the government introduced a form of self-targeting subsidy by subsidizing "roller mealie meal", which it believed was the type of maize meal mostly consumed by the poor people. The other type of maize meal, "breakfast mealie meal", believed to be consumed by the relatively better-off people, was left to be sold at a higher price determined by the government. This was a wrong assumption on the part of the government because it sparked food riots which indicated that actually most people consume breakfast mealie meal including some in the low income.

In January 1989, the government introduced the coupon system to facilitate the gradual removal of the subsidy from the maize meal price. This coincided with a general decontrol of other commodities. The coupon system was introduced to subsidize urban maize mealie meal consumption through the distribution of coupons initially to the whole urban population, and later to only those urban households that earned less than K20,500.00 per annum (Siandwazi, 1990). The coupon, with a given kwacha value based on the estimate of maize meal requirement of 14 kg per person per month, could be exchanged for any type

of maize meal (Siandwazi, 1988). However, this coupon system was eliminated at the beginning of 1992 after the coming of the new government in October 1991.

There have also been maize fertilizer-related subsidies. Nitrogen Chemicals of Zambia (NCZ), the only fertilizer manufacturing organization, meets only about 40% of the national fertilizer requirements (Ndalamei, 1990). The rest of the fertilizer is imported. Since imported fertilizer usually costs more than the domestic selling price set by the government, the government subsidizes the importation of fertilizer too. In fact, the selling price of fertilizer also does not cover the production costs incurred by the NCZ, implying that fertilizer production as well as distribution is subsidized.

The fertilizer subsidies are shown in Table 3.5 above. The government made the first move in reducing fertilizer subsidies in 1983 and as a result fertilizer prices increased by over 50%. In the study conducted by the Zambian government on the performance of maize subsector in 1990, it was reported that maize uses about 70% of the total fertilizer sold in the country. So, fertilizer subsidies have been part of the process of providing cheap maize mealie meal to the vocal urban population since the bulk of fertilizer is used in maize production.

All these maize-related subsidies have left fertilizer, maize producer prices and maize mealie meal retail prices lower in Zambia than those in neighboring countries, leading to smuggling of the commodities, especially into Zaire in the case of maize mealie meal. Fertilizer smuggling is estimated between 15,000 to 25,000 tons per year (Ndalamei, 1990). Currently, the government is in the process of removing all maize marketing and fertilizer subsidies, which are expected to be completely eliminated by 1993.

## 3.11 Summary

This chapter describes the maize subsector and shows how its performance has been influenced by the institution and environmental policies within which it operates. It discusses maize yields, area harvested and production. With the use of hybrid maize seed and commercial fertilizer, maize yield has been increasing over time. However, the area harvested of maize has been fluctuating resulting in fluctuations in maize production. It shows that the government policy has had an impact on the direction of sorghum production over time due to its bias toward maize production at the expense of the other staple food crops.

Maize consumption is also analyzed in relation to its own retail price, real GDP, and the production of sorghum. Maize retail prices and sorghum production showed their expected relationship to maize consumption. Per capita real GDP was negatively related to per capita maize consumption which implies that maize is an inferior good. However, based on the literature reviewed on South Africa and Zimbabwe where maize also the main staple food, it is possible that maize could be a normal good in Zambia. Hence this study could not conclude that maize is an inferior good. It is possible that the per capita GDP does not reflect the incomes which maize consumers have considering that the country is highly urbanized. The negative relationship between per capita GDP and per capita maize consumption could also partly be due to the retail pricing policy for staple food crops whose aim has been to provide cheap maize meal to the vocal urban population for political reasons.

# 4. RESEARCH METHODOLOGY

To be able to achieve the forecasting objective outlined in the introductory chapter, an analytical tool was required. A quantitative model of the maize market was selected to meet this objective. This chapter first provides the economic theory of supply and demand for a commodity. It then discusses the general steps involved in commodity modeling and applies them to the maize subsector in Zambia.

## 4.1 Supply and Demand of a Commodity

### 4.1.1 Supply of a Commodity

Traditionally, supply analysis is embedded in the theory of production. According to production theory, output produced is a function of factors of production available to the producer. However, supply analysis is based on economic theory which goes beyond production theory. Apart from the factors of production, it incorporates other various supply shifters which affect the supply of a commodity. The various factors that affect the supply of a commodity include own price of a commodity under consideration; weather and pests; changes in technology that influence both yields and costs of production; changes in input (or factor) prices; changes in prices (hence returns) of commodities that compete for the same resources; changes in the prices of the joint products (that is, commodities that are produced together such as wool and mutton); changes in the level of price and/or yield risks faced by the producer; and institutional constraints such as government acreage-control programs. Any supply function should be formulated based on this economic theory.

The relationship between the commodity under analysis and the factors that affect it is important for economic analysis. According to economic theory, supply of a commodity

is negatively related to prices of inputs used in its production, but positively related to its own price and the prices of commodities with which it has a joint relationship. Other things remaining the same, a rise in the price of commodity B can be expected to lead to a decrease in the area planted to commodity A. Supply of a commodity is positively related to improved technology and weather which lead to improvement in yield.

### 4.1.2 Demand of a Commodity

Asuming-Brempong (1991) cites three common aspects of consumption behavior used in economic policy analysis and forecasting models, namely consumer demand analysis, Engel curve analysis and consumption functions in more aggregated contexts. Engel curves are employed to estimate income elasticities; aggregate consumption functions relate microeconomic variables, such as household consumption, to income and socioeconomic characteristics; while demand analysis provides price and income elasticities that are important policy parameters. Demand analysis incorporates demand equations which are formulated according to the purpose for which a commodity is demanded and the factors affecting demand. Of these three aspects of consumption behavior, this study will focus on demand analysis.

Demand analysis is traditionally embedded in the theory of consumer behavior. A commodity can be demanded for various reasons (Ferris, 1991). It can be demanded for domestic consumption (the basis of consumer demand theory), for export, and for storage and speculation. According to consumer demand theory, the quantity of a commodity buyers will be willing to purchase from the market over a given period of time depends on the price of the commodity itself; the prices of substitutes and complements; the consumers' incomes and income distribution; the level of general inflation; the consumers' tastes and

preferences; living patterns; promotion of the commodity; and the population size and its distribution by age, sex, ethnic group and region.

Demand for storage and speculation of a given commodity depends on current price versus expected prices; storage costs; interest rates; and storage availability. The demand of a commodity for export depends on the commodity's own price in the exporting country; its price in competing exporting countries; transportation costs; shortage possibilities in the importing country(ies); and various other factors in the importing country(ies) such as price of the commodity, its production, consumer income, livestock numbers (for feed demand), and farm programs and trade policies.

## 4.2 Modeling Commodity Markets

There are various steps involved in building a model for any given commodity. First, the model builder must determine the purpose for which the model is being developed and the information being sought from it. Palm and Smit (1991) argue that a model can be used for an analytical problem and for a policy problem. On one hand, an analytical problem involves solving the endogenous variables for the fixed values of the exogenous variables. That is, it involves forecasting short- and long-term prices, production and consumption. On the other hand, a policy problem entails giving some endogenous and exogenous variables a certain target value and the model is used to find the matching values of the other exogenous and endogenous variables. In the latter case, the analysis tries to answer "what if" questions about market responses to specific economic, policy and/or institutional changes.

The second step in commodity modelling is the selection of the appropriate model structure to use in the analysis. The selection of the structure of a commodity model should

reflect the attributes of a commodity market or a particular commodity problem to be analyzed, in addition to the formal methodology employed which includes model specification, estimation and forecasting. The stochastic structure of prices and quantities must be specified to justify the use of a particular estimator. In general, it is important to know whether or not price or quantity of a commodity whose supply and demand is being analyzed is predetermined. Thurman (1987) argues that the text-book competitive market determines price and quantity simultaneously and requires instrumental variables-type estimators of demand. This is based on the assumption that both the price and quantity of the commodity are determined by market forces. Thurman (1987) further argues that if one is dealing with a market structure in which prices or quantities are predetermined, then regression estimates of equations should be such that the predetermined variable is an independent variable which should only appear on the right-hand-side of the equation. Therefore, even the regression estimator to be used should be one which allows for the predetermined variables in question to be on the right-hand-side.

The third step in commodity modelling is the specification of relationships of a particular commodity market. Equations of a model should be specified in such a way that they are able to capture economic relationships between model variables while maintaining consistency with the model structure. While this process includes determination of behavioral relationships based on economic theory, model specification goes beyond economic theory. Economic theory guides a commodity model builder to select variables that should appear in each equation but it does not tell you which specific prices to include, whether to lag variables or not and by how much time period a lag should be, what functional form the equation should take, etc. Answers to all these questions are also part of model specification.

The fourth step in commodity model building is the estimation of parameters for the variables in the behavioral equations of the model. This process involves selecting the appropriate technique to use.

The fifth step in commodity model building is the validation of the model. The final validity of a model depends on the conclusions reached from the application of the different techniques aimed at the analysis of the information supplied by a model once it has been specified and estimated. This process involves performing tests and diagnostic checks with the model, most of which are statistical in nature, to select the model with the most appropriate specification. The acceptance of the model as satisfactory depends on the intended purpose of the model. Sowey (1973) points out:

> By validation, on the other hand, is understood simply determining whether the model fulfills well the demand made of it. It is not a question of whether the model embodies strictly causal mechanisms, but rather whether the estimated model, with all its inherent imperfections, does an adequate job of prediction, both within and beyond the estimation period. (p.196).

Dhrymes et al. (1972) affirm that validation of a given model differs from case to case as the proposed use of the model under consideration changes. However, they still argue that although a particular model may be validated for one purpose and not for another, in each case the process should be such that the model fulfills the stated purpose.

Grasa (1989) argues that a model is selected if it adequately characterizes the data by being more accurate and more precise than the other models. To be able to adequately characterize the data, Grasa argues that a model should resist repeated refutation with success and should provide more information than other models. This information should be corroborated by new facts which are not themselves used in the specification of the model.

Generally, models built for forecasting purposes are subjected to more rigorous tests than those developed for policy analysis purposes. Some of the most commonly used statistical tests discussed by Asuming-Brempong (1991) which are also used in this study are:

(a) consistency to a priori relationship - the estimated parameters are evaluated on the basis of their magnitude and signs to see if they conform to their expected values and signs as stipulated by economic theory.

(b) Level of significance of regression coefficients - this will be tested using the t-test (or student t-statistic). The rule of thumb is that if the t-statistic is at least equal to 2, then the regression coefficients are significant at the 5% level of significance.

(c) Validity of the model - This is tested using the F-test which shows the significance of the entire regression equation and its appropriateness for the particular analysis being conducted.

(d) Coefficient of determination ($R^2$) - This measures the degree of the relationship between the dependent and independent variables, and shows how much of the variation in the dependent variable is explained by the independent variables. The higher the magnitude of $R^2$ the better the model. However, the magnitude of $R^2$ increases with the increase in the number of the independent variables while the degrees of freedom decrease. Therefore, the corrected (or adjusted) $R^2$ is a better statistic for empirical analysis.

(e) Standard error of Regression (SER) - SER measures the extent to which the estimated (or observed) value approaches the true value of the variable. Since the deviations of the observed value from the true value must be minimum, the smaller the SER, the greater the precision and the more reliable the estimates of the parameters of the regression equation.

(f) Durbin Watson (D-W) test - the D-W statistic is used to measure the presence of serial correlation. Its value is expected to be around 2 when there is no auto-correlation in the model.

The final step in commodity model building is the performing of a forecast, a prediction or a simulation. To do a forecast, one has to first forecast the future values of exogenous variables and then use them to forecast the future values of the endogenous variables.

## 4.3 Modeling Methodologies

A commodity model can be built for various purposes. It is not possible to have all of the purposes met with the use of one methodology only. Therefore, a model may sometimes require the use of different kinds of quantitative methodologies. Labys (1988) discusses some categories of models which are based on econometric methods (like market models) as well as linear programming methods.

### 4.3.1 Time Series Models Versus Econometric Models

Time series models are mainly used for forecasting in commodity market analysis. Harvey (1990) and Kennedy (1985) argue that while time series models attempt to explain the behavior of a variable in terms of its own past, an econometric model is set up on the basis of a behavioral relationship suggested by economic theory. Although time series models will be used to forecast exogenous variables in this study, an econometric model will be used to specify, estimate and forecast the endogenous variables. One major category of econometric models is the market models.

4.3.2 Market Models

These are models usually based on econometric methods concerned with the determination of prices and with the behavior of participants in a competitive commodity market. The price is determined by the market clearing conditions. The following is the standard commodity market model:

$$Q_t^d = f(P_t, P_t^o, Y_t, T_t)$$

$$Q_t^s = f(P_{t-i}, W_t, P_t^s, G_t)$$

$$P_t = f(S_t)$$

$$S_t = S_{t-1} + Q_t^s - Q_t^d$$

Where:

$Q_t^d$ = quantity demanded in time t;

$Q_t^s$ = quantity supplied in time t;

$P_t$ = commodity price in time t;

$S_t$ = level of stock-holding of the commodity in time t;

$P_t^o$ = price of other commodities (substitutes or complements) that can be demanded in time t;

$Y_t$ = income level in time t;

$T_t$ = consumer tastes and preferences in time t;

$W_t$ = weather in time t;

$P_t^s$ = prices of substitutes that can be supplied in time t; and

$G_t$ = government policy in time t.

In other cases where prices are not determined by competitive adjustment, other modeling approaches have to be used.

## 4.4 Modeling the Maize Market in Zambia

The description of the maize subsector given in Chapter 3 is essential in choosing the correct model structure, and especially for the selection of variables to include in the price, supply and demand equations.

### 4.4.1 Model Structure

From the discussion on the maize subsector in Zambia, it is clear that the government sets all the maize subsector-related prices (maize producer price, fertilizer prices, maize seed prices, maize marketing transportation rates, maize buying and selling prices by milling companies, and wholesale and retail prices). On this note, one would consider prices to be exogenous in the model and use Thurman's argument (1987) since maize prices would be considered to be predetermined or controlled. However, in setting the maize producer price, the Zambian government considers the previous year's maize stocks and production levels which are endogenous in the maize subsector, along with production costs and other policies that might be exogenous to the model. Therefore, since maize prices are partially endogenously determined, they will be formulated as endogenous variables so that the government policy can be captured.

Although maize prices will be considered endogenous, it does not imply that an equilibrium maize price exists which is determined by market clearing conditions. This implies that the market clearing conditions (equating maize supply and demand) cannot be applied to determine an equilibrium price for maize given the fact that prices are not fully determined by the interaction of supply and demand.

4.4.2 Model Specification

Total maize supply in Zambia includes domestic production and net imports and stocks at any given time. As argued by Tomek and Robinson (1990), separate equations are required to explain each component of supply of a commodity. Each of these maize supply components will therefore have a separate equation. For production, it is simpler to formulate only one equation in which total production is a dependent variable in analyzing producers' supply response to various factors. However, Tomek and Robinson (1990) argue that it is usually more appropriate to consider yields and units separately since some detail is lost in the process. Therefore, this study will formulate separate equations for the area planted to maize and for the average maize yield. Maize production will be derived as a product of the behavioral equations of yield and area harvested of maize.

The area planted to maize will initially be formulated as a function of area planted to maize in the previous year, the producer price of maize, the producer prices of the other crops a farmer can produce, the production cost, and the amount of rainfall. Because of lack of data on other inputs, the cost of fertilizer will be used as a proxy for the total cost of producing maize.

Producers usually have more control over the number of units planted than over the yield. Yields are largely influenced by factors over which a farmer has no control (like moisture, temperatures, pests, etc.). These factors render the specification of the yield equations difficult; the latter frequently exhibit strong underlying trends. Moreover, it is often difficult to identify or measure precisely how much of a given change in output is due to technical improvements and how much is due to changes in factor or product prices. Because of the definitional and measurement problems involved, there has been a tendency in empirical analysis of supply to use time or some simple trend variable as a measure of

technological improvements without specifically identifying and measuring those factors responsible for shifts in supply (Tomek and Robinson, 1990). Therefore, yield will be formulated as a function of time trend, fertilizer consumption index and rain.

Net maize imports are determined by the change in stocks which are derived as the residual of domestic production plus net imports less total maize demand and waste. The level of change in stocks is used as a proxy for the level of stocks since the there are no data on maize stocks.

Maize is demanded for domestic consumption, for feed, for seed, and for industrial processing into maize products other than mealie meal. Domestic consumption is determined by commodity price, prices of substitutes, income, change in tastes and preferences captured by time trend, and population which is incorporated by estimating per capita domestic maize consumption. Demand of maize for feed will be determined as a derived demand due to lack of data on livestock and feed price. That is, demand for feed is derived from the demand for livestock, which in turn is determined by income and time trend. The same argument follows for the demand of maize for industrial processing. Maize demand for seed is determined by the area planted to maize.

The regression equations will initially be specified as follows:

(1) $TMZY_t = f(C, RAIN_t, TIME_t)$

(2) $TMZAREA_t = f(C, TMZAREA_{t-1}, MZPPD_t, PPD_t^0, FERTPD_t, RAIN_t)$

(3) $TMZPROD_t = TMZY_t * TMZAREA_t$

(4) $NMZIMP_t = f(C, MZSTOCK_{t-1}, TMZPROD_t)$

(5) $TMZQ_t^s = TMZPROD_t + NMZIMP_t + MZSTOCK_{t-1}$

(6) $TMZCPC_t = f(C, MZMRPD_t, TIME_t, GDPPCD_t, RICERPD_t, SGPRODPC_t)$

(7) $TMZC_t = TMZCPC_t * TPOP_t$

(8) $PROCPC_t = f(C, GDPPCD_t, TIME_t)$

(9) $MZPROC_t$ = $PROCPC_t * TPOP_t$

(10) $FEEDPC_t$ = $f(C, GDPPCD_t, TIME_t)$

(11) $MZFEED_t$ = $FEEDPC_t * TPOP_t$

(12) $MZSEED_t$ = $f(C, TMZAREA_t)$

(13) $TMZQ_t^d$ = $TMZC_t + MZPROC_t + MZFEED_t + MZSEED_t$

(14) $MZSTOCK_t$ = $TMZQ_t^s - TMZQ_t^d$

(15) $MZPPD_t$ = $f(C, FERTPD_t, MZSTOCK_{t-1}, PRODCOST_t)$

(16) $MZMS_t$ = $f(C, CPI_t, MZSUBSP_t)$

(17) $MZMRPD_t$ = $(MZMS_t * MZPP_t)/CPI_t$

Where:

$TMZY_t$ = average maize yield in time t (in mt./ha.)

$TMZAREA_t$ = area harvested of maize in time t (in 000 ha.)

$TMZAREA_{t-1}$ = area harvested of maize lagged one period

$TMZPROD_t$ = total maize production in time t (000 mt.)

$MZPPD_t$ = deflated producer price of maize in time t (K/mt.)

$PPD_t^o$ = deflated producer prices of other crops in time t (K/mt.)

$FERTPD_t$ = deflated fertilizer price in time t (K/mt.)

$SGPRODPC_t$ = Per capita sorghum production in time t (000 mt.)

$TMZC_t$ = total domestic maize consumption in time t (000 mt.)

$TMZCPC_t$ = domestic maize consumption per capita in time t (mt.)

$GDPPCD_t$ = deflated per capita gross domestic product in time t (000 K)

$NMZIMP_t$ = Net maize imports in time t (in 000 mt.)

$MZSTOCK_t$ = maize stocks in time t (000 mt.)

$MZSTOCK_{t-1}$ = maize stocks lagged one period (000 mt.)

$MZMRPD_t$ = deflated maize mealie meal retail price in time t (K/mt.)

$RICERPD_t$ = deflated retail price of rice in time t (K/mt.)

$MZPROC_t$ = maize demanded for processing in time t (000 mt.)

$MZFEED_t$ = maize demanded for feed in time t (000 mt.)

$PROCPC_t$ = per capita maize demanded for processing in time t (mt.)

$FEEDPC_t$ = per capita maize demanded for feed in time t (mt.)

$MZSEED_t$ = maize demanded for seed in time t (000 mt.)

$TMZQ_t^s$ = total quantity of maize supplied in time t (000 mt.)

$TMZQ_t^d$ = total quantity of maize demanded in time t (000 mt.)

$TPOP_t$ = total population in period t ('000 persons)

$RAIN_t$ = average rainfall in period t (mm.)

$TIME_t$ = time trend

$PRODCOST_t$ = other costs in maize production in time t

$CPI_t$ = consumer price index in time t (1985 =100)

$MZSUBSP_t$ = maize marketing subsidy per bag in time t (K/mt)

$MZMS_t$ = nominal maize marketing spread in time t (K/mt)

$MZPP_t$ = nominal producer price of maize in time t (K/mt)

C = constant

Equations (1) to (5) are supply equations while equations (6) to (13) are demand equations. Equations (5), (13) and (14) are identities. Equations (15) to (17) are price equations. Although the equations are originally specified as above, other specifications will be tried and only those that pass the statistical and economic tests will be selected for use in forecasting.

Generally, it is argued that if area planted in the current time period is the dependent variable, then the independent variables for prices and costs are those for the previous year (Tomek and Robinson, 1990). This is based on the fact that at the time of planting, farmers do not know the prices at which they will sell their produce. However, in Zambia, the government announces both the producer prices and the input prices (for seed and fertilizer) at the beginning of each marketing/cropping season (May), which is five

months before planting time. Since these prices remain in effect until the next crop and marketing season, no time lags are included in the model for prices.

4.4.3 Choice of Estimator

In this study, the ordinary least squares (OLS) estimator will be employed to generate parameter estimates. To obtain unbiased and consistent results from the OLS technique, the following conditions are assumed to hold (Kennedy, 1985):

(1) The dependent variable should have a linear functional relationship with both the independent variables and the error term. The unknown coefficients of this linear function are assumed to be constant.

(2) The conditional expected value of the error term (e) given any exogenous variable is assumed to be zero. That is, $E(e_t|X_t)=0$

(3) $E(e_t,e_s) = 0$ for $t \neq s$; $t,s = 1, 2, ..., n$; and $E(e_t)^2 = Var(e_t|X_t)=\sigma_e^2$. The first equation states that the error terms are not correlated with each other since they are assumed to be distributed randomly. The second equation states that all the error terms have the same variance, thus assuming homoscedasticity in the model.

(4) The fourth assumption is that observations of independent variables are fixed in repeated samples such that the explanatory variables are not correlated with the error term. That is, $E(e_2,X_t) = 0$.

(5) The last assumption is that the number of observations is greater than the number of independent variables and that there are no linear relationships between the independent variables. That is, there is no perfect multicollinearity among the regressands.

(5) The last assumption is that the number of observations is greater than the number of independent variables and that there are no linear relationships between the independent variables. That is, there is no perfect multicollinearity among the regressands.

When lagged endogenous variables are used in the equation as explanatory (and hence exogenous) variables, the fourth assumption is violated since the lagged dependent variable is correlated with all of the past disturbances (Kennedy, 1985). In this case, the model is said to have auto-regression. However, Kennedy (1985) argues that although the lagged dependent variable is not independent of the disturbance vector, it is contemporaneously independent of the disturbance since it is not correlated with the current and future disturbances. This implies that although OLS is a biased estimator of the parameters, it is consistent and it is on these grounds that the OLS is usually adopted as the most appropriate estimator. Moreover, Potlury and Miller (1970) point out that when lagged dependent variables are on the right-hand-side of the equation, no estimation procedure has been shown to be better in small samples. Therefore, based on the above justifications, the OLS estimator will be used even though some equations will violate the fourth assumption.

When a model has endogenous variables among independent variables, it is said to be simultaneous. When a model is simultaneous, Kennedy (1985) says the OLS is both biased and inconsistent. In such a situation, a two-stage least squares (2SLS) estimator is preferred to the OLS since it is consistent, and if it there are no lagged endogenous variables appearing among the exogenous variables, it is also unbiased. However, Kennedy (1985) further argues that not all simultaneous systems of equations are biased. If a simultaneous system of equations is recursive, there is no contemporaneous correlation between the disturbance and the regressors. Hence the OLS is consistent, and if no lagged

endogenous variables appear among the exogenous variables, it is unbiased. Therefore, although the model used in this study is simultaneous, the use of the OLS estimator is justified by the fact that the system of simultaneous equations is recursive.

### 4.4.4 Model Validation

A number of validation statistics will be applied to the estimated models to come up with one to use to forecast maize prices, supply and demand. These will include the ones mentioned in section 4.2, the graphical method, the Mean Squared Error (MSE) method, the Root Mean Squared Percentage Error (RMSPE) and Theil's U-Statistic.

### 4.4.5 Model Forecasting

Once estimates of the parameters of an econometric model are available, the model can be employed to forecast the dependent variables if the associated values of independent variables are given. Both ex ante forecasting and ex post forecasting will be utilized in this study. The former is the forecasting of unknown values while the latter is the forecasting of known values.

For independent variables whose actual future values are known, these values will be incorporated a priori in forecasting future values of dependent variables. For the period where actual future values of the independent variables are unknown, the values will be forecasted using the method that seems appropriate and then used to forecast dependent variables.

## 4.5 Summary

This chapter reviews economic theory behind supply and demand of a commodity and discusses various steps involved in commodity market modeling. The steps in commodity modeling include model structure, model specification, parameter estimation, model validation, and model forecasting. This information is used in specifying the econometric model suited for the maize market in Zambia. Based on the structure of the model, the OLS estimator is selected to be used to generate parameter estimates in the model. Since a number of specifications will be tried, the model will be validated using various methods to come up with the 'best' one that will be used for forecasting.

# 5. PRESENTATION AND ANALYSIS OF RESULTS

As pointed out earlier, a good model for forecasting should be both economically and statistically sound. This chapter discusses the results of the model that is selected for analysis based on the economic and statistical tests and forecasts of prices and quantities of maize. The equations are estimated using annual data from 1964 to 1990. Prices and income are deflated using the consumer price index (CPI) to incorporate the general inflation rate rather than use the CPI as a separate variable. Total population is also not used as a separate variable since demand equations are estimated on a per capita basis.

## 5.1 Estimated Maize Supply Equations

The aim of estimating supply equations is to measure the farmers' response, which is indicated by the acres planted in the case of crop production. Due to the need to separate farmer response from weather and disease effects which affect yield, equations for the area planted to maize and average maize yield are estimated separately. Domestic production of maize is obtained by multiplying maize yield by maize area harvested. The estimated equations on the supply side of the model are presented below together with the selected diagnostics. The values in brackets are the t-statistics for the respective coefficients.

### 5.1.1 Estimated Average Yield of Maize

$$\underset{\text{TMZY}}{} = \underset{}{0.498} + \underset{\text{TIME}}{0.038} + \underset{\text{FCI}}{0.440} + \underset{\text{RAIN}}{0.0002} + \underset{\text{DV88}}{0.720} - \underset{\text{DV90}}{0.609} \qquad (5.1)$$

$$\underset{}{} \quad (1.785) \quad (2.957) \quad (1.580) \quad (0.721) \quad (3.748) \quad (-2.994)$$

ADJ. R-SQUARED: 0.88 SER: 0.175 D-W STAT:1.19 F-STAT: 38.647
PERIOD OF FIT: 1964-1990

Where:

| | |
|---|---|
| TMZY | = national average maize yield |
| TIME | = time trend variable |
| FCI | = fertilizer consumption index |

RAIN = national annual average rainfall
DV88 = dummy variable equal 1 in 1988 and 0 otherwise
DV90 = dummy variable equal 1 in 1990 and 0 otherwise

As mentioned in chapter four, the yield of maize is dependent on the use of improved technology such as the use of high-yielding seeds and fertilizer. In section 3.1.1.2, it was observed that there is a positive relationship between the use of fertilizer and maize yield. In the model, the effect of commercial fertilizer on maize yield is captured by the fertilizer consumption index variable, while other technological effects, diseases and secular shifts are captured by the time trend variable.

The yield of maize also depends on weather conditions which are captured by the rainfall variable. It is due to a priori information on the importance of weather on yield that the rainfall variable has been maintained in the maize yield equation even though it is not significant. The explanation for the non-significance of rainfall could be that the stations on which data are available and from where the national average rainfall is calculated are not representative of the locations of maize production. Zero-one dummy variables for 1988 and 1990 are used to capture the abrupt shifts in average maize yield for the respective years.

### 5.1.2 Estimated Area Harvested of Maize

TMZAREA = 556.800 + 37.834 MZGMD + 0.489 TMZAREA(-1) - 16.371 GNUTPPD
(3.005) (1.990) (3.241) (-1.485)

-238.406 DV78ON (5.2)
(-3.342)

ADJ. R-SQUARED: 0.84 SER: 86.439 D-W STAT:2.510 F-STAT: 31.282
PERIOD OF FIT 1967-1990

Where:

TMZAREA = total area harvested of maize
MZGMD = maize gross margin deflated

TMZAREA(-1) = total area harvested of maize lagged one period
GNUTPPD = groundnut producer price deflated
DV78ON = dummy variable equal to 1 from 1978 onwards and 0 otherwise

The response of farmers represented by the area harvested of maize is explained by the deflated maize gross margin which captures the producer price of maize and the price of fertilizer which is a major input; the area harvested of maize in the previous period; the deflated producer price of groundnuts as a substitute; and a dummy variable from 1978 onwards. Due to lack of data on total cost of maize production, only the cost of fertilizer is taken into account when calculating the maize gross margin. The separate use of maize producer price and fertilizer price generated coefficients that were not significant and some variable combinations even generated wrong signs on coefficients of these variables, hence the use of the maize gross margin.

A dummy variable of ones from 1978 onwards and zeros otherwise is used to capture the unexplained drop in the area harvested of maize starting from the late 1970s of which 1978 seems to be in the middle.

Domestic production of maize was an identity obtained as:

TMZPROD = TMZAREA * TMZY (5.3)

Where:
TMZPROD = total maize production
TMZAREA = total area harvested of maize
TMZY = total maize yield

### 5.1.3 Estimated Net Imports of Maize

NMZIMP = 4.143 - 0.061 TMZPROD - 0.068 MZSTOCK(-1) + 6.068 TIME - 166.857 DV67
(0.098) (-1.441) (-1.267) (3.154) (-2.662)

+ 253.229 DV71 + 256.141 DV80 (5.4)
(4.130) (4.213)

ADJ. R-SQUARED: 0.72 SER: 58.697 D-W STAT: 1.73 F-STAT: 11.466
PERIOD OF FIT: 1965-1990

Where:

| | |
|---|---|
| NMZIMP | = net maize imports |
| TMZPROD | = total maize production |
| MZSTOCK(-1) | = change in maize stocks lagged one period |
| TIME | = time trend variable |
| DV67 | = dummy variable equal to 1 in 1967, 0 otherwise |
| DV71 | = dummy variable equal to 1 in 1971, 0 otherwise |
| DV80 | = dummy variable equal to 1 in 1980, 0 otherwise |

Variations in net maize imports are explained by domestic production, the previous year's change in stocks of maize, the time variable, and three zero-one dummy variables for 1967, 1971 and 1980, respectively, which have captured the abrupt shifts (outliers) in the dependent variable. Consumption of maize in the previous year also affects the current year's net maize imports but this is captured in the lagged change in maize stock variable because of the way the latter variable was calculated.

The sum of equations 5.3 and 5.4 less maize wasted gives an identity which is the total net maize supply.

$$TMZQ^{s} = TMZPROD + NMZIMP - MZWASTE \qquad (5.5)$$

Where:

| | |
|---|---|
| $TMZD^{s}$ | = total quantity of maize supplied |
| TMZPROD | = total maize production |
| NMZIMP | = net maize imports |
| MZWASTE | = maize wasted |

## 5.2 Evaluation of Supply Equations

The statistical diagnostics selected for analysis are the t-statistic, the adjusted R-squared, the standard error of regression (SER), the F-statistic and the Durbin-Watson (D-W) statistic. The adjusted $R^2$ will be used in the analysis rather than an unadjusted $R^2$ because the latter is biased if many independent variables are used to explain the variation in the dependent variable. Each of these statistics is discussed in chapter four section 4.2. In addition to statistical viability, the estimated supply and demand equations are also selected based on the correctness of the relationship between the dependent and

independent variables as indicated by the sign of the coefficient and the significance and importance of that relationship.

### 5.2.1 Statistical Evaluation of Supply Equations

#### 5.2.1.1 The Maize Yield Equation

In general, the higher the $R^2$ the closer is the functional relationship between the dependent and the explanatory variables. The yield equation has an adjusted $R^2$ of 0.88 which means that 88 percent of the variation in the dependent variable is explained by the independent variables after correcting for the effect of the number of explanatory variables included in the equation.

The yield equation is also tested with regard to the t-statistics corresponding to each independent variable used in it. A t-statistic tests whether a coefficient of an independent variable explains nothing in the regression. It is the ratio of the coefficient to its standard error. In general, a t-statistic of greater than one means there is at least a two-thirds likelihood that the true value of the coefficient is not zero, while if the t-statistic exceeds two in magnitude it is at least 95% likely that the coefficient is not zero (Hall, et al., 1990).

Using this rule of thumb, it is found that in the yield equation, all the regression coefficients, except for the ones corresponding to the fertilizer consumption index and rainfall, are significant at the 5% level of significance. However, the coefficient on fertilizer consumption index has a t-statistic greater than one indicating that at least there is a two-thirds chance that it has influence on the dependent variable. Due to a priori information on the effect of fertilizer and rain on maize yield, the fertilizer consumption index and rainfall variables are maintained in the equation even though they are not significant at the 5% level of significance.

The F-statistic is a test of the hypothesis that all the coefficients in a regression, except the intercept or constant, are zero. If the F-statistic is greater than the critical level, it means that at least one of the coefficients is probably non-zero. In the yield equation, the F-statistic of 49.28 exceeds the critical values at both the 5% ($F_{0.95(5,21)} = 2.69$) and the 1% ($F_{0.99(5,21)} = 4.04$) levels of significance, respectively. This implies that there is a regression relation between the yield of maize per hectare and at least one of the independent variables.

The Durbin-Watson (D-W) statistic is a statistic for serial correlation. As a "rule of thumb", a D-W statistic of much less than 2 implies there is positive serial correlation and vice versa if it is much above 2. A D-W statistic of around 2 indicates that there is no serial correlation. When there is serial correlation, it is better to re-specify the equation, although it can also be corrected. In the yield equation, D-W statistic of 1.19 fell in the inconclusive region as to whether serial correlation is present or not. Hence, there was no need to re-specify the equation or correct for auto-correlation.

5.2.1.2 The Area Harvested of Maize Equation

The adjusted $R^2$ of 0.84 shows that the independent variables used in the area harvested of maize equation explain 84% of the variations in the dependent variable. T-statistics greater than 2 for coefficients of the lagged area harvested of maize and the dummy variable for 1978 onwards show that these variables are significant at the 5% level of significance. The coefficients on maize gross margin and the deflated retail price of groundnuts are not significant at the 5% level of significance but they still provided at least two-thirds certainty that they affect the dependent variable since they have t-statistics that are greater than one.

The equation for the area harvested of maize has an F-statistic of 31.282 which exceeds the critical values of 2.9 and 4.50 at the 5% and the 1% levels of significance, respectively. This implies that not all the independent variables are equal to zero.

#### 5.2.1.3 Maize Net Imports Equation

The equation for the net imports of maize has an adjusted $R^2$ of 0.72. The t-statistics of the coefficients corresponding to the time variable and all dummy variables are significant at the 5% level of significance. The t-statistics corresponding to lagged change in maize stocks and total maize production are not significant at the 5% level of significance. However, with their coefficients being greater than one, they are maintained in the model.

The F-statistic of 11.466 is significant since it exceeds the critical values at both the 5% ($F_{0.95(6,19)} = 2.63$) and the 1% ($F_{0.99(6,19)} = 3.94$) levels of significance. A D-W statistic of 1.73 in the equation of net maize imports indicates no presence of auto-correlation.

### 5.2.2 Economic Evaluation of Supply Equations

#### 5.2.2.1 The Maize Yield Equation

Economic evaluation of the estimated equations refers mainly to the signs and magnitudes of the estimated parameters. Both the TIME and FCI variables have expected signs according to economic theory. Positive coefficients on the TIME, FCI and RAIN variables in the yield equation imply that holding other things constant, the yield of maize in the current year would increase with the use of improved technology like hybrid seed (captured by TIME), the use of more fertilizer in maize production and more rainfall (at least within a normal range).

5.2.2.2 The Area Harvested of Maize Equation

The coefficients of all independent variables in the equation for area harvested of maize have the right signs according to a priori information. The gross margin of maize has a positive sign indicating that the more profit farmers expect from the sales of maize, the more land they will plant to maize. A negative sign on the producer price of groundnuts indicates that the higher the producer price of groundnuts in relation to that of maize, the less land that will be utilized for maize production. This indicates that groundnuts are a substitute for maize.

5.2.2.3 Maize Net Imports Equation

The net maize imports equation reflects correct signs on the coefficients of all the independent variables. The negative sign on the coefficient of domestic maize production implies that holding other things constant, net imports of maize would decline with an increase in domestic maize production. The same interpretation follows for the negative sign on the change in maize stocks lagged one period. However, the positive sign on the time trend depicts the increase in net imports of maize over time. This is true since for the most part of the period under analysis, Zambia has not been self-sufficient in maize production and has been a net importer of maize.

## 5.3 Estimated Maize Demand Equations

The selected maize demand equations are presented in equations 5.6 through 5.13, together with their respective diagnostics.

### 5.3.1 Estimated Per Capita Maize Consumption

$$TMZCPC = 0.114 + 0.291\ TMZCPC(-1) - 0.023\ MZMRPDR - 0.688\ SGPRODPC + 0.001\ TIME - 0.023\ DV70 \quad (5.6)$$
$$(5.328) \quad (2.182) \quad (-1.852) \quad (-1.338) \quad (2.501) \quad (-4.346)$$

ADJ. R-SQUARED: 0.91 SER: 0.908 D-W STAT:2.27 F-STAT: 50.643
PERIOD OF FIT: 1965-1990

Where:

| | |
|---|---|
| TMZCPC | = total maize consumption per capita |
| TMZCPC(-1) | = total maize consumption per capita lagged one period |
| MZMRPDR | = ratio of deflated maize meal retail price to deflated polished rice retail price |
| SGPRODPC | = per capita production of sorghum |
| TIME | = time trend variable |
| DV70 | = dummy variable equal to 1 in 1970, 0 otherwise |

Per capita domestic maize consumption is explained by domestic maize consumption lagged one period, the ratio of the deflated retail price of maize mealie meal to the deflated retail price of polished rice, the per capita production of sorghum, the time variable, and a zero-one dummy variable for 1970 which captures the abrupt decrease in maize consumption in 1970. The ratio of the retail price of maize to that of rice captures the effects of own price and the price of a substitute (rice). The ratio of the two retail prices is used instead of separating them because where the right signs were obtained upon using separate prices for maize and rice, the generated coefficients were insignificant. In other cases, the use of separate prices gave wrong signs for the coefficients of these variables.

Generally, if quantity is the dependent variable, then the prices are supposed to be independent variables. However, per capita production of sorghum was used as an independent variable (substitute) in this model because sorghum is basically produced for own consumption with no readily available market such that the retail price of sorghum has never been published.

According to economic theory, income is one of the major determinants of demand. For a normal commodity, there is a positive relationship between income and consumption

of a commodity while there is a negative relationship between income and consumption of an inferior good. The deflated per capita gross domestic product had a negative relationship with per capita domestic consumption of maize indicating that it is an inferior good in Zambia. This was expected in the model as is observed and discussed in section 3.8.1 of chapter three. However based on the discussion in section 3.8.1, this study could not conclude that maize is an inferior good in Zambia and per capita real GDP was dropped from the model.

The total demand of maize for domestic consumption is given in the identity below:

$$TMZC = TMZCPC * TPOP \quad (5.7)$$

Where:

| | | |
|---|---|---|
| TMZC | = | total maize consumption |
| TMZCPC | = | total maize consumption per capita |
| TPOP | = | total population |

### 5.3.2 Estimated Demand of Maize for Industrial Processing

$$PROCPC = -0.0002 + 0.0565\ GDPPCD + 0.844\ PROCPC(-1) + 0.001\ DV77 \quad (5.8)$$
$$(-0.486) \qquad (1.500) \qquad (8.260) \qquad (2.012)$$

ADJ R-SQUARED: 0.94 SER: 0.0004 D-W STAT: 1.74 F-STAT: 132.304
PERIOD OF FIT: 1965-1990

Where:

| | | |
|---|---|---|
| PROCPC | = | per capita maize for industrial processing |
| GDPPCD | = | per capita gross domestic product deflated |
| DV77 | = | dummy variable equal to one in 1977, 0 otherwise |

Variations in per capita demand of maize for industrial processing are explained by the deflated per capita gross domestic product, the per capita demand of maize for industrial processing lagged one period, and a zero-one dummy variable for 1977 in which year there was an abrupt shift in the dependent variable. Due to lack of variables to estimate demand of maize for industrial processing as a direct demand, demand of maize for industrial processing is estimated as a derived demand whereby it is assumed maize is

demanded for processing based on the demand for the final products in which processed maize is used as an input. Therefore per capita gross domestic product has to be included in the equation as a major variable. It is for this reason and because it at least has a t-statistic greater than one that it is maintained in the equation even though it is not significant at the 5% level of significance.

Total demand of maize for industrial processing is obtained as:

MZPROC = PROCPC * TPOP (5.9)

Where:

| | |
|---|---|
| MZPROC | = total processed maize for industrial use |
| PROCPC | = per capita processed maize for industrial use |
| TPOP | = total population |

### 5.3.3 Estimated Per Capita Demand of Maize for Feed

FEEDPC = - 0.0012 + 0.264 GDPPCD + 0.772 FEEDPC(-1)
(-0.735) (3.227) (7.7186)

- 0.005 DV79 + 0.006 DV83 (5.10)
(-2.871) (3.187)

ADJ. R-SQUARED: 0.78 SER: 0.0018 D-W STAT:2.2 F-STAT: 23.06
PERIOD OF FIT: 1965-1990

Where:

| | |
|---|---|
| FEEDPC | = maize feed per capita |
| GDPPCD | = per capita gross domestic product deflated |
| FEEDPC(-1) | = maize feed per capita lagged one period |
| TIME | = time trend variable |
| DV79 | = dummy variable equal to 1 in 1979, 0 otherwise |
| DV83 | = dummy variable equal to 1 in 1983, 0 otherwise |

The per capita demand of maize for feed is explained by itself lagged one period, the deflated per capita gross domestic product, and zero-one dummy variables for 1979 and 1983, respectively. In the absence of variables like the livestock numbers which could allow for the direct estimation of the demand of maize for feed, the same logic that is used to estimate demand of maize for industrial processing is used to estimate the demand of maize for feed. The total demand of maize for feed is obtained as:

MZFEED = FEEDPC * TPOP (5.11)

Where:

| | |
|---|---|
| MZFEED | = total maize for feed |
| FEEDPC | = maize feed per capita |
| TPOP | = total population |

### 5.3.4 Estimated Demand of Maize for Seed

MZSEED = 2.120 + 0.0273 TMZAREA - 8.193 DV78 (5.12)
(0.969) (10.425) (-2.925)

ADJ. R-SQUARED: 0.82 SER: 2.749 D-W STAT: 1.68 F-STAT: 58.655
PERIOD OF FIT: 1964-1990

Where:

| | |
|---|---|
| MZSEED | = maize seed |
| TMZAREA | = total area harvested of maize |
| DV78 | = dummy variable equal to zero in 1978, 0 otherwise |

The variation in the demand of maize for seed is explained by total area harvested of maize and a zero-one dummy variable for 1978.

The total demand for maize is represented as an identity as follows:

$TMZQ^d = TMZC + MZPROC + MZFEED + MZSEED$ (5.13)

Where:

| | |
|---|---|
| $TMZQ^d$ | = total quantity of maize demanded |
| TMZC | = total maize consumption |
| MZPROC | = total maize demanded for industrial processing |
| MZFEED | = total maize demanded for feed |
| MZSEED | = maize seed |

Equation 5.14 is an identity representing changes in maize stocks in each year and it is used in the model as a proxy for maize stocks whose data are not available.

$MZSTOCK = TMZQ^s - TMZQ^d$ (5.14)

where:

| | |
|---|---|
| MZSTOCK | = annual change in maize stocks |
| $TMZQ^s$ | = total net maize quantity supplied |
| $TMZQ^d$ | = total quantity of maize demanded |

## 5.4 Evaluation of Maize Demand Equations

### 5.4.1 Statistical Evaluation of Maize Demand Equations

#### 5.4.1.1 Per Capita Domestic Maize Consumption Equation

The independent variables in the per capita domestic maize consumption equation explain 91% of the variation in the dependent variable. The lagged per capita domestic maize consumption, the time variable and the dummy variable for 1970 have significant t-statistics at the 5% level of significance. Although per capita production of sorghum and the ratio of the retail prices of maize to that of rice are not significant at the 5% level of significance, their t-statistics are greater than unit. Therefore, they are maintained in the equation.

The per capita domestic maize consumption equation has an F-statistic of 38.46. This is greater than the critical values of 2.71 and 4.10 at the 5% and the 1% levels of significance, respectively, thereby verifying its significance. A D-W statistic of 2.27 shows that there is no serial correlation in the equation.

#### 5.4.1.2 Per Capita Industrial Processed Maize Equation

The equation of per capita demand of maize for industrial processing has an adjusted $R^2$ of 0.94. The t-statistic of the coefficient corresponding to deflated per capita gross domestic product is not significant at the 5% level of significance but has a t-statistic which is greater than one. It is maintained in the equation for that reason and because it is taken to be an important variable based on the assumption that demand of maize for industrial processing is a derived one in this model. The t-statistics of the other coefficients of the independent variables are significant at the 5% level of significance.

An F-statistic of 132.304 in the per capita demand of maize for industrial processing equation is significant at both the 5% and the 1% levels of significance since it exceeds the critical values of 3.05 and 4.82 at those levels of significance, respectively. The equation has a D-W statistic of 1.74 which shows no presence of serial correlation.

5.4.1.3 Per Capita Maize Feed Equation

The independent variables in the equation for per capita demand of maize for feed explain 78% of the variation in the dependent variable. The t-statistics of all the coefficients are significant at the 5% level of significance. An F-statistic of 23.06 exceeds the critical values of 2.84 and 4.37 at the 5% and the 1% levels of significance, respectively, and is hence significant. A D-W statistic of 2.2 in the per capita demand of maize for feed equation shows no presence of auto-correlation.

5.4.1.4 Maize Seed Equation

The adjusted $R^2$ in the demand equation for maize seed is of 0.82. The t-statistic of the coefficients of both independent variables in the regression is significant at the 5% level of significance. An F-statistic is also significant at both the 5% and the 1% levels of significance while a D-W statistic of 1.68 falls in the inconclusive region.

5.4.2 Economic Evaluation of Maize Demand Equations

5.4.2.1 Per Capita Domestic Maize Consumption Equation

All the coefficients of the independent variables have expected signs. The negative coefficient on per capita sorghum production shows that holding all other things constant, the higher the per capita production of sorghum the lower the per capita domestic maize

consumption. The negative sign on the ratio of retail price of maize to that of rice indicates that per capita domestic consumption increases as the ratio decreases. This is true according to a priori information since rice is a substitute of maize. A low retail price ratio implies that the retail price of maize is relatively lower than that of rice, and vice versa for the reverse situation. The positive coefficients on the time variable and on the lagged per capita domestic maize consumption indicate that per capita domestic maize consumption has been increasing with time and with per capita domestic maize consumption in the previous year.

5.4.2.2 Per Capita Maize Demand for Industrial Processing

In the equation of per capita demand of maize for industrial processing, both the deflated per capita gross domestic product and lagged per capita demand of maize for industrial processing have positive coefficients as expected. This means that holding other things constant, an increase in either of them leads to an increase in the current per capita demand of maize for industrial processing.

5.4.2.3 Per Capita Maize Demand for Feed

As in the per capita demand of maize for industrial processing equation, all the coefficients of independent variables in the per capita maize feed demand equation are positive. The same interpretation as above applies here too.

5.4.2.4 Demand of Maize for Seed

The positive sign on the area harvested of maize coefficient implies that the demand for maize seed increases with the increase in area harvested of maize in the current year.

This result is expected since any additional area will require more seeds for planting, assuming the same planting density.

## 5.5 Estimated Price Equations

### 5.5.1 Deflated Maize Producer Price Equation

$$\underset{}{MZPPD} = \underset{(1.485)}{0.831} + \underset{(3.197)}{0.396}\, MZPPD(-1) + \underset{(3.409)}{0.254}\, FERTAPD \underset{(-1.320)}{-0.003}\, TMZPROD + \underset{(3.915)}{1.430}\, DV86 \qquad (5.15)$$

ADJ. R-SQUARED: 0.66 SER: 2.433 D-W STAT: 2.11 F-STAT: 13.381
PERIOD OF FIT: 1965-1990

Where:

| | |
|---|---|
| MZPPD | = deflated producer price of maize |
| FERTAPD | = deflated retail price of fertilizer |
| TMZPROD | = domestic maize production |
| DV86 | = zero-one dummy variable with 1986 equal to 1, 0 otherwise |

This equation attempts to capture the factors and policies that influence the government in setting the maize producer price. Some of the factors found to be taken into account by the government when setting the maize producer price in the current period include the producer price of maize lagged one period, the deflated retail price of fertilizer, the previous year's maize production level, and a zero-one dummy variable for 1986. The dummy variable for 1986 is included to capture the introduction of fertilizer subsidies meant to decrease production costs thereby keeping the maize producer price relatively higher. Fertilizer price explains more than 50% of the variations in the maize producer price.

In the absence of the maize stocks, the variable of change in maize stocks was tried in the equation as a proxy for the former. However, it was dropped from the equation because it had a t-statistic of less than one. This does not necessarily mean that maize stocks do not influence producer price setting. To partly capture the effect of the maize stocks on the producer price of maize, the previous year's maize production is used and maintained in the equation since it has a t-statistic greater than one.

### 5.5.2 Deflated Maize Meal Retail Price Equation

MZMS = - 84.822 + 5.774 CPI - 1.016 MZSUBSP - 1157.435 DV88 (5.16)
(-1.818) (22.359) (-7.157) (-5.071)

ADJ. R-SQUARED: 0.98 SER: 219.213 D-W STAT: 1.66 F-STAT: 386.762
PERIOD OF FIT: 1964-1990

Where:

| | |
|---|---|
| MZMS | = maize marketing spread |
| CPI | = consumer price index (1988=100) for March |
| MZSUBSP | = maize marketing subsidy per metric ton |
| DV88 | = dummy variable with 1988 equal to 1, 0 otherwise |

MZMRPD = (MZPP + MZMS)/CPI (5.17)

Where:

| | |
|---|---|
| MZMRPD | = deflated breakfast maize meal retail price |
| MZPP | = nominal maize producer price |
| MZMS | = maize marketing spread |
| CPI | = consumer price index (1988=100) |

For the deflated retail price of maize, the equation for maize marketing margin (marketing spread) is estimated (equation 5.16) and then the former is obtained as an identity by adding the maize marketing spread to the producer price of maize and deflating the sum (equation 5.17). The maize marketing spread is explained by the consumer price index, the maize marketing subsidy per metric ton, and a dummy variable for 1988. The dummy variable for 1988 captures the beginning of the gradual removal of maize marketing subsidies when the government reduced into-mill price subsidies by K30.00 per 90-kg bag of maize in the 1988/89 marketing season.

## 5.6 Evaluation of Price Equations

### 5.6.1 Statistical Evaluation of Price Equations

#### 5.6.1.1 Deflated Maize Producer Price

Taking into account the number of variables used in the equation, the independent variables included in the deflated maize producer price equation explain 67% of the

variations in the dependent variable. All the independent variables' coefficients, except the one for lagged maize production, have t-statistics greater than 2, implying that they are significant at the 5% level of significance. However, the t-statistic of the lagged maize production is greater than one in absolute terms which provides at least two-thirds certainty that the previous year's maize production level affects the current producer price of maize.

An F-statistic of 13.381 is significant at both the 5% and the 1% levels of significance, while a D-W statistic of 2.12 does not indicate any presence of serial correlation.

#### 5.6.1.2 Maize Marketing Spread

The adjusted $R^2$ in the maize marketing spread equation is 0.98. All the coefficients of the independent variables are highly significant at the 5% level of significance. The F-statistic of 386.762 is significant at both the 5% and the 1% levels of significance. A D-W statistic of 1.66 falls in the inconclusive region.

### 5.6.2 Economic Evaluation of Price Equations

#### 5.6.2.1 Deflated Maize Producer Price

All the independent variables are consistent with economic a priori information. A positive sign on the coefficients of fertilizer price and lagged maize producer price imply that holding other things constant, the higher the fertilizer price in the current year or the higher the maize producer price in the previous year, respectively, the higher will be the producer price of maize in the current year. However, as expected, the higher the previous year's production of maize, the lower will be the current year's maize producer price.

5.6.2.2 Maize Marketing Spread

The signs on all the independent variables are as expected. Holding all other things constant, the maize marketing spread increases with a rise in inflation but decreases with an increase in the maize marketing subsidy. The positive sign on the coefficient of the dummy variable indicates that the maize marketing spread increased with the removal of some into-mill price maize subsidy, resulting in the reduction of the overall marketing subsidy for maize.

5.7 Supply elasticities

The short-run and long-run price and income elasticities of supply and demand are given in Table 5.1. Short-run elasticities are calculated at the mean level of the respective variables involved. As expected, the long-run elasticity of supply and demand are greater

Table 5.1

Short-run and Long-run Supply and Demand Elasticities

| | Short-run | Long-run |
|---|---|---|
| Gross margin elasticity of supply | 0.19 | 0.37 |
| Price elasticity of supply | 0.22 | 0.51 |
| Cross-price elasticity of supply | -0.21 | -0.42 |
| Demand price elasticity (Consumption) | -0.03 | -0.04 |
| Income elasticity (feed) | 0.32 | 1.39 |
| Income elasticity (processed maize | 0.15 | 0.96 |

than short-run ones since in the long-run, farmers have more time to shift their resources around than in the short-run while consumers' expenditure on a commodity has a multiplier effect over time.

The short-run (crop year-to-crop year) and long-run elasticity of supply with respect to deflated maize gross margin is 0.19 and 0.37, respectively. This means that if farmers expect the maize gross margin to increase by 1%, they would increase the area harvested of maize by 0.19% in the short-run and by o.37% in the long-run. The short-run and long-run price elasticities of supply are 0.22 and 0.51, respectively. These results are quite comparable to that estimated by Timmer at el. (1983) who claim that short-run grain supply elasticities are generally between 0.2 and 0.3 although there is a noticeable tendency for the supply elasticity to be larger in more developed countries and in regions with longer commercial histories.

The results in Table 5.1 show that farmers are more responsive to maize producer price than to the maize gross margin. This could be because farmers may not be sure whether the variable costs of maize production (like labor costs) would change from the time they are planting to the time they are harvesting, fertilizer and seed prices are fixed by the prices set by the government. Therefore, if the government wanted to increase maize production, it could choose between policies that increase the maize producer price and those that reduce the cost of production thereby increasing the maize gross margin.

The short-run and long-run cross-price elasticity of supply with respect to the deflated producer price of groundnuts is -0.21 and -0.42, respectively. This implies that holding other things constant, a 1% increase in the producer price of groundnuts relative to that of maize would result in a 0.21% shift in the area harvested of maize to the

production of groundnuts or other crops in the short-run while there would be a 0.42% reduction in the area harvested of maize in the long-run.

This shows that groundnuts compete with maize for land resources, hence holding other things constant, increasing the producer price of groundnuts would lead to farmers allocating part of the land that was previously under maize production to groundnuts production, and vice versa for the reverse situation.

This could be true in that groundnuts are produced throughout the country and some parts of the country (Eastern, Northern and Luapula Provinces) have groundnuts accounting for the second largest area under cultivation after maize (Republic of Zambia, 1990). In fact, Northern and Eastern Provinces are even among the four maize surplus producing provinces in the country.

## 5.8 Demand Elasticities

In the equation for per capita domestic consumption of maize, only the ratio of prices is included and not the separate price or income variables. Therefore, only the price not income elasticity of demand is calculated. The short-run and long-run price elasticities of demand of maize for domestic consumption are -0.03 and -0.04, respectively, as in Table 5.1. These are very inelastic price elasticities of demand, indicating that even if the maize mealie meal price increased by 1%, people would only reduce their maize meal consumption by 0.03% in the short-run and by 0.04% in the long-run. This result could be due to a combination of the price structure of food stuffs that has left maize mealie meal the cheapest staple food and the worsening economic situation of the people as reflected in per capita real GDP that has continued to decline since the 1970s.

The short-run and long-run income elasticity of per capita demand of maize for feed is 0.32 and 1.39 while those of the maize demanded for industrial processing are 0.15 and 0.96, respectively. A comparison of the income elasticities of demand of maize for feed and for industrial processing shows that the income elasticity of demand of maize for feed is higher than that for demand of maize for industrial processing.

## 5.9 Validation of the Model

### 5.9.1 Statistical Validation

The values of the adjusted $R^2$ vary from 0.67 in equation (5.15) to 0.98 in equation (5.16). In general, the higher the $R^2$, the closer the functional linear relationship between the dependent and the explanatory variables. How high the $R^2$ should be to be accepted is not known. Since in all cases, apart from one, more than 70% of the total variation in each equation was explained by the respective independent variables, the model can be said to be satisfactory.

With regard to the t-statistic, most of the coefficients had t-statistics above 2, hence these were significant at the 5% level of significance. The rest of the variables had t-statistics at least equal to one and thus offered at least two-thirds certainty that they influence the respective dependent variables. The level of significance one chooses to work with in the social sciences is based on a value judgement by the analyst. While in the natural sciences, where there are control experiments, a 1% loss in the level of significance could make quite a substantial difference, in the social sciences this may not be the case. Problems may arise with the way the data were collected, the assumptions made, and so on. Therefore, based on the fact that this study used secondary data whose methods of collection were not known and considering a priori information on the importance of each

variable, it was decided that variables with a t-statistic of more than one be maintained in the model.

In this study, the F-statistics range from 11.466 to 386.762 and are all significant at both the 5% and the 1% levels of significance. The D-W statistics, which range from 1.19 to 2.51, either show no presence of serial correlation between variables or fall in regions where one cannot confidently confirm the presence or absence of serial correlation. Therefore, it is concluded that the model is statistically viable.

### 5.9.2 Graphical Validation

To validate the model graphically, each of the endogenous variables has its actual and projected values plotted against time. Figures 5.1 to 5.16 in Appendix A provide visual evidence of how well the model tracked by comparing the distance between the actual and projected values. One may be misled by the graphical validation of the model in the sense that the size of the difference between the actual and projected values of a variable depicted in the graph depends on the scale used in the graph. The validation is more exact the smaller the scale.

It is observed that in some periods of the forecast, the model tracks the actual values better than in the other periods. In some years, the model generates forecast values that are greater or less than the actual values. However, the visual observation shows that the model is satisfactory.

5.9.3 Validation Using Mean Squared Error

The mean squared error (MSE) measures the mean of the squared difference between actual and forecast variables. When defined in terms of the differences in the levels of the variables, the MSE is formulated as follows:

$$MSE = \frac{1}{n} \sum_{i=1}^{n} (P_i - A_i)^2$$

where:

$P_t$ = Predicted values of the dependent variable

$A_t$ = Actual values of the dependent variable

n = number of observations

With this kind of definition, the result of the MSE varies with the units of variables. To provide comparisons of forecasting accuracy for variables used in this model which have different units, the MSE is measured in terms of percentage changes (MSEP) as:

$$MSEP = 1/n \sum (p_t - a_t)^2$$

where:

$p_t = (P_t - A_{t-1})/A_{t-1}$

$a_t = (A_t - A_{t-1})/A_{t-1}$

The results of this method are presented in Table 5.2, together with the results from the other validation methods discussed below. The closer the MSEP is to zero, the better the ability of the model to forecast. Thirteen variables (TMZPC, TMZC, FEEDPC, MZFEED, PROCPC, MZSEED, $TMZQ^d$, TMZY, TMZAREA, TMZPROD, $TMZQ^s$, MZPPD, and MZMRPD) have MSEP statistics that are less than 5%. Only one variable

(NMZIMP) has a MSEP greater than 10%. The other two variables (MZPROC and MZSTOCK) have MSEPs equal to 6% and 9.4%, respectively. Overall, since almost all the MSEPs of the endogenous variables are very close to zero, the model is said to be satisfactory.

5.9.4 Validation Using the Root Mean Squared Percentage Error

The root mean squared percentage error (RMSPE) is a statistic that shows how well the forecast values of the endogenous variables match with their actual values. RMSPE is defined as:

$$\text{RMSPE} = (1/n \sum ((P_t - A_t)/A_t)^2)^{1/2}$$

where:

$A_t$ = actual value of an endogenous variable

$P_t$ = predicted value of an endogenous variable

n = number of observations

The smaller the value of the RMSPE, the better the fit and the more accurate the model is for forecasting. However, this statistic has two drawbacks. First, the RMSPE is a measure of central tendency. Therefore, sometimes a few very large errors can raise the value of the RMSPE of an endogenous variable that otherwise tracks very well. Second, small errors in absolute terms give rise to large errors in percentage terms when actual values of an endogenous variable are small.

The RMSPE for the endogenous variables are presented in Table 5.2 above, which shows that all variables have RMSPE statistics less than 5%, except the ones for change in maize stocks (12.7%) and for net maize imports (9.9%). Thus, the net maize imports and

Table 5.2

Quantitative Measures of the Model's Ability to Forecast

| Variable | MSEP | RMSPE | U-Statistic |
|---|---|---|---|
| TMZY | 0.044 | 0.020 | 0.102 |
| TMZAREA | 0.031 | 0.017 | 0.090 |
| TMZPROD | 0.046 | 0.036 | 0.174 |
| NMZIMP | 0.667 | 0.099 | 0.490 |
| $TMZQ^s$ | 0.035 | 0.039 | 0.191 |
| TMZCPC | 0.031 | 0.005 | 0.025 |
| TMZC | 0.036 | 0.005 | 0.024 |
| FEEDPC | 0.047 | 0.029 | 0.146 |
| MZFEED | 0.049 | 0.031 | 0.160 |
| PROCPC | 0.039 | 0.016 | 0.079 |
| MZPROC | 0.060 | 0.017 | 0.085 |
| MZSEED | 0.046 | 0.023 | 0.112 |
| $TMZQ^d$ | 0.036 | 0.005 | 0.024 |
| MZSTOCK | 0.094 | 0.127 | 0.622 |
| MZPPD | 0.034 | 0.016 | 0.081 |
| MZMRPD | 0.040 | 0.019 | 0.090 |

the change in maize stocks, which are the least accurate using the MSEP, turn out to be the least accurate even using the RMSPE. However, the net maize imports variable, which has a MSEP of 66.7%, has a RMSPE of 9.9%. Overall, the model has performed well in tracking the actual values of the endogenous variables.

### 5.9.5 Validation Using Theil's U-statistic

Theil's inequality coefficient is related to both the MSE and the RMSPE. It is defined as:

$$U = \frac{\sqrt{MSE}}{\sqrt{\Sigma A_t^2}}$$

where MSE, $A_t$ and n are as defined above. The closer the U-statistic is to zero, the better the forecast ability of the model.

Table 5.2 above gives the Theil's U-statistics for the endogenous variables. Unlike the results from the MSEP and the RMSPE, the Theil's U-statistic is less than 10% for only eight variables. Six variables have U-statistics between 10% and 20% while two of the variables have U-statistics greater than 20%. Net maize imports and change in maize stocks with U-statistics of 49% and 62%, respectively, show consistent results with those obtained using MSEP and RMSPE in that they are the least accurate variables in tracking the actual values even with the U-statistic. However, even this test shows that the model has performed well enough to be used for forecasting.

## 5.10 Forecasts of Exogenous Variables

Once the modeler is reasonably comfortable with the model's performance against actual values, the next challenge is to generate projections. Before endogenous variables can

be forecast, exogenous variables have to be obtained for the forecast period. Where exogenous variables are not known, they have to be projected to the end of the forecast period first and then used to forecast the endogenous variables.

Exogenous variables that do not show a time trend have their future values forecasted by first regressing the respective variable against time and then the forecast is made based on that result. This method of forecasting assumes that the same conditions that prevailed during the observation period would continue. The exogenous variables that are forecasted using this method include rainfall, deflated retail price of groundnuts, maize wasted, the maize marketing subsidy, and the ratio of the retail price of maize to that of rice.

The exogenous variables that indicate a trend (fertilizer consumption index, deflated gross margin of maize, total population, and consumer price index), are forecasted using double exponential smoothing. This method of forecasting does not make use of information from series other than the variable being forecasted. Double exponential smoothing, which makes a forecast which grows along a trend, gives high weight to the most recent value and little weight to a longer-run average. It carries out the recursive computation within the sample and then extends it for the rest of the observations in the range which includes the forecast period.

For the period between 1991 and 1995, deflated per capita gross domestic product is forecasted at a constant declining rate of 4.08 percent (average decline rate between 1980 and 1990). It is assumed to grow at an average rate of 5% between 1996 and 2000. The declining trend in the first part of the forecast is assumed as a period of implementing policy changes that the new government has proposed and is still proposing. It is assumed that from 1996, the positive impact of the policies will start to be felt.

For per capita production of sorghum, an average decline rate of 0.04% for the period 1964 to 1990 is calculated at which rate the future level of per capita sorghum production is expected to decline.

## 5.11 Forecast Results

### 5.11.1 Maize Supply Forecasts

The model's forecasted values for the area harvested of maize, average yield and production of maize are given in Table 5.3. Total area harvested of maize is projected to be 732.74 thousand hectares in 1991 and to grow at an average annual rate of 0.94% per year between 1991 and 1995 and 0.21% per year between 1996 and 2000, reaching 806.96 thousand hectares in the year 2000.

In 1991, the average yield of maize is projected to reach 2.07 metric tons per hectare. It would then increase at an annual average growth rate of 10.4% between 1991 and 1995 and 1.68% between 1996 and 2000. By the year 2000, the yield is projected to have reached 2.41 metric tons per hectare. This growth rate in maize yield is justified in that in the late 1980s, the average maize yield was about 2.2 metric tons per hectare. However, it dropped to about 1.4 metric tons per hectare in 1990 because of the drought, which in turn resulted in relatively lower maize production than usual. Hence, large percentage growth rates for the forecast period for both maize yield and maize production reflect the move from the unusual low levels of 1990.

Domestic maize production is projected to be 1512.74 thousand metric tons in 1991 but would increase to 1923.23 thousand metric tons by the year 2000. This would entail an average annual growth rate of 13.65% and 1.89% between 1991 and 1995 and between 1996

Table 5.3

Zambia: Projections of Maize Area Harvested, Yield, and Production, 1991-2000*

| Year | TMZAREAF (000 ha) | Growth Rate % | TMZYF (mt/ha) | Growth Rate % | TMZPRODF (000 mt) | Growth Rate % |
|---|---|---|---|---|---|---|
| 1990 | 764.00 | | 1.43 | | 994.35 | |
| 1991 | 732.74 | -4.09 | 2.07 | 44.84 | 1512.74 | 52.13 |
| 1992 | 776.39 | 5.96 | 2.11 | 2.27 | 1639.24 | 8.36 |
| 1993 | 779.13 | 0.35 | 2.15 | 1.66 | 1672.24 | 2.01 |
| 1994 | 793.50 | 1.72 | 2.18 | 1.63 | 1728.63 | 3.37 |
| 1995 | 798.59 | 0.77 | 2.22 | 1.60 | 1769.81 | 2.38 |
| 1996 | 796.94 | -0.21 | 2.27 | 2.27 | 1806.24 | 2.06 |
| 1997 | 800.07 | 0.39 | 2.30 | 1.56 | 1841.66 | 1.96 |
| 1998 | 799.27 | -0.10 | 2.34 | 1.54 | 1868.11 | 1.44 |
| 1999 | 803.99 | 0.59 | 2.37 | 1.52 | 1907.60 | 2.11 |
| 2000 | 806.96 | 0.37 | 2.41 | 1.49 | 1943.23 | 1.87 |
| Annual Average Percentage Growth Rates | | | | | | |
| 1991-1995 | | 0.94 | | 10.40 | | 13.65 |
| 1996-2000 | | 0.21 | | 1.68 | | 1.89 |
| 1991-2000 | | 0.58 | | 6.04 | | 7.77 |

* Variables are as defined earlier in the Chapter, the only difference is the "F" at the end of each variable name which indicates that it is a forecast value.

and 2000, respectively. The growth rate in the first period seems high because the calculation included the movement from 1990 which had very low maize production level because of the drought. The increase in domestic maize production is expected to result more from an increase in maize yield than from the increase in the area harvested of maize over the forecast period (see Table 5.3).

5.11.2 Maize Demand Forecasts

The forecasts for the various types of demand for maize are given in Table 5.4. In 1991, maize for domestic consumption is projected to be 1509.11 thousand metric tons. It would grow at an average annual rate of 2.87% and 3.21% between 1991-1995 and 1996-2000, respectively. For the whole ten-year forecast period, domestic maize consumption is projected to grow at an average annual rate of 3.04%. By the year 2000, human maize consumption would have increased to 2009.548 thousand metric tons according to the projection.

The increase in domestic maize consumption is projected to result from both the increase in the total population and in the increase in per capita domestic maize consumption over the forecast period. On one hand, total population is assumed to increase from 7818.45 thousand persons in 1990 (according to the 1990/91 census) to 9957.08 thousand persons in the year 2000. On the other hand, the projections on domestic maize consumption reveal an average per capita domestic maize consumption of 0.188 metric tons in 1991 and 0.202 in the year 2000. This increase in per capita domestic maize consumption is quite reasonable considering that starting from the 1980s, per capita domestic maize consumption has been around 0.190 metric tons.

Table 5.4

Zambia: Projections of Demand of Maize for Domestic Consumption, for Feed, for Industrial Processing and for Seed, 1991-2000*

| | Thousand Metric Tons | | | | |
|---|---|---|---|---|---|
| Year | TMZCF | MZFEEDF | MZPROCF | MZSEEDF | $TMZQ^dF$ |
| 1990 | 1490.00 | 62.75 | 26.40 | 21.13 | 1600.28 |
| 1991 | 1509.11 | 72.07 | 25.32 | 23.83 | 1630.33 |
| 1992 | 1553.20 | 72.51 | 24.58 | 24.07 | 1672.26 |
| 1993 | 1605.24 | 82.84 | 24.21 | 24.31 | 1733.43 |
| 1994 | 1660.16 | 85.30 | 23.95 | 24.55 | 1790.24 |
| 1995 | 1715.83 | 88.74 | 23.78 | 24.80 | 1849.11 |
| 1996 | 1772.88 | 112.25 | 23.70 | 25.05 | 1929.64 |
| 1997 | 1830.87 | 132.53 | 23.69 | 25.20 | 2008.01 |
| 1998 | 1889.66 | 129.16 | 23.75 | 25.33 | 2063.64 |
| 1999 | 1949.23 | 140.54 | 24.86 | 25.50 | 2135.84 |
| 2000 | 2009.55 | 158.24 | 24.02 | 25.62 | 2213.19 |
| Annual Average Percentage Growth Rates | | | | | |
| 1991-1995 | 2.87 | 7.34 | -2.06 | 3.36 | 2.93 |
| 1996-2000 | 3.21 | 12.69 | 0.23 | 0.65 | 3.66 |
| 1991-2000 | 3.04 | 10.01 | -0.91 | 2.01 | 3.29 |

* Variables are as defined earlier in the Chapter, the only difference is the "F" at the end of each variable name which indicates that it is a forecast value.

Maize demanded for feed is projected to be 72.07 thousand metric tons in 1991 and would rise to 158.238 thousand metric tons in the year 2000. There would be an average growth rate of 7.34% during the period 1991-1995 and this would increase to a rate of 12.69% during the period 1996-2000.

The maize demanded for industrial processing is projected to decrease from 25.32 thousand metric tons in 1991 to 24.02 thousand metric tons in the year 2000. This would result from a projected decline in the growth of processed maize at an average rate of 2.06% between 1991 and 1995 and an increase in the growth rate of 0.23% between 1996 and 2000. This result assumes that since demand of maize for industrial processing has been declining since the 1970s, this trend would continue in the first part of the forecast period but that the trend would change in the second half of the forecast period.

An explanation for the decrease in demand of maize for industrial processing may lie in data errors. Maize demanded for industrial processing is mainly used in local beer brewing. It is most probable that the data only reflect the maize that is used by the known commercial local beer brewing companies, while the maize used in local beer brewing by individual households is greatly under-estimated.

The maize seed demand is projected to be 23.83 thousand metric tons in 1991 and is expected to increase at an average rates of 3.36% and 0.65% between 1991 and 1995 and between 1996 and 2000, respectively. By the year 2000, maize seed is projected to have reached 25.62 thousand metric tons. This increase in the demand for maize seed would result from the increase in the area harvested of maize during that period.

The total demand for maize is projected to reach 1630.33 thousand metric tons in 1991, increase at annual average growth rates of 2.93% and 3.66% for the periods 1991-1995 and 1996-2000 respectively, to reach 2108.21 thousand metric tons in the year 2000. The

projected growth rate in total demand for maize is lower than the one projected for domestic maize production. However, the projected domestic maize production is not sufficient to meet total demand for maize implying that maize will have to be imported to meet that excess demand throughout the forecast period.

### 5.11.3 Projection of Required Maize Imports

Table 5.5 shows the projected imports of maize that will be required to supplement domestic production if demand for maize has to be met. Maize imports are projected to increase from 188.59 thousand metric tons in 1991 to 342.73 thousand metric tons by the year 2000. Maize import are projected to increase at an average annual growth rate of 1.76% between 1991 and the year 2000.

If no appropriate measures are taken, the lowest maize imports are projected to be 101.85 thousand metric tons in 1992 while the largest maize imports (188.59 thousand metric tons) will be in the year 2000. Importing such huge amounts of maize would entail a serious drain of the already scarce Zambian foreign currencies and hence a big loss on the country's capacity to import the most needed technologies. In addition, considering that the aim of the government has been to achieve self-sufficiency in maize and food production in general, the question that arises is whether the projected imports of maize can be avoided or minimized.

There are two possible ways of at least reducing, if not avoiding, maize imports in Zambia. First, maize imports can be reduced by increasing maize production. Increased maize production at a level even higher than the projected one can result from an expansion in the area harvested of maize and/or an improvement in the maize yield. Increasing maize production by increasing the area under maize is possible since there is a lot of arable land

Table 5.5

Zambia: Projection of Required Maize Imports, 1991-2000

| Year | Thousand Metric Tons | | | | |
|---|---|---|---|---|---|
| | Production | Waste | Net Domestic Supply | Total Demand | Required Imports |
| 1990 | 994.35 | 65.00 | 929.35 | 1600.28 | 670.93 |
| 1991 | 1512.74 | 71.00 | 1441.74 | 1630.33 | 188.59 |
| 1992 | 1639.24 | 68.83 | 1570.41 | 1672.26 | 101.85 |
| 1993 | 1672.24 | 66.08 | 1606.17 | 1733.43 | 127.26 |
| 1994 | 1728.63 | 63.32 | 1665.31 | 1790.24 | 124.92 |
| 1995 | 1769.81 | 60.56 | 1709.25 | 1849.11 | 139.86 |
| 1996 | 1806.24 | 72.77 | 1733.47 | 1929.64 | 196.18 |
| 1997 | 1841.66 | 72.77 | 1768.89 | 2008.01 | 239.13 |
| 1998 | 1868.11 | 72.77 | 1795.34 | 2063.64 | 268.30 |
| 1999 | 1907.60 | 72.77 | 1834.83 | 2135.84 | 301.01 |
| 2000 | 1943.23 | 72.77 | 1870.46 | 2213.19 | 342.73 |
| Annual Average Percentage Growth Rates | | | | | |
| 1991-1995 | 13.65 | | | 2.93 | -16.56 |
| 1996-2000 | 1.89 | | | 3.66 | 20.08 |
| 1991-2000 | 7.77 | | | 3.30 | 1.76 |

that is unutilized and under-utilized. For instance, Jansen (1988) reported that reasonably potential arable land was estimated at 9 million hectares while the study done by the Republic of Zambia (1990) showed that only about 1.27 million hectares of land was planted to major crops in the whole country in the 1988/89 season.

Moreover, this study has shown that farmers are quite responsive to both the producer price and the gross margin of maize. Therefore, if more area has to be planted with maize to increase maize production, policies may be required that would increase the maize producer price and/or decrease the cost of maize production so as to motivate farmers. Moreover, other constraints that are prevalent in the maize subsector should be addressed such as lack of credit, inadequate infrastrustural facilities such as roads, storage facilities, etc. There is also need to introduce competition in input and maize marketing and in the processing and distribution subsector.

The second way in which maize production can be increased is through the improvement in maize yield. Even in this area, there is a lot of potential for improvement. For instance, the average maize yield on commercial farms is about 3.5 metric tons per hectare while it is only about 1.5 metric tons per hectare on small-scale farms. The big difference in maize yield between small-scale and commercial farmers is mainly as a result of limited of accessibility to inputs such as commercial fertilizer and hybrid maize seed and the inappropriate application rates of the same inputs by the former.

The study by the Republic of Zambia (1990) reveals that most of the agricultural extension services are available to commercial farmers who reside along the railway line while small-scale farmers receive almost no extension services at all. Since about 70% of maize is produced by small-scale and emergent (medium-scale) farmers, it is possible that if more and adequate credit facilities were made available to ease accessibility to inputs and

extension services provided to small-scale farmers, then maize yield would improve even further, thereby increasing maize production. For instance, the Republic of Zambia (1990), indicated that if national average fertilizer application rates were to increase to those levels employed by large-scale commercial farmers, then there would be

> - a three-fold increase in the total quantity of commercial fertilizer used on maize
> - an increase in the national average yield of maize to about 55 bags per hectare (assuming appropriate seed and cultural practices are used), and
> - a doubling in the national production of maize from the same land area cultivated. p. 55.

Although higher real fertilizer prices may reduce this potential, they would not eliminate it. It should be pointed out that although it is possible to increase maize production both by increasing the area harvested of maize and by improving the maize yield, policies that would be introduced for such a purpose would require detailed analysis of their impact on all parties involved such as farmers, marketing agencies, processing agencies and consumers.

The second possible method of reducing or getting rid of maize imports would be to decrease the total demand of maize, although this may not be as easy as increasing maize production. The most effective way to decrease total maize demand would be to decrease the domestic consumption of maize which accounts for about 90% of total maize demand.

Decreasing domestic maize consumption would entail a reduction in per capita domestic consumption of maize. This may partly come about if per capita consumption of other cereal crops is increased. This would further entail putting in place those policies that would encourage that. For instance, the increase in demand of maize for domestic consumption has partly resulted from the price structure that exists for food products (Republic of Zambia, 1990). While all food products had their prices decontrolled in the 1980s, those of maize were not. This has left maize to be the cheapest and most affordable staple food crop as the real per capita GDP continued to decrease. Therefore, if imports

of maize have to be reduced by decreasing maize demand, consumption of staple food crops other than maize has to be encouraged partly by removing price controls on maize and encouraging the production of such crops as sorghum, millet and cassava.

However, it should be pointed out that even if maize imports were to be got rid of by increasing maize production and/or decreasing the total demand of maize, that would only ensure adequate availability of maize at national level. Availability alone is not a sufficient criteria upon which to assess the nutritional state of individual households. It is possible to have a coexistence of food self-sufficiency and food insecurity. Therefore, policies should go beyond targeting only food self-sufficiency if each household is to be food secure.

### 5.11.4 Maize Price Forecasts

The projected real producer price of maize, the real retail price of maize, and the real maize marketing spread, together with their growth rates, are presented in Table 5.6. Over the whole forecast period, the real producer price of maize is predicted to increase at an annual average rate of 1.07%.

The overall average annual growth rate of the real maize retail price is predicted at 2.06% over the whole forecast period. This would entail an increase in the real maize retail price from K6.42 per metric ton in 1991 to K7.66 per metric ton in 2000. It is predicted that a larger part of the increase in the real retail price of maize would take place in the first five years (average of 3.39%). This is compared to an average annual growth rate of only 0.73% in the real retail price of maize in the last five years of the forecast period.

Table 5.6

**Zambia: Projections of the Maize Producer Price, Maize Mealie Meal Retail Price and Maize Marketing Spread, 1991-2000**

| Year | Producer Price | | Retail Price | | Marketing Spread | |
|---|---|---|---|---|---|---|
| | K/MT | % Growth Rate | K/MT | % Growth Rate | K/MT | % Growth Rate |
| 1990 | 2.68 | | 6.26 | | 3.58 | |
| 1991 | 3.20 | 19.36 | 6.42 | 2.68 | 3.22 | -9.83 |
| 1992 | 2.80 | -12.40 | 6.67 | 3.88 | 3.87 | 20.03 |
| 1993 | 2.87 | 2.36 | 6.81 | 2.01 | 3.94 | 1.75 |
| 1994 | 2.90 | 1.05 | 7.21 | 5.92 | 4.31 | 9.48 |
| 1995 | 3.36 | 15.78 | 7.39 | 2.45 | 4.03 | -6.52 |
| 1996 | 3.28 | -2.39 | 7.50 | 1.50 | 4.22 | 4.74 |
| 1997 | 3.26 | -0.56 | 7.57 | 0.92 | 4.31 | 2.06 |
| 1998 | 3.08 | -5.53 | 7.63 | 0.85 | 4.55 | 5.67 |
| 1999 | 2.87 | -6.69 | 7.65 | 0.23 | 4.78 | 4.92 |
| 2000 | 2.86 | -0.31 | 7.66 | 0.13 | 4.79 | 0.40 |
| Annual Average Percentage Growth Rates | | | | | | |
| 1991-1995 | | 5.23 | | 3.39 | | 2.98 |
| 1996-2000 | | -3.09 | | 0.73 | | 3.56 |
| 1991-2000 | | 1.07 | | 2.06 | | 3.27 |

This pattern of growth rates in prices of maize is partly expected taking into account the policies that the new government is trying to implement such as the gradual removal of the maize-related subsidies, decreasing the inflation rate, and increasing the maize producer price. This direction has already been evidenced by the real retail price of maize in 1990 and 1991 when some maize marketing subsidies and all the maize consumption subsidy in form of coupons were removed. When all the maize subsidies have been removed, it is predicted that the real retail price of maize would tend to approach the economic price and somehow level off. Moreover, with another policy in effect to curb the inflation rate (estimated at about 200% in 1991), it is further predicted that the growth rate in the producer price and retail price of maize would be relatively stable.

The maize marketing spread is projected to grow at a faster rate during the last half of the forecast period. This is in line with the argument presented above since it is predicted that the maize marketing subsidies that reduce the marketing spread would have been eliminated or tremendously reduced by the second half of the forecast period.

## 5.12 Summary

The chapter presents the results of the estimated model of the maize market in Zambia. Each regressed equation is subjected to statistical and economic tests before it is selected for analysis. The statistically and economically sound model is then used to first forecast prices, production and consumption of maize over the period under observation. Various methods, including the MSEP, RMSPE and Theil's "U" statistic and the graphical method, are used to test the model's ability to forecast.

When satisfied with the model's performance over the period of observation, the model is used to forecast future values of the endogenous variables. This entails first forecasting the unknown values of the exogenous variables into the future and second using these values to forecast the future values of the endogenous variables. Whenever the actual value of the exogenous variable is known it is incorporated a priori in forecasting the endogenous variables. Average growth rates of the predicted values of the endogenous variables are calculated and analyzed. These are broken down into three periods: the first five years, the last five years, and the whole ten-year period.

# 6. SUMMARY, CONCLUSION, POLICY RECOMMENDATIONS AND AREAS OF FUTURE RESEARCH

## 6.1 Summary

The main purpose of the study is to specify and estimate an econometric model of the maize subsector in Zambia, calculate supply and demand elasticities, and then forecast prices, production and consumption of maize after testing and validating the model.

In chapter two, the Zambia's economy and sectoral performance is reviewed since independence in 1964, along with the priorities embodied in the different policies that have been employed by the government over the years and how these have affected the different sectors of the economy, particularly the agricultural sector.

A descriptive, diagnostic and graphical analysis of the major institutional, policy, environmental and economic factors and relations that characterize the agricultural sector, and the maize subsector in particular, is presented in chapter three. This descriptive, diagnostic and graphical analysis of the maize subsector is done with regard to pricing, production and marketing policies and consumption patterns. It shows how the Zambian maize subsector's performance is a function of the institutional and policy environment within which it operates. Information in chapters two and three provides a background for the economic formulation of the supply, demand and price behavioral equations for the maize econometric model in the later sections.

In chapter four, the supply and demand theories and the stages involved in commodity model building are discussed. In addition, the initial model is specified and the estimator selected for model analysis.

The results of the econometric model are presented and the model is tested and validated in chapter five. On the supply side of the model, three equations are estimated.

The first equation is that of the average maize yield which is specified to be related to fertilizer consumption index, average rainfall and the time variable.

The second equation is that of area harvested of maize whose variations are explained by the maize gross margin, the producer price of groundnuts, and lagged area harvested of maize. This estimation captures the price sensitivity of producers to changes in relative prices of substitute crops and maize gross margin sensitivity of producers. In the third equation, net imports of maize are estimated as a function of maize production, lagged change in stocks of maize and time trend. The econometric results are satisfactory and provide short-run and long-run cross-price elasticities of supply of -0.21 and -0.42, respectively, with respect to the producer price of groundnuts. The short-run and long-run elasticities of supply with respect to the maize gross margin are 0.19 and 0.37 while those with respect to the price are 0.22 and 0.51, respectively.

On the demand side, separate equations are estimated for per capita demand of maize for domestic consumption, per capita demand of maize for feed, per capita demand of maize for industrial processing and demand for maize seed. Per capita demand of maize for domestic consumption is estimated as a function of lagged domestic maize consumption, per capita sorghum production, the ratio of the retail price of maize to that of rice, and the time trend. In the per capita demand of maize for feed and for industrial processing equations, the regressors are the respective lagged dependent variable and per capita gross domestic product. The demand for maize seed is explained by the area harvested of maize.

The short-run income elasticities of demand of maize for feed and per capita demand of maize for industrial processing are 0.32 and 0.15, respectively, while their respective long-run income elasticities of demand are 1.39 and 0.96. The short-run and

long-run price elasticity of demand for per capita domestic maize consumption is -0.03 and -0.4, respectively.

The remaining part of the model is the formulation of the producer price and retail price equations. The producer price of maize is specified as a function of lagged maize producer price, fertilizer price, and lagged maize production. The lagged maize production partly captures the effect of maize stocks on the producer price since the maize stocks were not available, and when the change in maize stocks was included in the equation it had a t-statistic less than one. The price flexibility with respect to lagged maize production is -9.71. The retail price of maize is obtained as an identity by adding the maize marketing spread to the maize producer price. The nominal maize marketing spread is estimated as a function of inflation rate (using consumer price index as a proxy) and maize marketing subsidy per metric ton.

The model equations are subjected to statistical and economic tests, and the model's ability to track actual data is validated using various methods: the graphical method, Mean Squared Error (MSE), Root Mean Squared Percentage Error (RMSPE) and Theil's U-statistic. In general, the model is good enough to be used for forecasting under all the tests. In the last part of chapter five, the forecast results are presented and analyzed, with growth rates calculated for endogenous variables.

## 6.2 Conclusion

The study has generally met the research objectives outlined in chapter one. An econometric model of the maize market is developed and highlights some important insights into how the maize subsector operates in Zambia; how its performance is determined by the

institutions, policies, the environment and economic factors within which it operates; and where the subsector might be headed to in the future.

The Zambian agricultural sector, and the food system in particular, has not had an impressive performance despite the emphasis placed on it by the government starting as far back as the late 1970s. The country only achieved maize self-sufficiency in the last two to three years of the 1980s. The country has been a net importer of maize and still imports about 75% and 50% of its wheat and rice requirements respectively (Ndalamei, 1990).

The model predicts that between 1991 and 2000, the producer price and retail price of maize would increase at average annual growth rates of 1.07% and 2.06%, respectively. The retail price of maize would increase at a faster rate than that of producer price partly because of the gradual removal of the maize marketing subsidies that is in effect. The predictions of the model also show that the area harvested of maize would increase at an average annual rate of 0.58% compared to the average annual growth rate of 6.04% in maize yield over the whole forecast period. This would result in an average annual growth rate of 7.77% in maize production. The low growth rate in the area harvested of maize would partly be due to the low real producer price of maize which has been decreasing since the late 1980s. This led to a reduction in maize production by commercial farmers during that same period as they switched to the production of other crops.

This study has projected a continuation of the national maize deficit up to the year 2000, if no preventative measures are taken. It predicts that total maize demand will grow at an average rate of 3.29%. This would mainly result from an increase in domestic maize consumption which accounts for about 90% of total maize demand. Domestic maize consumption is projected to increase at an annual rate of 3.04% over the forecast period due to both an increase in total population and in per capita maize consumption. Although

demand of maize for feed is projected to increase at an annual rate of 10.01%, it will not influence total maize demand much since it only accounts for about 4% of the latter. Demand of maize for seed and for industrial processing is projected to grow at average annual rates of 2.01% and -0.91%, respectively, over the whole forecast period.

The conclusion emerging from this study is that although maize production is projected to increase at a faster rate than that of total maize demand, the resulting increase in maize production will be insufficient to meet maize demand. As such, it is predicted that maize imports will grow at an average annual rate of 1.76% to meet the excess maize demand if no preventative measures are taken to hedge against these projected maize imports.

Considering the need for the government to efficiently use the already scarce foreign currency and its interest to achieve food self-sufficiency as well as food security, there is a need to make the food system more efficient. There is a need to reduce maize imports, if not eliminate them. It is shown in the previous chapter that with supportive policies in place, there is a good potential to reduce or eliminate maize imports by increasing maize production (by expanding area under maize and/or by improving maize yield) and/or reducing total maize demand by encouraging the production of other staple food crops such as sorghum or by decontrolling the maize retail price too as is the case with other staple food crops like rice and wheat.

## 6.3 Policy Recommendations

To ensure availability of adequate and accessible supplies of food products to the population at large, production, marketing and distribution of food should be efficient. There is need to increase labor productivity in agriculture and to promote and encourage

the production of crops well suited to the different agro-ecological zones. This means that some resources should be shifted from maize to more suitable crops in regions that are not suitable for maize. Increased production of food crops other than maize would even reduce maize demand and hence the projected maize imports. At the same time, more maize production should be encouraged in those areas where it is suitable.

However, increased maize production, increased production of other food crops and the reduction in maize demand meant to reduce or eliminate maize import whilst aiming to achieve food self-sufficiency and food security in the country, can only come about if policies that would support such moves and motivate all parties concerned are put in place.

The problems constraining production, marketing and distribution in the food system which need to be addressed include:

- shortage of labor at peak farming periods coupled with non-use of labor-saving technologies among small-scale farmers;
- inadequate extension services for small-scale farmers in maize production and inadequate extension services and research for traditional crops grown by the majority of the poor rural households;
- insufficient seasonal and limited availability of medium and long-term credit;
- high cost of farm inputs and implements;
- limited use of irrigation in crop production to hedge against drought;
- late payment for crops purchased by the cooperative unions;
- late delivery of agricultural inputs;
- scarcity of foreign exchange for the importation of agro-chemicals, agricultural implements, machinery and spare parts;
- inadequate storage facilities for agricultural inputs and output;

- limited availability of funds for crop purchases;
- inadequate serviceable vehicles, locomotives, wagons and spare parts compounded by an inappropriate pricing regime for freight transport;
- poor conditions of the basic infrastructure such as roads (feeder roads) and rail lines in areas with potential land for agricultural development;
- lack of skilled personnel;
- undue government involvement in agricultural marketing and processing;
- capacity under-utilization of milling plants;
- declining real income; and
- non-availability of retail outlets in some rural areas.

Furthermore, the agricultural distribution system needs to be restructured. For instance, more competition is required in fertilizer, seed, and maize marketing and in the processing and retailing sectors.

## 6.4 Areas of Further Research

Some areas have been identified for improving the model. First, future work should collect and incorporate direct variables that influence demand of maize for feed and demand of maize for industrial processing so as to formulate their direct demand functions, rather than formulating their derived demand is the case in this study. For instance, the number of livestock that use maize feed and the price of feed can be used in the maize feed equation. The quantity produced of the final product, its price, and the price of the maize for industrial processing can be incorporated in the equation of maize demand for industrial processing.

Second, collection of data on and inclusion of maize stocks would improve the prediction, particularly on the maize imports. If in actual fact there were huge maize stocks at the end of the previous year, then the current total maize supply is under-estimated since that amount of maize stocks is not accounted for as beginning stocks if maize stocks are missing.

Third, only fertilizer cost was considered in calculating the maize gross margin used in this study. Therefore, for the maize gross margin to be more representative of the expected profit accrued to farmers per hectare, there is need to incorporate other maize costs of production such as labor costs, maize seed costs and costs of herbicides and insecticides.

Fourth, this study was carried out using annual time series secondary data aggregated at the national level from 1964 to 1990. The information loss due to the aggregation bias is obvious and implies that one should be cautious in interpreting some of the results. Therefore, there is a need to investigate factors affecting supply and demand of maize and other crops at a more disaggregated level. For instance, separate equations can be estimated for commercial farmers and for small-scale farmers to determine their different supply responsiveness. This would help come up with more specific, targeting and appropriate recommendations for the different categories of farmers.

Disaggregation can also be done at various levels, such as provincial level, regional level, rural versus urban level, and at different income levels within and between rural and urban areas. This would help determine the consumption and production patterns at each of these levels separately. This would in turn help implement appropriate policies at different levels and in different regions.

Fifth, research is needed to come up with possible institutional changes that should be made to improve the maize subsector in terms of improved production, transportation, storage for inputs and output, marketing, production credit, input procurement and delivery, and pricing policies. This is crucial in the case of the maize subsector in Zambia where currently all the marketing of maize is done by the cooperatives which are inefficient and result in heavy subsidies by the government. For instance, even with the realization and authorization in 1990 that the private sector should be participating in maize marketing, private organizations have not shown any interest to do so yet. Therefore, investigations into reasons why the private sector is not attracted into that venture should be done and corrections made.

Sixth, another area of research would be establishing how accurate information can be collected and made available to different users at the time it is needed in the maize subsector to improve its performance. This is crucial for policy purposes as well as for planning by different organizations affected by the subsector. For instance, with the decontrol of producer and retail prices for food crops other than maize in the 1970s and in the 1980s and the maize producer price in 1991, different prices charged in different markets should be collected and communicated to the users to promote competition.

Seven, one of the major concerns of the Zambian government is to achieve food self-sufficiency and food security. Therefore, an area of research would be to determine the least-cost, size and location of grain warehouses and transportation which would enhance the efficiency of grain handling and distribution of maize (and other foods) within and between surplus and deficit regions.

Last but not the least, with the removal of government support of maize production and marketing in form of subsidies and considering the drought that has been prevalent

since the 1980s, there is a need for research to consider the feasibility of strategies designed to promote production of other staple food crops that are more drought resistant than maize, like sorghum and millet, for sale as well as for increased consumption. Basic constraints to improving sorghum, millet and cassava production require socio-economic and agronomic investigation. These drought resistant crops are not perceived as competitive with maize in production. They are grown for their drought resistance while consumers strongly prefer maize. As a result, maize receives the greatest proportion of inputs and attention. There is need to examine the elasticity of rural and urban consumer preferences for alternative coarse grains.

# APPENDICES

# APPENDIX A

## Figures for Chapter 5

**Figure 5.1 National Average Yield of Maize in Zambia: 1966-1990 and Projected to the Year 2000**

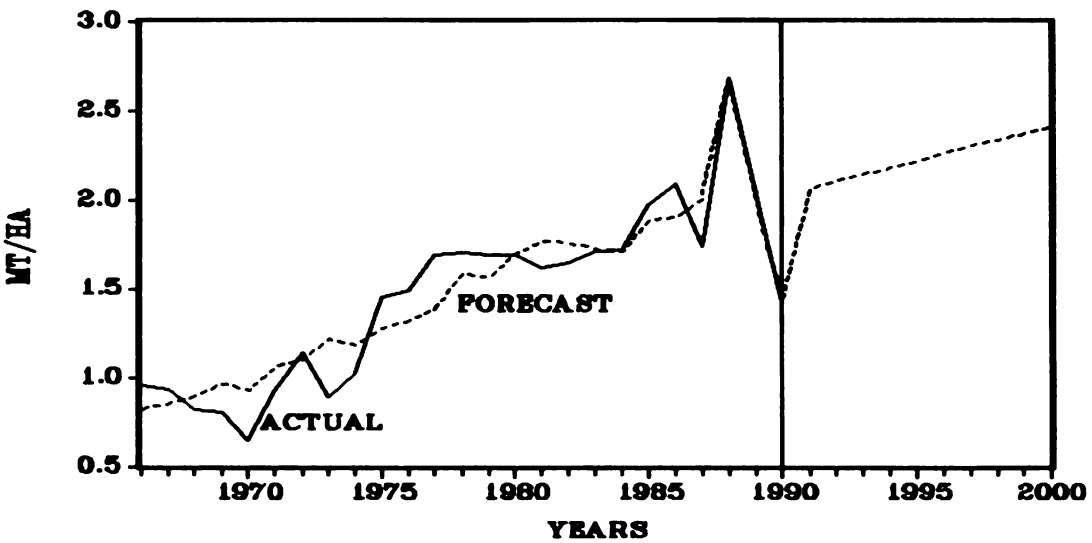


**Figure 5.2 Area Harvested of Maize in Zambia: 1966-1990 and Projected to the Year 2000**

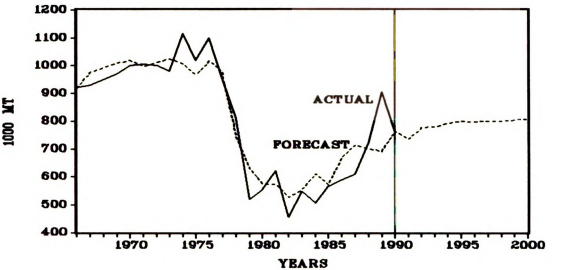



**Figure 5.3 Maize Production in Zambia: 1966-1990 and Projected to the Year 2000**

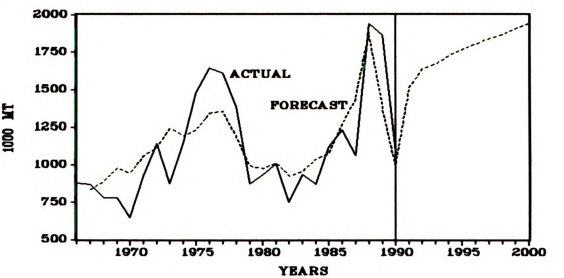


**Figure 5.4 Net Maize Imports in Zambia: 1966-1990 and Projected to the Year 2000**

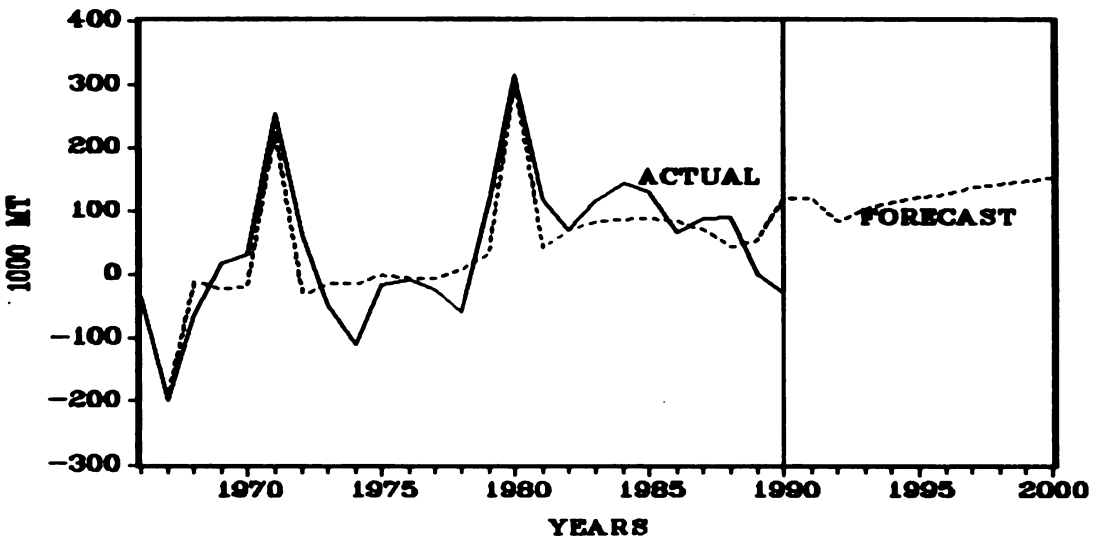



**Figure 5.5 Net Maize Supply in Zambia: 1966-1990 and Projected to the Year 2000**

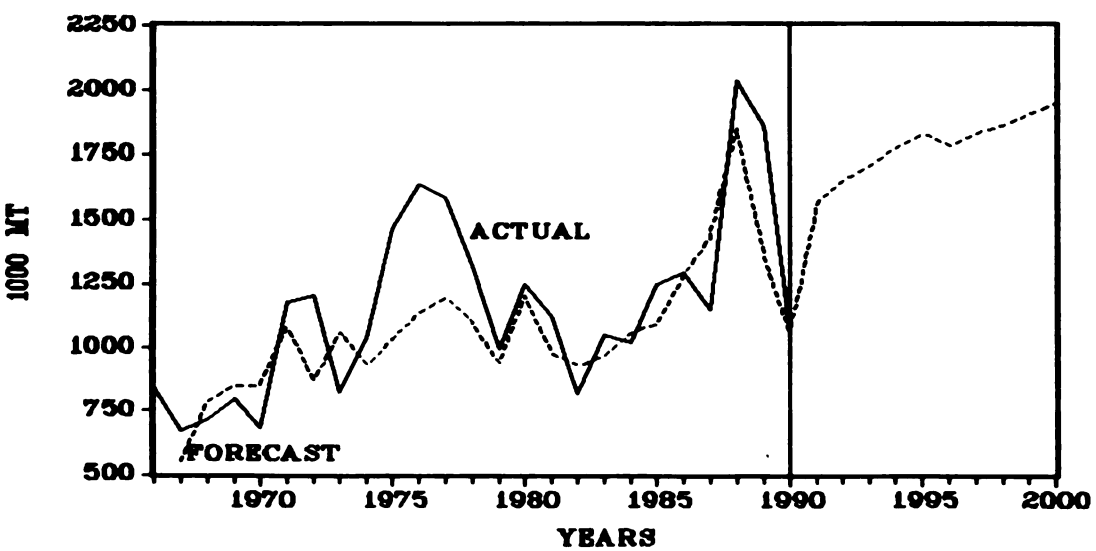


**Figure 5.6 Per Capita Domestic Consumption of Maize in Zambia: 1966-1990 and Projected to the Year 2000**

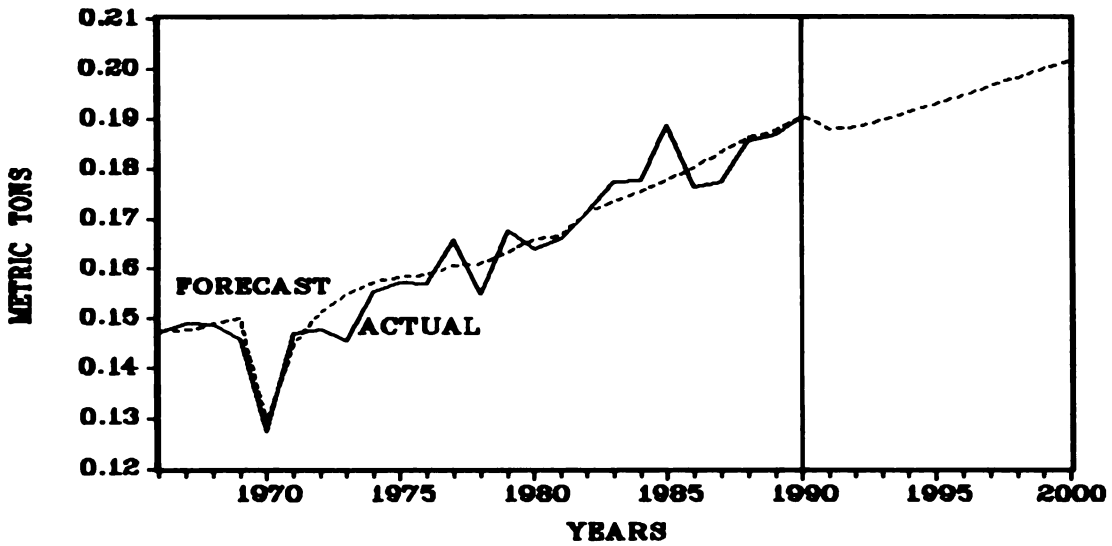



**Figure 5.7 Total Domestic Consumption of Maize in Zambia: 1966-1990 and projected to the Year 2000**

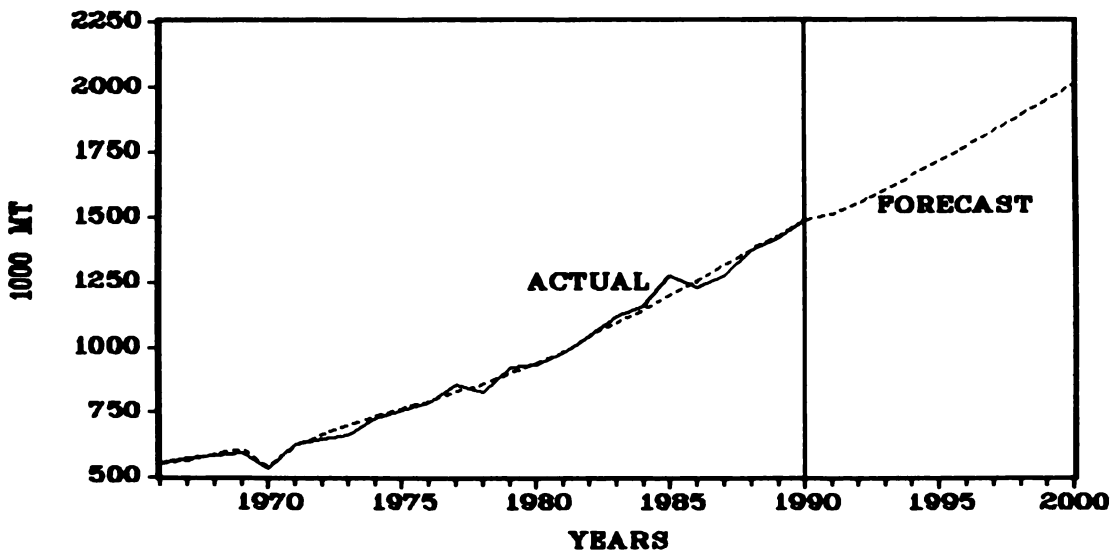


**Figure 5.8 Per Capita Demand of Maize for Feed in Zambia: 1966-1990 and Projected to the Year 2000**

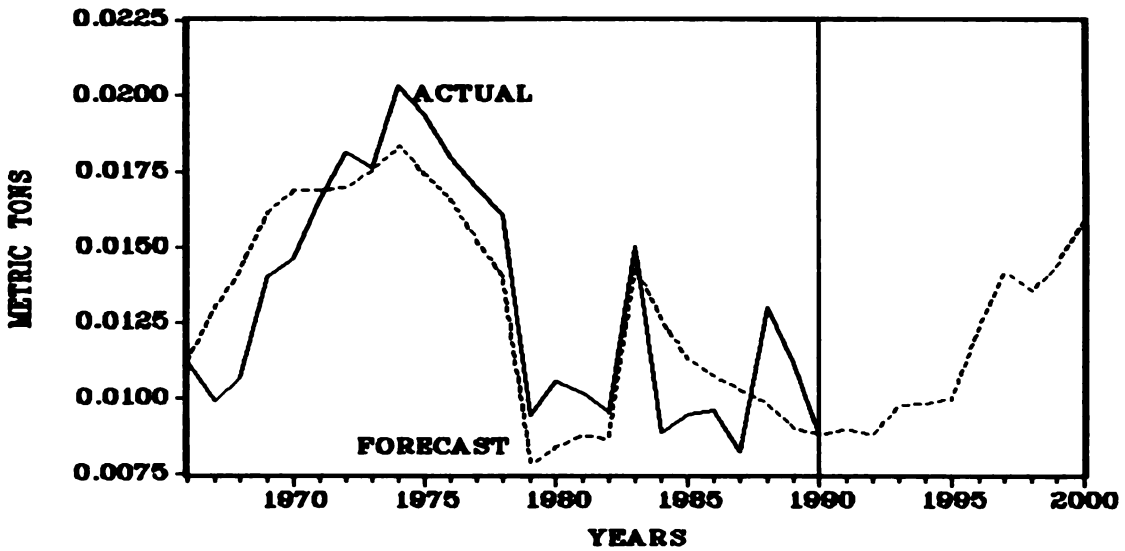



**Figure 5.9 Total Demand of Maize for Feed in Zambia: 1966-1990 and Projected to the Year 2000**

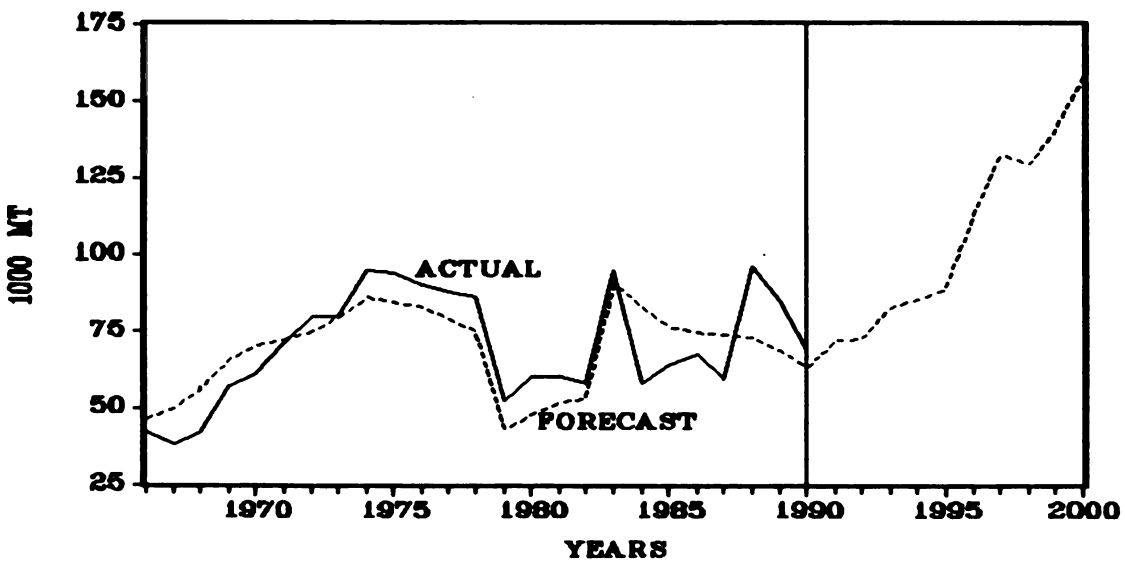


**Figure 5.8 Per Capita Demand of Maize for Feed in Zambia: 1966-1990 and Projected to the Year 2000**

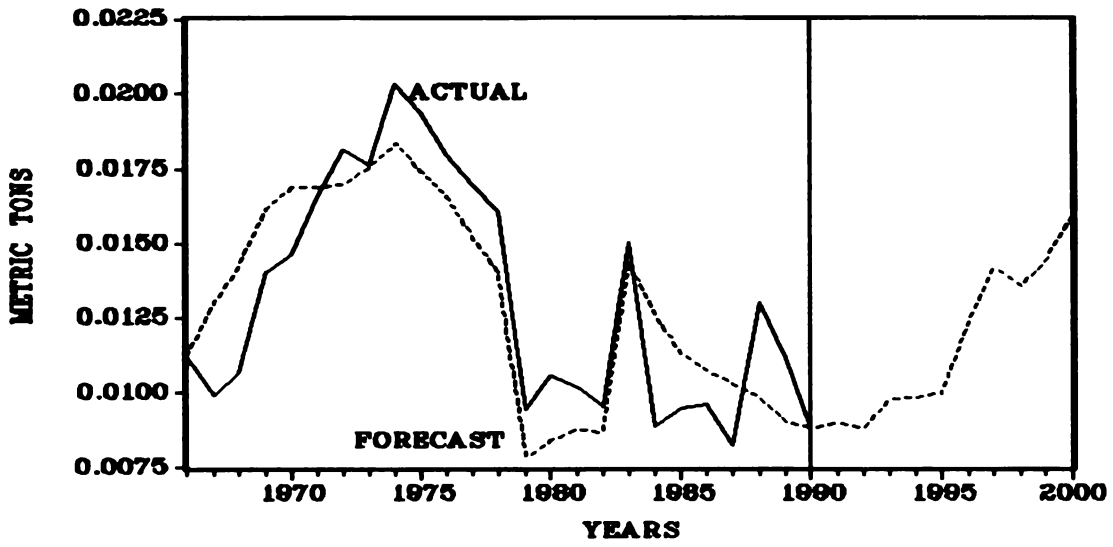



**Figure 5.9 Total Demand of Maize for Feed in Zambia: 1966-1990 and Projected to the Year 2000**

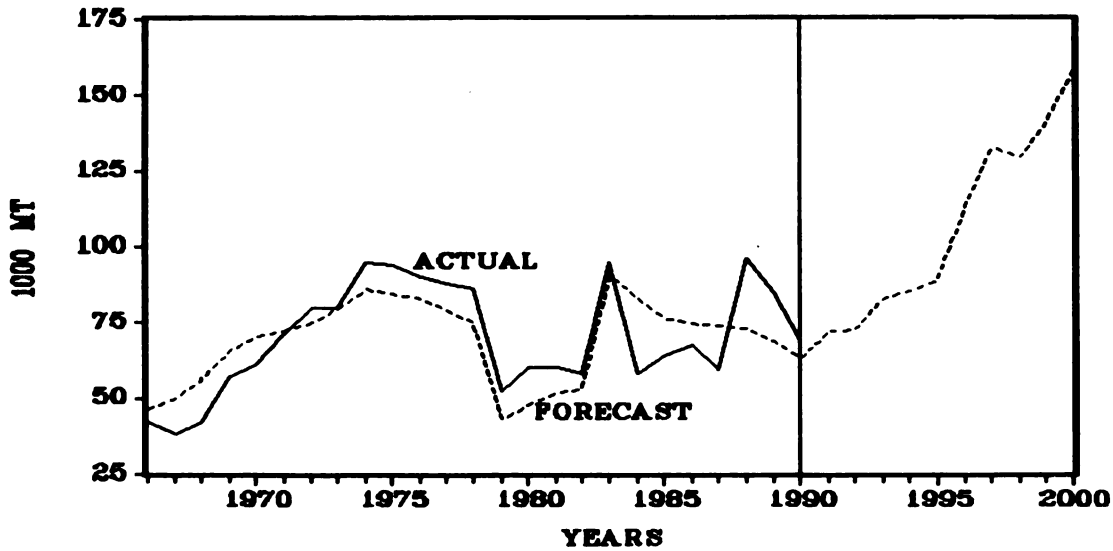


**Figure 5.10 Per Capita Demand of Maize for Industrial Processing in Zambia: 1966-1990 and Projected to the Year 2000**

**Figure 5.11 Total Demand of Maize for Industrial Processing in Zambia: 1966-1990 and Projected to the Year 2000**

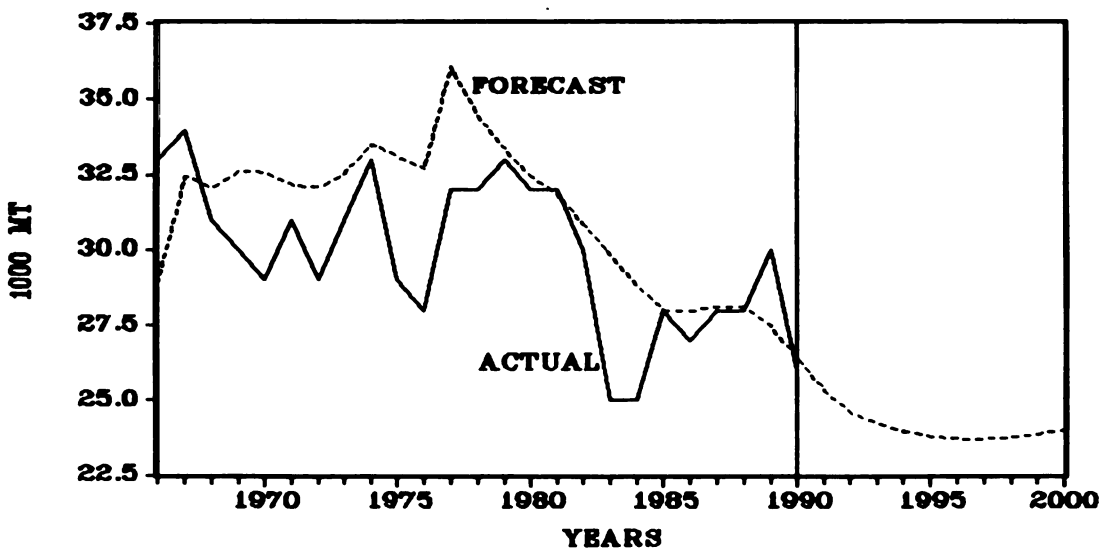


**Figure 5.12 Maize Seed Demand in Zambia: 1966-1990 and Projected to the Year 2000**

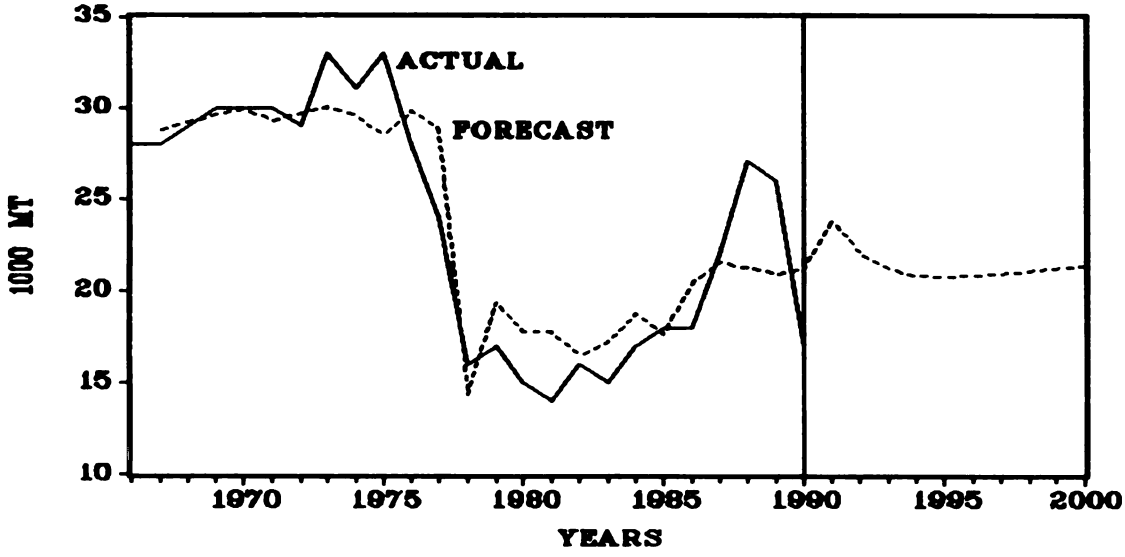



**Figure 5.13 Total Demand of Maize in Zambia: 1966-1990 and Projected to the Year 2000**

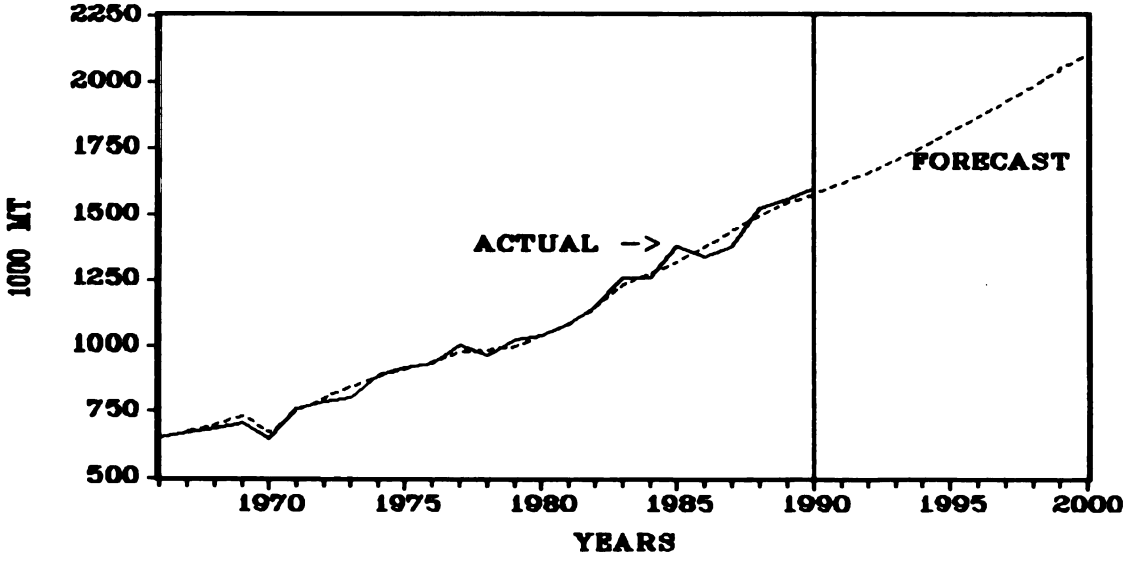


**Figure 5.14 Change in Maize Stocks in Zambia: 1966-1990 and Projected to the Year 2000**

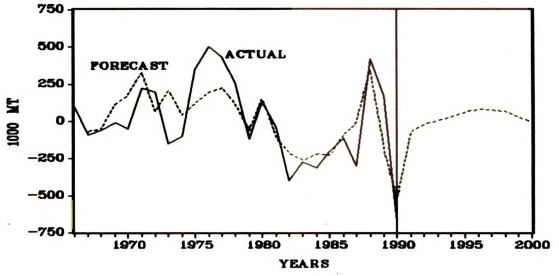



**Figure 5.15 Real Maize Producer Price in Zambia: 1966-1990 and Projected to the Year 2000**

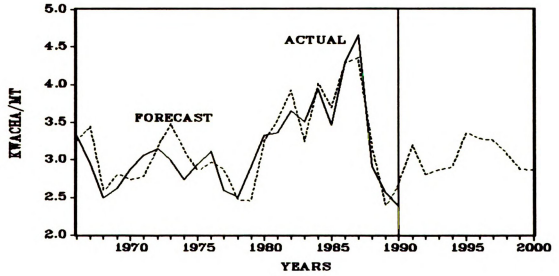
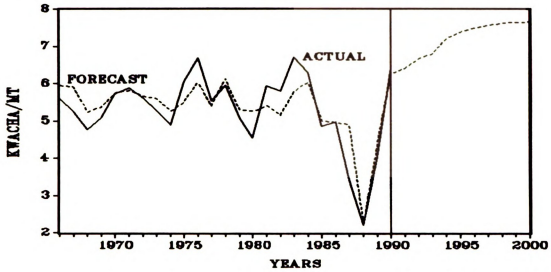


**Figure 5.16 Real Maize Retail Price in Zambia: 1966-1990 and Projected to the Year 2000**



## APPENDIX B

Sources of Data Used in the Study

| VARIABLE | PERIOD | SOURCE |
|---|---|---|
| TMZY | 1964-1979 | FAO "Agrostat" data |
| | 1980-1990 | Zambia, Agricultural Statistics Bulletin, various issues.* |
| TMZAREA | 1964-1979 | FAO "Agrostat" data |
| | 1980-1990 | Zambia, Agricultural Statistics Bulletin, various issues.* |
| TMZPROD | 1964-1979 | FAO "Agrostat" data |
| | 1980-1990 | Zambia, Agricultural Statistics Bulletin, various issues.* |
| NMZIMP | 1964-1979 | FAO "Agrostat" data |
| | 1980-1990 | Zambia, Evaluation of the Performance Zambia's Maize Subsector, Lusaka, 1990. |
| TMZC | 1964-1990 | FAO "Agrostat" data |
| MZFEED | 1964-1990 | FAO "Agrostat" data |
| MZPROC | 1964-1990 | FAO "Agrostat" data |
| MZSEED | 1964-1990 | FAO "Agrostat" data |
| MZWASTE | 1964-1990 | FAO "Agrostat" data |
| MZPP | 1964-1969 | Zambia, Ministry of Cooperative, Department of Marketing, Market Logistics and Information section, Lusaka. |
| | 1970-1989 | Zambia, Ministry of Agriculture, Agricultural Statistics Bulletin, Lusaka, 1988. |
| | 1990 | Zambia, Central Statistics Office, Zambia in Figures, 1991, Lusaka. |
| MZMRP | 1964-1980 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |

| VARIABLE | PERIOD | SOURCE |
|---|---|---|
| | 1981-1989 | Zambia, Evaluation of the Performance Zambia's Maize Subsector, Lusaka, 1990. |
| | 1990 | Zambia, Monthly Digest of Statistics, December, 1990, Central Statistics Office, Lusaka. |
| GDP | 1964-1979 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |
| | 1980-1983 | Zambia, National Accounts Statistics Bulletin # 2, 1987, Central Statistics Office, Lusaka. |
| | 1984-1988 | Zambia, Monthly Digest of Statistics, January-August, 1990, Central Statistics Office, Lusaka. |
| | 1989-1991 | Zambia, Zambia in Figures, Central Statistics Office, Lusaka, 1991. |
| RICERP | 1964-1970 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |
| | 1971-1985 | Jansen, D., Trade, Exchange Rate, and Agricultural Pricing Policy in Zambia, 1988. |
| BRP | 1964-1970 and 1986-1990 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |
| | 1971-1985 | Jansen, D., Trade, Exchange Rate, and Agricultural Pricing Policy in Zambia, 1988. |
| GNUTPP | 1964 | Zambia, Ministry of Cooperative, Department of Marketing, Market Logistics and Information section, Lusaka. |
| | 1965-1969 | Jansen, D., Trade, Exchange Rate, and Agricultural Pricing Policy in Zambia, 1988. |
| | 1970-1989 | Zambia, Ministry of Agriculture, Agricultural Statistics Bulletin, Lusaka, 1988. |
| | 1990-1991 | Zambia, Zambia in Figures, Central Statistics Office, Lusaka, 1991. |

| VARIABLE | PERIOD | SOURCE |
|---|---|---|
| FERTAP | 1964-1970 and 1990-1991 | Zambia, Ministry of Cooperative, Department of Marketing, Market Logistics and Information section, Lusaka. |
| | 1971-1989 | Zambia, Ministry of Agriculture, Agricultural Statistics Bulletin, Lusaka, 1988. |
| CPI | 1964-1989 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |
| | 1990-1991 | Zambia, Consumer Price News, Fourth Quarter, Central Statistics Office, Lusaka, 1991. |
| TPOP | 1964-1990 | Zambia, Monthly Digest of Statistics, various issues, Central Statistics Office, Lusaka. |
| RAIN | 1964-1990 | Zambia, Meteorological Reports, various issues, and Mount Makulu Research Station, Lusaka. |
| FCI | 1964-1977 and 1988-1990 | Calculated from the FAO Fertilizer Yearbook, various issues. |
| | 1978-1987 | Calculated from data on fertilizer consumption in the Agricultural Statistics Bulletin, Lusaka, 1988. |
| SGY | 1964-1990 | FAO "Agrostat" data |
| SGAREA | 1964-1990 | FAO "Agrostat" data |
| SGPROD | 1964-1990 | FAO "Agrostat" data |
| SGPP | 1964-1974 | FAO "Agrostat" data |
| | 1975-1990 | Zambia, Ministry of Cooperative, Department of Marketing, Market Logistics and Information section, Lusaka. |
| MZSUBS | 1964-1968 | Zambia, Monthly Digest of Statistics, December, 1971, Central Statistics Office, Lusaka. |
| | 1969-1979 | Zambia, Economic Report, various issues, Ministry of Finance and National Commission for Development Planning, Lusaka. |

where:

| | |
|---|---|
| TMZAREA | = area harvested of maize |
| TMZY | = average maize yield per hectare |
| TMZPROD | = domestic maize production |
| NMZIMP | = net import of maize |
| MZFEED | = maize feed |
| MZSEED | = maize seed |
| MZWASTE | = maize wasted |
| MZPROC | = maize processed for industrial use |
| TMZC | = human consumption of maize |
| TPOP | = total population |
| RAIN | = national average rainfall |
| MZPP | = maize producer price |
| MZMRP | = maize breakfast meal retail price |
| FERTAP | = fertilizer average price for Urea and "D" Compound |
| FCI | = fertilizer consumption index |
| RICERP | = Polished rice retail price |
| BRP | = bread retail price |
| GDP | = gross domestic product |
| SGAREA | = area harvested of sorghum |
| SGPROD | = sorghum production |
| SGY | = sorghum average yield per hectare |
| SGPP | = sorghum Producer price |
| CPI | = Annual consumer price index |
| GNUTPP | = chalimbana groundnut producer price |
| MZSUBS | = maize subsidy |

## APPENDIX C

### Calculation of Fertilizer Consumption Index and Fertilizer cost per Hectare

Fertilizer consumption index (FCI) is calculated using FAO data on fertilizer consumption in Zambia with 1978 = 1. That is, all fertilizer consumption series are divided by the value for 1978 to come up with the fertilizer consumption index with 1978 as base year. The FAO data are broken down into potash, nitrogen and phosphate fertilizers and is available for the period 1964 to 1990.

1978 was selected as the base year because the same index is used in calculating fertilizer cost per hectare for maize production which is in turn used in calculating the maize gross margin, using the data from Zambia rather than using FAO data directly. Unlike FAO data that is only broken down into potash, nitrogenous and phosphate fertilizers, Zambian data is broken down into specific separate compounds and other types of fertilizers.

The basal fertilizers used in maize production in Zambia are basically compounds "X", "D" and "R" while the top dressing fertilizers usually used are Urea, Ammonium Nitrate and Ammonium Sulphate. These are the fertilizers that are used in calculating the fertilizer cost per hectare for maize production. Since Zambian data are only available for the period 1978 to 1987, the FAO data are adjusted to the Zambian data for 1978 to come up with FAO Zambian-equivalent data for the period earlier than 1978. The fertilizer cost per hectare is calculated using the following steps:

1 Fertilizer consumption index per hectare (FCI/ha) is calculated by dividing the FCI (calculated as above with 1978 = 1) by total area harvested of maize for each year.

2 The fertilizer price index is calculated as the average of the price of Urea (top dressing) and the price of Compound "D" (basal dressing) divided by the 1978 figure. Urea and "D" Compound prices are selected because these are the two commonly used types of fertilizers among those mentioned above and their prices are quite representative of the prices of other top dressing and basal fertilizers, respectively.

3 Fertilizer cost index per hectare is the product of the results in steps 1 and 2.

4 From 1978 to 1990, the total cost of fertilizer in maize production is calculated as a sum of the cost of each type of fertilizer used in maize production. The cost of each type of fertilizer used in maize production is calculated as the amount used multiplied by its own price. To get the fertilizer cost per hectare of maize produced for the period 1978-1987, the total cost of fertilizer is divided by the area harvested of maize.

5 To get the cost of fertilizer per hectare of maize for the periods 1964-1977 and 1988-1990, the fertilizer cost index per hectare for these years (calculated in step 3) is multiplied by the cost of fertilizer per hectare for 1978 calculated in step 4.

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