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**FOOD DEMAND AND POLICY ANALYSIS FOR LESOTHO:  
AN APPLICATION OF THE ALMOST IDEAL DEMAND SYSTEM**

A Thesis Submitted to the College of  
Graduate Studies and Research  
In Partial Fulfilment of the Requirements  
For the Degree of Doctor of Philosophy  
in the Department of Agricultural Economics  
University of Saskatchewan  
Saskatoon

By

Varghese A. Manaloor

Fall 1995

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College of Graduate studies and research

**SUMMARY OF DISSERTATION**

Submitted in Partial fulfilment

of the requirements for the

**DEGREE OF DOCTOR OF PHILOSOPHY**

by

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## **Food Demand and Policy Analysis For Lesotho: An Application of the Almost Ideal Demand System.**

Food and nutrition policy analysis, especially for a developing country, requires information on food demand and income parameters. Often, such information is not readily available for different income groups.

The Lesotho government, in the process of developing the agriculture sector, aims to increase the domestic production of maize through the Food Self Sufficiency Programme (FSSP) by providing incentives to producers. The FSSP has the potential to affect prices at the consumer level for maize and maize meal. Higher maize meal prices could have adverse nutritional impacts especially for low income households.

The objective of this study was to analyze the effects of price and income changes on the nutritional well being of consumers with a focus on low income households. A related objective was to provide an estimate of the parameters for food demand.

The results of the estimation indicate that total food expenditure elasticity declines as income increases. The sign and magnitude of the elasticities indicates that all food groups are necessary.

The estimated demand and expenditure elasticities were used to calculate calorie and protein demand and expenditure elasticities for the low income households. Calorie and protein demand elasticities are negative for maize and cereals. For all other food groups they are positive. Simulation results indicate that if the price of maize increases by 50 percent the total calorie availability decreases by 14.6 percent and the total protein availability decreases by 12.6 percent. A 50 percent increase in the price of maize and milk reduces calorie availability by 10.1 percent and protein availability by 8.7 percent. A 50 percent increase in the price of fruits and

vegetables results in approximately 5 percent increase in calorie and protein availability which results due to substitution towards grains. The estimated calorie and protein expenditure elasticity for low income groups is 0.88 and 0.87 respectively.

Food consumption patterns in Lesotho, based on Household Budget Survey data indicate that maize meal is the staple across low, middle and high income groups. Seventy percent of calorie and protein availability is from maize meal and other cereals. The per capita per day availability of calorie among households in the low income group is only 1850. A price subsidy or income transfer policy can be used to help low income households meet the nutritional targets of 2500 calories per capita per day. This programme, however, has budgetary implications.

The cost minimizing solution of the least cost cheap food policy, indicate that a maize meal price subsidy of 31 percent is the cheapest way to achieve nutritional targets of the low income households. If this subsidy is applied to total quantity of maize meal purchased by the low income households, the cost of the programme will be 24 million maloti. The cost of the programme increases to 34 million maloti if maize meal consumption by all income groups is subsidised.

The results of an income transfer policy indicate that an income expansion of 16.3 percent is needed to allow low income consumers to achieve the nutritional targets. The total cost of this programme will be 36 million maloti.

The simulation results indicate that increasing the price of maize meal to attain self-sufficiency in maize production will have adverse nutritional impacts. If households are net consumers of maize, that is household consumption of maize is higher than household production. the objective of attaining self sufficiency in maize production may not be an appropriate policy. On the other hand, should the government of Lesotho try to increase the production of some other

agricultural commodity in which it has a comparative advantage, for example fruits and vegetables, there is no reduction in calories and protein availability even if consumer prices increase by 50 percent.



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## ABSTRACT

Manaloor, Varghese A., Food Demand and Policy Analysis for Lesotho: An Application of the Almost Ideal Demand System. Co-supervisors: Dr. Gary Storey and Dr. Richard Gray.

Food and nutrition policy analysis, especially for a developing country, requires information on food price and expenditure elasticities. Often, such information is not readily available for different income groups. For Lesotho, this information currently does not exist. This study analyses the food consumption and nutrition of households in Lesotho by estimating a set of food demand parameters.

The Lesotho government, in the process of developing the agriculture sector, aims to increase the domestic production of maize through the Food Self Sufficiency Programme (FSSP) by providing incentives to producers. The FSSP has the potential to affect prices at the consumer level for maize and maize meal. Higher maize meal prices could have adverse nutritional impacts especially for low income households.

The objective of this study was to analyze the effects of price and income changes on the nutritional well being of consumers with a focus on low income households. A related objective was to provide an estimate of the parameters for food demand.

The Almost Ideal Demand System was used to estimate demand parameters for seven food groups: maize, other cereals, meat, milk, eggs, fats and oils, and fruits and vegetables. Data for analysis was obtained from the Household Budget Survey (HBS) that was carried out in 1986/87 by the Bureau of statistics over a twelve month period. Households were divided into low, middle and high income groups. The share equations

were first estimated by imposing the homogeneity and symmetry restrictions. The null hypothesis of symmetry given homogeneity is not rejected in any of the income groups.

The results of the estimation indicate that total food expenditure elasticity declines as income increases. The sign and magnitude of the elasticities indicates that all food groups are relative necessities. Expenditure elasticity of maize declines from 0.91 for the low income group to 0.47 for the high income households.

The estimated demand and expenditure elasticities were used to calculate calorie and protein price and expenditure elasticities for the low income households. Calorie and protein price elasticities are negative for maize and cereals. For all other food groups they are positive. Five different price policy scenarios were used to analyze the impacts of price changes on nutritional levels. Simulation results indicate that if the price of maize increases by 50 percent the total calorie availability decreases by 12.9 percent and the total protein availability decreases by 9.9 percent. A 50 percent increase in the price of maize and milk reduces calorie availability by 9 percent and protein availability by 7 percent. The percentage reduction of calorie and protein availability is smaller than the previous scenario which results because milk calorie and protein elasticities are positive. Thus when price of milk increases there is an increase in the availability of calories and protein. A 50 percent increase in the price of fruits and vegetables results in 4.7 percent increase in calorie and 4.3 percent increase in protein availability. This results from substitution towards grains.

The estimated calorie and protein expenditure elasticity for low income groups is 0.87 and 0.86 respectively. These results are comparable to results obtained for other countries: 0.6 for Morocco and 0.9 for rural Nigeria.

Food consumption patterns in Lesotho, based on Household Budget Survey data indicate that maize meal is the staple across low, middle and high income groups. Seventy percent of calorie and protein availability is from maize meal and other cereals. The per capita per day availability of calorie among households in the low income group is only 1844. A price subsidy or income transfer policy can be used to help low income households meet the nutritional targets of 2500 calories per capita per day. This programme, however, has budgetary implications. In this study the estimated price and income parameters are also used to determine a least cost cheap food policy.

The cost minimizing solution of the least cost cheap food policy indicate that a maize meal price subsidy of 31 percent is the cheapest way to achieve nutritional targets of the low income households. If this subsidy is applied to total quantity of maize meal purchased by the low income households, the cost of the programme will be 24 million maloti. The cost of the programme increases to 34 million maloti if maize meal consumption by all income groups is subsidised.

The results of an income transfer policy indicate that an income expansion of 16.3 percent is needed to allow low income consumers to achieve the nutritional targets. The total cost of this programme will be 36 million maloti.

The simulation results indicate that increasing the price of maize meal to attain self-sufficiency in maize production will have adverse nutritional impacts. If households are net consumers of maize, that is household consumption of maize is higher than household production, the objective of attaining self sufficiency in maize production may not be an appropriate policy. On the other hand, should the government of Lesotho try to increase the production of some other agricultural commodity in which it has a

comparative advantage, for example fruits and vegetables, there is no reduction in calories and protein availability even if consumer prices increase by 50 percent.

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## **Chapter 1**

### **INTRODUCTION**

#### **1.1 Problem Situation**

A major challenge for the government of a developing country, is to balance the food and nutrition needs of its population along with the development requirements of its agricultural sector. Agricultural and food policy objectives can often be in conflict. For example, an agricultural policy that establishes high prices to encourage increased agricultural and food production could penalize low income consumers especially the urban poor and rural landless. Alternatively, a low price policy is a disincentive to producers while assisting the population to meet its food and nutrition needs.

The problem is to be able to measure the impacts of various price and related policies on primary production and food consumption. There is often insufficient information on food consumption for different income groups and knowledge of responsiveness to price and income changes.

Effective development policy for the agri-food sector requires a comprehensive approach to be taken which requires information on both demand and supply. Agri-food development policies, however, tend to stress the production side and not the demand side. This study focuses on food consumption, and hence the demand side in the issue of developing the agricultural sector.

## **1.2 The Problem in Lesotho**

Lesotho is a small country in Southern Africa with a population of approximately 1.8 million. A vast majority, nearly 85 percent, reside in rural areas. The country has become increasingly dependent on food imports and food aid. The government has experimented with restructuring the agricultural sector with the help of donor agencies in an attempt to increase the level of food self-sufficiency. The evidence, however, is that major food products are produced at a level far below national requirements. Forty percent of Lesotho's food is imported, some in the form of food aid (The Ministry of Agriculture, Lesotho, 1990).

Lesotho only produces approximately 60 percent by weight of the food it consumes. The nation's land resources are limited; only 13 percent of the total area is suitable for crop production. Studies on employment in Lesotho generally conclude that off-farm migrant employment in the Republic of South Africa (RSA) has been detrimental to agricultural productivity. Nearly 20 percent of the total labour force and 50 percent of able bodied male workers were employed in RSA mines (Fourth Five Year Development Plan, 1987). This results because the return to labour from mining employment is at least three times higher than from agriculture, however, opportunities for migrant employment are declining. It is predicted that in the near future nearly 15,000 migrant labour will return to Lesotho (Becker,1989). These workers will have to be integrated into agriculture or other occupations. This trend along with the growth of landless households that has doubled from 12.7 percent in 1970 to 26.3 percent in 1986 has major implications for future development policies. Developing appropriate food and nutrition policies will therefore be a particular challenge superimposed on the



long-run challenge to improve the standard of living in the country.

Government policies are, currently, based on the primacy of agriculture in the economy. It strongly believes that the agricultural sector can be improved to provide gainful employment to the vast majority of Lesotho's population and is the best means to overcome its social, economic and political difficulties. The importance of agriculture is recognised by the fact that it is a major contributor (nearly 20 percent) to the Gross Domestic Product (GDP). In 1990, the total GDP was 387.9 million maloti, of which agriculture's share was nearly 73.3 million maloti (Lesotho National Accounts 1980-1990). Lesotho is, however, faced with a deteriorating land base, low productivity in farming, a deficit in food production, a high degree of dependence on revenue from migrant labour, lack of an income incentive in agriculture and an institutional and management infrastructure not sufficiently well geared to deal with the problems effectively. Food production is lagging behind population growth and the skewed pattern of income distribution implies that low income households access to food may have declined. This situation is likely to worsen unless the economy grows faster and employment opportunities expand.

If development efforts are successful and translate into economic growth it will lead to an increase in household income. In order to measure the effect on food consumption both price and income effects need to be studied. The rate of economic growth, however, depends on the availability of capital which has been one of the main constraints to development. The country's poor land base and shortage of natural resources has resulted in low levels of capital accumulation. International aid has a potentially important role for economic development in Lesotho. The development

assistance in 1990 as a percentage of GNP was nearly 25 percent (World Bank, 1992).

Future agricultural production will depend on the degree of foreign assistance. Two types of development policies which have important implications for the demand side of the agri-food system are possible. They are: (a) an independent agricultural pricing policy; and (b) price subsidy or income transfer to meet the basic food needs.

(a) Independent Agricultural Pricing Policy

The nation's economy, because Lesotho is entirely surrounded by the RSA, is tied very closely to the much larger economy of the RSA. Four countries, the RSA, Lesotho, Swaziland, and Botswana are signatories to an agreement which forms the Southern African Customs Union (SACU). Lesotho's trade is primarily with the SACU. For example, in 1985, ninety six percent of Lesotho's total imports and thirty four percent of its total exports were within the SACU. Lesotho's major trading partner is the RSA and the trading relationship within the fold of the Customs Union make independent policy decisions difficult.

In the case of maize, the pricing policy of the RSA has been followed. The problem is that maize productivity is much higher in the RSA. The subsidy to farmers in the RSA results in better use of inputs resulting in higher yields. On the other hand, yields in Lesotho are low because of low levels of fertilizer use and the non adoption of high yielding varieties. Agronomic practices too are not comparable to that of the RSA farmers. The size of fields are small and cultivation practices are more labour intensive. Mechanization is at a very low level.

A similar situation exists in the production of other cereal grains, pulses

vegetables and fluid milk. For milk, the price in Lesotho cannot be significantly different from the import price and the local dairy industry can exercise pricing and marketing options only within the range established by policies formed outside the country (Mochebelele, 1987). More recently there has been an attempt to regulate imports and raise milk prices to local producers at a level above the milk price in the RSA. Should the government of Lesotho attempt to develop a domestic policy independent of the RSA that raises price of maize and milk? This would be one way to provide an incentive to expand domestic agricultural production, but what would be the effect on the consumption patterns and on the level of calorie and protein availability?

(b) Price Subsidies/Income Transfers

A change in price or income would imply changes in consumption pattern. If households cannot meet nutritional requirements under existing prices and income, price subsidy or income transfer policies can be used for achieving the recommended levels of calories. This policy, however, has budgetary implications. If the program is not administered or targeted to the desired group of households, the program can be expensive for the government. Budgetary pressures will require that cost of subsidy/income transfer programs be kept at a minimum and at the same time achieve the desired objectives. In other words a least cost food policy for meeting nutritional norms is needed. Such an attempt is made in this study.

Studies on poverty and malnutrition have shown that income redistribution in favour of the poor can lead to a lessening of malnutrition; Sahn (1988), World Bank

(1986), Pinstруп-Andersen and Caicedo (1978). Berhrman and Deolalikar (1987) show that income increases for low income households do not always translate into improvements in nutrition. This is because of changes in taste associated with the change in income. Panda (1986) argues for a need to set price targets along with income targets so as to induce a person to purchase normatively stipulated quantities when the targets are met. Gray (1982) compared targeted food subsidy with income transfer polices and found the former to be superior in meeting nutritional objectives. This empirical evidence on fighting poverty, malnutrition and income allocation of consumers suggests that, to fulfil the basic needs of the people of Lesotho, analysis should be carried out to take into account the possibility of restructuring market prices of major food commodities. Such an attempt is made in this study. Estimating the responsiveness to price and income changes can be seen as a first step in understanding the effects of the above policy changes.

### **1.3 Importance of Demand Parameters**

An attempt was made in this study to analyze the above mentioned policies by estimating a system of food demand equations for major food groups. Demand parameters can be analyzed in both aggregated and disaggregated forms. Timmer (1981), argued that the former helps in understanding the macro linkages in the agri-food sector. This can help in designing appropriate polices that influence domestic production, consumption and international trade. The analysis at a disaggregated level is useful to trace the effects of income and price changes on the level and pattern of consumption. In the case of Lesotho, the knowledge of demand parameters based on

income classification would be helpful in determining whether an income support policy or price subsidy is a better means of meeting nutritional targets for the poor households. A complete system of demand equations describing household allocation of expenditure among some set of consumption bundles help in estimating the demand elasticities that are theoretically plausible and consistent with observed behaviour. These demand estimates, besides providing an information base to characterize the food demand structure, also provide a complete and consistent framework for evaluating the impact of policy changes and behavioural differences between households in cross-sectional studies.

Despite the obvious importance no attempt has been made to estimate a complete set of demand parameters for Lesotho. Partial demand elasticities have been estimated but without any reference to utility theory. These, however, cannot be used for studying the effects of changes in prices of different food groups and the varying levels of income among households.

A rural household consumption and expenditure survey was conducted in 1967-69 but was processed only for demographic characteristics. Subsequently an urban household budget survey was conducted in 1972/73 but was mainly used for the construction of cost of living indices.

A household allocates total expenditure among a set of consumption categories. Since food is the single most important item in a consumer's budget, especially in a developing country like Lesotho, an accurate estimate of food demand parameters is needed. In this study price and income elasticities for major food groups in Lesotho are estimated.

#### **1.4 Purpose and Objectives**

The primary purpose of the study is to analyze the impacts of alternative price and income policies on the nutritional well being of low income households in Lesotho. In order to achieve this a set of demand parameters for major food groups is estimated and the results are used for the following specific objectives,

- (i) to examine the implications of a price reform policy on calorie and protein consumption.
- (ii) to compare price subsidy with income transfer as alternative policies and discuss the budgetary implications in determining the least cost food policy for the fulfilment of nutritional requirements of low income households.

A second purpose of the study is to provide information on food consumption patterns.

#### **1.5 Scope and Organization of the Study**

In order to meet the objectives of the study it is postulated that a household's consumption of food depends on income and prices. The scope of this study is limited to food expenditure. It does not include other household expenditures like clothing and housing.

In Chapter 2 a general overview of Lesotho, its agriculture and trade, income distribution and food consumption patterns is outlined. In Chapter 3 the focus is on the theoretical issues underlying demand studies. It begins with the demand models which are mainly single equation methods and follows with a discussion of the systems

approach. The literature on demand studies is discussed and this forms the basis of selection of the theoretical model for analysis. This is followed by a section describing the Almost Ideal Demand System (AIDS) model which is used for empirical analysis in this research. The generation and characteristics of data from the household budget survey, 1986/87 is discussed in Chapter 4. The estimation procedure of the empirical model and the results are discussed in Chapter 5. Using the estimated parameters different policy options and their implications on calorie and protein consumption of households in Lesotho are analyzed in Chapter 6. The summary, conclusions and limitations of the study are outlined in Chapter 7.

## **Chapter 2**

### **BACKGROUND TO THE STUDY AREA**

#### **2.1 Introduction**

Lesotho is a small densely populated country, surrounded by the Republic of South Africa (RSA). The per capita GDP in 1990 was 860 maloti. Traditional rural activities provide an important source of income for about 85 percent of the people. The remaining 15 percent of the population is mainly urban with employment in the public sector, in industry and services.

Only 10 percent of the country is suited for crop cultivation; the rest is mountainous which is suitable for grazing. United Nations Development Programme (UNDP) 1990, has identified a potential to develop hydroelectric generation stations for exporting electricity to RSA. The Highlands Water Development project is under construction. Otherwise, it is a country with few natural resources. Rapid population growth, deteriorating soil and declining agricultural yields have over the years led to a situation where the country is no longer able to provide enough food for its people.

Of the total land area of 11,716 square miles about one quarter of the country in the west and south is lowlands, varying in height from 5,000 to 6,000 feet. The remainder of the country is mountainous with peaks that reach over 11,000 feet. Most of the land in the lowlands is arable. The mountains primarily are suited for grazing and have a potential for generating hydroelectricity and clear mineral water.



## **2.2 Agriculture**

Agricultural production is mainly dependent on rainfall as there is limited irrigation. The average rainfall is 29 inches a year which normally is sufficient for farming and grazing. From time to time, however, extended droughts cause crop failures and loss of livestock. In the long term average, droughts have occurred about one year in five. Most rain occurs in the growing season but heavy downpours and hailstorms are common, causing damage to soil and crops. In winter the weather in the mountains is too severe for effective grazing and livestock are placed under stress. Most of the livestock are moved to the lowlands. Very limited supplemental feeding occurs which adds further stress.

Extreme pressure on land, primitive methods of cultivation, and unchecked grazing have over the years led to acute erosion problems. Lesotho's erosion problems have long been recognized. Since the mid 1930s the Ministry of Agriculture has carried out soil conservation programmes, but with limited funds little has been achieved.

The major crops grown in the country are maize, sorghum, wheat, beans and peas. Production trends show that crop productivity had been declining till 1986/87. The Fourth Five Year Development Plan (1985-90) focused on improving the agricultural productivity through adoption of improved agricultural varieties and increased use of fertilizer. This has resulted in improved yields during 1988/89 to 1990/91. Table 2.1 shows the average yield for the major crops for the period 1980-1994. Over the ten year period yields of maize and sorghum have varied slightly. Maize yields increased especially in the years 1988-1990. These years coincided with good weather and special incentives offered by the government to increase yields of staples. Wheat yield has been

relatively stagnant over the ten year period.

Table 2.1 Average Yield of Major Crops Grown in Lesotho (tonnes/ha)

Year	Maize	Sorghum	Wheat	Beans	Peas	Coarse Grains
1980	0.96	0.97	0.97	0.43	0.68	0.96
1981	0.88	0.80	0.85	0.38	0.65	0.86
1982	0.83	0.52	0.58	0.29	0.43	0.73
1983	0.65	0.66	0.57	0.25	0.29	0.65
1984	0.67	0.76	0.50	0.11	0.41	0.69
1985	0.75	1.22	0.58	0.25	0.32	0.88
1986	0.67	0.70	0.76	0.20	0.25	0.68
1987	0.92	0.92	0.61	0.18	0.31	0.92
1988	1.17	0.67	0.61	0.24	0.38	1.03
1989	1.31	0.48	0.65	0.39	0.15	1.08
1990	1.83	0.41	0.56	0.65	n.a	1.08
1991	0.80	0.43	0.80	n.a	n.a	0.65
1992	0.91	0.71	0.68	n.a	n.a	0.85
1993	1.01	0.71	0.68	n.a	n.a	0.95
1994	1.22	0.86	0.80	n.a	n.a	1.14

Source: For maize, sorghum, wheat, and coarse grains - PS&D, USDA, 1994. For beans and peas Lesotho Agricultural Situation Report, 1990 and Fifth Five Year Development Plan, 1992.

Note: n.a = not available.

Table 2.2, shows the percent self-sufficiency for different food grains produced in the country. Over a period of six years (1984 - 1990) only fifty percent of the traditional staple maize requirement has been domestically produced. Wheat self-sufficiency too has been low during this period but improved from 15 percent in

1985/86 to 40 percent in 1989/90. Overall, domestic food grain production has fallen short of domestic consumption.

Table 2.2 Self-Sufficiency of Major Food Grains in Lesotho (percent)

Year	84/85	85/86	86/87	87/88	88/89	89/90
Maize	46	42	46	55	52	50
Wheat	24	15	23	19	30	40
Sorghum	98	97	97	94	98	98
Pulses	76	70	68	81	83	87

Source: Lesotho Agricultural Situation Report (1990) and Fifth Five Year Development Plan (1992).

The Food Self-Sufficiency Programme (FSSP) has been one of the government's policy initiatives to improve agricultural production through the introduction of seeds of high yielding varieties and improved agronomic practices.

Planned development efforts to improve the standard of living started with the inception of the First Five Year Plan in 1970. The Fourth Five Year Plan (1986/87-1990/91), places emphasis on developing the agricultural sector. The main objective is to provide better living conditions for the people through accelerated development and equitable distribution of wealth. The government, in order to raise agricultural production plans to change the pricing policies that are designed to encourage parity pricing with the RSA for agricultural commodities.

### 2.2.1 Agricultural Pricing Policy

Marketing of grains and pulses has changed over the years. Prior to 1974, this

was mostly the responsibility of private traders (Tuoane, 1989). Prices for farmers' products were set by the traders and bartering was very common. The producers were at a disadvantage because instead of cash payments they usually received overpriced commodities from the private traders in exchange for their marketable surplus. Commodity transactions resulted in little or no savings and therefore leading to no investment in the farm. In response, the government assuming exploitation decided to regulate agricultural markets. Prices of maize and sorghum were first regulated; wheat and pulses were included later. The Produce Marketing Co-operative (PMC) was started in 1975 to facilitate trading in grains. In 1981, the PMC was dissolved and Coop Lesotho took over the produce marketing functions. At present Coop Lesotho handles the marketing of grains and pulses.

Producer price has been determined by two different methods: cost-plus pricing and parity pricing. Cost-plus pricing has not been used in recent years, while parity pricing is more commonly used. The farm gate price in Lesotho is set after the RSA maize marketing board releases its grain prices. Transportation cost from the nearest point in the RSA to Lesotho and the marketing margin is added to the fixed import price determined outside Lesotho. This becomes the regulated price at which Coop Lesotho buys grain from farmers. Prices, therefore are the same as those in the RSA except for transportation costs.

The Fourth Five Year Development Plan states that the government will selectively modify this approach by providing price incentives in conjunction with import supply determination in order to stimulate production of staple grains and horticultural products. This means that when it becomes necessary to establish

independent prices border control measures will be established. These changes will affect consumers as a result of increased prices, which in turn will depend on the type of border protection used. In order to determine how consumers would respond to these changes, knowledge of demand parameters is required.

### 2.3 Income Distribution

Information on the distribution of income among households is important for the formulation of food policies. There are three broad ways to measure and illustrate income distribution.

The first measure shows the percentage distribution of monthly income received by each 25 percent of the population. Thus, the population is divided into four quartiles and the percentage of income received by each is calculated. The income distribution among households for each quartile of population is shown in table 2.3.

Table 2.3 Income Distribution in Lesotho Households

Income Group ( unit = maloti )	Percent Income	Percent Population	Cumulative Population	Accumulated Income ( percent )
0 - 40	1.5	25	25	1.5
41 - 112	9.2	25	50	10.7
113 - 263	28.2	25	75	38.9
264 - >	61.1	25	100	100.0

Source: Distribution of Income and Consumption in Lesotho- A Study Based on the 1986/87 Household Budget Survey Data, 1989.

The data from the Household Budget Survey (HBS) shows that the lowest 25

percent of the population survive on only 1.5 percent of the country's total income. The lowest 50 percent share only 10.7 percent of the income, while the upper 50 percent receive 89.3 percent of the income. This represents an extremely uneven distribution of income. The lowest 75 percent of the households receive only 38.9 percent of the total income. The top 25 percent receive 61.1 percent of total income.

Depicting income distribution of households by using a Lorenz curve is the second measure of income distribution. The cumulative percentage of population and cumulative percentage of their income is plotted, beginning from the lower left corner of the graph and beginning at the lowest income level. The 45° line OE, from the lower left corner to the upper right corner is the line of perfect equality, therefore the farther the Lorenz curve is from this line the greater the inequality. The Lorenz curve, however is just an illustration of the inequality that exists but is not a precise measure of it.

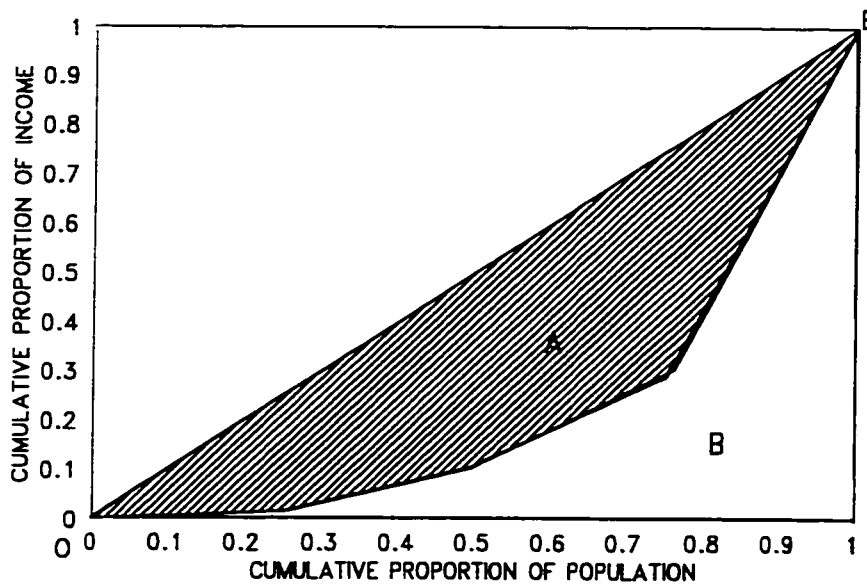


Figure 2.1 Lorenz Curve Depicting Income Distribution for Lesotho.

The third measure is the Gini Coefficient which quantifies the magnitude of the inequality and makes possible international comparisons. It is defined as the ratio of the area between the 45° OE in figure 1 and the Lorenz curve represented by the shaded area to the entire area below the 45° line. The ratio of area A/(A+B) from figure 2.1 gives a coefficient 0.62 for Lesotho suggesting a large inequality or a skewed distribution of income. On a rural-urban basis these coefficients are 0.61 and 0.64 respectively. The closer this coefficient is to zero, the more equitable is the distribution of income. As the coefficient approaches unity the inequality increases. Past estimates of Gini coefficients based on 1967/69 Rural Household Consumption and Expenditure Survey and 1972/73 Urban Household Budget Survey suggest that inequality of income distribution has increased. The comparative Gini coefficients from various surveys are outlined in table 2.4.

Table 2.4 Gini Coefficients by Regions in Lesotho.

	1967/69	1972/73	1986/87
Urban	na	0.50	0.64
Rural	0.23	na	0.61
All	na	na	0.62

Source: " Options for a Dependent Economy ", International Labour Office, 1979 for gini coefficients in 1967/69 and 1972/73. For 1986/87, the coefficients were estimated from the HBS data.

#### 2.4 Nutritional Levels of Lesotho Households

The eligible group for nutritional reforms can be identified by using the existing levels of calorie intake. The per capita per day calorie and protein availability for

households in different income groups is shown in table 2.5. The data for calculation of calories and proteins are taken from Nutrient Value of Some Common Foods, Health and Welfare Canada, 1988 and Food Composition Tables for use in Africa, FAO, 1968.

Table 2.5(a) Per Capita Per Day Calorie and Protein Availability from Different Food Groups for Households in Rural Areas of Lesotho.

Food Group	Low Income		Middle Income		High Income	
	Calorie	Protein (grams)	Calorie	Protein (grams)	Calorie	Protein (grams)
Cereals	318.96	10.46	432.01	14.06	505.47	17.11
Maize	1386.16	34.91	1574.51	38.66	1636.91	41.23
Meat	36.57	4.19	37.06	4.46	46.34	4.99
Milk	23.66	1.14	26.86	1.29	32.23	1.55
Eggs	6.42	0.51	5.73	0.46	5.50	0.44
Fats & oil	71.59	0.00	91.38	0.01	111.35	0.01
Fruits & veg.	28.35	1.26	30.16	1.34	26.14	1.15
Total	1871.71	52.47	2197.71	60.28	2363.94	66.48

Source: Calculated from HBS (1986/87).

In rural areas, table 2.5 (a), both calorie and protein availability increase as income rises. Most of the calorie increase is from increased consumption of maize in spite of the fact that income has increased. This means that demand for maize increases even at high levels of income. Across income groups, the contribution of maize to total calorie supply is highest in low income households at 74.05 percent. Middle income households get 70.35 percent of the total calorie from maize while high income households get 69.24 percent. Although there is a decline in the percentage of calorie supply from maize with a rise in income levels, it is still the staple food crop of



Lesotho.

In urban areas other than Maseru, table 2.5(b), maximum calorie availability is in high income groups but this is lower than the total calories of income groups in rural areas. The contribution of maize to total calorie consumption varies from 65.21 percent in low income households to 64.84 percent in high income households.

Table 2.5(b) Per Capita Per Day Calorie and Protein Availability from Different Food Groups for Households in Other Urban Areas of Lesotho.

Food Group	Low Income		Middle Income		High Income	
	Calorie	Protein (grams)	Calorie	Protein (grams)	Calorie	Protein (grams)
Cereals	368.66	11.65	441.60	15.84	562.28	14.77
Maize	1183.13	29.80	1387.21	32.13	1463.12	35.81
Meat	53.67	5.96	62.03	6.66	72.87	7.95
Milk	49.84	2.40	56.57	2.72	41.67	2.00
Eggs	6.86	0.55	4.98	0.40	5.46	0.44
Fats & oil	107.51	0.01	117.13	0.01	85.41	0.02
Fruits & veg.	44.60	1.98	38.60	1.97	25.45	1.20
Total	1814.27	52.35	2108.12	59.73	2256.26	62.19

Source: Calculated from HBS (1986/87).

Households in Maseru, table 2.5(c), have almost similar calorie and protein availability as do households in rural areas, but the source varies. Maize still dominates other food groups with calorie supplies of 59 to 64 percent.

**Table 2.5(c) Per Capita Per Day Calorie and Protein Availability from Different Food Groups for Households in Maseru.**

Food Group	Low Income		Middle Income		High Income	
	Calorie	Protein (grams)	Calorie	Protein (grams)	Calorie	Protein (grams)
Cereals	390.61	12.67	548.41	18.05	669.84	18.43
Maize	1161.91	29.26	1395.44	33.63	1362.02	32.78
Meat	87.01	8.25	62.49	6.39	92.80	10.17
Milk	45.78	2.20	44.75	2.15	60.19	2.90
Eggs	9.29	0.74	6.53	0.52	5.75	0.46
Fats & oil	132.33	0.01	92.35	0.01	110.89	0.03
Fruits & veg.	19.93	0.79	33.15	1.67	16.05	0.58
Total	1846.86	53.92	2183.12	63.42	2317.54	65.35

Source: Calculated from HBS (1986/87).

## 2.5 Trade

As explained in Chapter 1 the RSA is Lesotho's major trading partner. Of the total imports in 1988, ninety six percent was from the RSA while eighty seven percent of the total exports were to the RSA.

### 2.5.1 Agricultural Trade

Lesotho imports a high percentage of the total food consumed. Table 2.6 shows the value of Agricultural imports for the period 1986-92. Cereals and cereal preparations constituted nearly one third of the total food and live animal imports. The government is attempting to increase production and reduce the dependency on imports of cereals. Fruits and vegetables account for nearly 18 percent of total imports.

Table 2.6 Value of Imports of Food Commodities (1986-92), in '000 \$

	1986	1987	1988	1989	1990	1991	1992
Live animals	5116 (5.2)	5755 (5.5)	8290 (6.4)	6190 (4.9)	7243 (5.5)	9550 (6.9)	9850 (7.0)
Meat and meat prep.	5656 (5.7)	7240 (6.9)	7840 (6.1)	8300 (6.6)	8700 (6.6)	8750 (6.4)	9500 (6.8)
Dairy products and eggs	5110 (5.2)	5255 (5.1)	6015 (4.7)	5120 (4.1)	5000 (3.8)	5070 (3.7)	4950 (3.5)
Other ag. products	1060 (1.1)	700 (0.7)	700 (0.5)	700 (0.6)	700 (0.5)	700 (0.5)	700 (0.5)
Cereals and preparations	39838 (40.6)	32081 (30.8)	44192 (34.3)	39302 (31.4)	40212 (30.6)	44353 (32.3)	45153 (32.3)
Oilseed prod. and feed	14 (0.0)	50 (0.0)	70 (0.1)	90 (0.1)	90 (0.1)	90 (0.1)	90 (0.1)
Vegetable oils	7600 (7.7)	7600 (7.3)	7600 (5.9)	7600 (6.1)	7600 (5.8)	7600 (5.5)	7600 (5.4)
Tobacco and products	6471 (6.6)	7000 (6.7)	7500 (5.8)	8000 (6.4)	8500 (6.5)	8500 (6.2)	8500 (6.1)
Fruit and vegetables	8187 (8.4)	14540 (13.9)	19985 (15.5)	23415 (18.7)	25815 (19.6)	26015 (18.9)	26515 (18.9)
Sugar and honey	9370 (9.5)	10055 (9.6)	11275 (8.7)	11925 (9.5)	13325 (10.1)	12325 (8.9)	12525 (8.9)
Coffee, tea, cocoa, & spices	2894 (2.9)	4370 (4.2)	5370 (4.2)	4570 (3.6)	4200 (3.19)	4250 (3.1)	4140 (3.0)
Other beverages	6777 (6.9)	9528 (9.2)	10050 (7.8)	10000 (7.9)	10200 (7.7)	10200 (7.4)	10300 (7.4)
<b>Total Food and Live Animals</b>	<b>98093 (100)</b>	<b>104174 (100)</b>	<b>128887 (100)</b>	<b>125212 (100)</b>	<b>131585 (100)</b>	<b>137403 (100)</b>	<b>139823 (100)</b>

(Figures in parenthesis represent percentage of total food imports)

Source: USDA, 1994.

Table 2.7 shows the overall agricultural trade balance for the period 1984-1991.

Lesotho has been a net importer of agricultural products during this period. During

1990 and 1991 the value of agricultural imports was approximately ten times greater than the value of total agricultural exports.

Table 2.7 Agricultural Trade Balance for Lesotho, 1984-1991 (Million \$)

	1984	1985	1986	1987	1988	1989	1990	1991
Ag. Exports	20	13	10	15	25	21	13	14
Ag. Imports	145	99	105	112	137	133	140	145
Ag. Trade Balance	-125	-86	-95	-97	-112	-112	-127	-131

Source: USDA, 1994.

## 2.6 Summary

Lesotho is a country with few natural resources. Nearly eighty five percent of the population depend directly or indirectly on the agricultural sector. Agricultural production has been stagnant for the past few years and the country is a net importer of agricultural products.

There is inequality in the distribution of income. The lowest 25 percent of the population survive on only 1.5 percent of the country's total income. The lowest 50 percent share only 10.7 percent of the income, while the upper 50 percent receive 89.3 percent of the income.

The calorie availability among households estimated from the household budget survey indicate that low income households have a low level of calorie consumption. It varies from 1814 calories per capita per day among low income households to a high of 2363 calories per capita per day in the case of high income households.

## **Chapter 3**

### **DEMAND THEORY AND THE EMPIRICAL MODEL**

The purpose of this chapter is to explain demand theory and its relevance to its application to demand analysis. The Almost Ideal Demand System (AIDS) model which is used as the empirical model in this study is also discussed in this chapter.

#### **3.1 Introduction**

The literature on demand studies reveal that there are basically two approaches to demand analysis.

- (1) directly specified demand models or a single equation approach, and,
- (2) utility based demand models or a demand system approach.

The directly specified demand models, do not rely on the economic theory of consumer behaviour. They are older in tradition and recognize only the importance of prices and incomes. The demand for each commodity is usually estimated in isolation of the other commodities. The latter, utility based demand models, are derived by postulating that the consumers behave in a way to choose the consumption basket which will maximize their utility function subject to a budget constraint. The theoretical importance that demand for each commodity depends on own price, cross prices and on income is taken into account in these models. This results in a complete system of demand equations. It describes the household's allocation of expenditure among some

well defined and exhaustive set of consumption categories. The data set for the estimation of such a system would be large, if every single commodity which is to be consumed is included separately in the model. Estimation of such a system would be impractical. However, theory provides a way around this, for the estimation of a subset of commodities. In a latter section of this chapter it will be shown that separability assumptions allow the use of the demand system approach to a subset of consumption categories, such as the demand for food. The systems approach provides empirical demand analysis with a conceptual framework, namely the neoclassical utility theory, to deal with the interdependence of demand for various commodities. It therefore, allows to impose and test cross equation restrictions such as symmetry relationship. The single equation approach is usually based on ad hoc specifications which do not necessarily adhere to economic theory. This approach, however, has great flexibility for modelling the demand for single commodities. In addition data requirements for single equations approach are less demanding and this method of estimation is still being used by researchers. However, the obvious drawback is that cross-commodity relationship cannot be determined simultaneously. This is overcome in the demand system approach.

### **3.2 Theory of Consumer Behaviour**

Consumer theory is based on the assumption that individuals maximize their utility subject to their budget constraint. A consumer is assumed to have preferences which are defined by a utility function. For a two commodity consumption bundle these preferences can be shown by indifference curves. It is also assumed that the consumer seeks to maximize utility subject to a budget constraint in order to decide on an optimal

choice bundle for consumption. The axioms required for preferences to be a representable utility function and those needed to establish the existence of a continuous utility function are:

- (1) completeness or comparability: for all  $x, y$  in  $X$  either  $x \geq y$  or  $y \geq x$  or both.
- (2) reflexivity: for all  $x$  in  $X$ ,  $x \geq x$ .
- (3) transitivity or consistency: for all  $x, y, z$  in  $X$  if  $x \geq y$ ,  $y \geq z$  then  $x \geq z$  and,
- (4) continuity.

In addition, axioms of monotonicity, strict convexity and differentiability are required for the maximization problem to yield a unique solution.

### 3.2.1 Utility Maximization Approach

This approach is based on the fact that the consumer can choose an affordable bundle of commodities that provide the maximum satisfaction. The objective is to maximize utility subject to a fixed level of income. The utility maximization problem faced by a consumer can be represented by,

$$\text{Max } u(q) \tag{3.1}$$

subject to,

$$pq \leq m \tag{3.2}$$

where  $u$  is a strictly increasing, strictly quasi-concave and twice differentiable utility function,  $p$  represents a vector of prices,  $q$  is the vector of commodity bundles and  $m$  is the consumers total expenditure. The budget constraint represented by equation 3.2 implies that the consumer takes the prices of all goods as given and total expenditure on  $n$  goods ( $p_1q_1 + \dots + p_nq_n$ ) must equal a fixed total  $m$ . Thus,  $p_1q_1$  is the expenditure

on the  $i^{\text{th}}$  good. Solution of equation (3.1) results in a set of  $n$  equations known as the Marshallian Demand function. It implies that the demand for the  $i^{\text{th}}$  commodity is a function of its own price, cross prices and income.

The utility function  $u(q)$  expresses utility of the quantity consumed and is called the direct utility function. Substituting the Marshallian demand function in (3.1) gives,

$$\begin{aligned} u &= f[q_1(m, p_1, \dots, p_n), \dots, q_n(m, p_1, \dots, p_n)] \\ &= v(m, p) \end{aligned} \tag{3.3}$$

The relationship shown in (3.3), above, is called an indirect utility function. It expresses utility in terms of prices and income as opposed to the direct utility function which expresses utility in terms of quantity. The direct and indirect utility functions; (3.1) and (3.3), represent the same preference ordering. This is explained by the fact that maximization of  $u$  with respect to the  $q$ 's, with given prices and income, or minimization of  $v$  with respect to prices and income result in the same demand functions. The indirect utility function has the following properties<sup>1</sup>:

- (1) continuous at all strictly positive prices and positive income,
- (2) non-increasing in prices, i.e., when prices increase utility cannot increase,
- (3) non-decreasing in  $m$ , i.e., when income increases utility cannot decrease,
- (4) quasi-convex in prices and
- (5) homogeneous of degree 0 in prices and income.

The indirect utility function approach allows the derivation of demand function by using Roy's identity which is defined as the ratio of the partial derivative of the indirect utility function with respect to price to the partial of indirect utility function

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<sup>1</sup> For details, see Geoffery (1991), Varian (1990)



with respect to  $m$ .

$$-\frac{\partial v/\partial p_i}{\partial v/\partial m} = q_i \text{ for } i = 1, \dots, n. \quad 3.4$$

### 3.2.2 The Expenditure Function Approach

The derivation of demand function here, assumes that preferences can be defined in terms of a cost function. The prices that a consumer faces is fixed and the cost (or expenditure) function is derived by assuming that the consumer is interested in minimizing the cost of attaining utility ( $u$ ) at fixed prices. This problem can be defined as,

$$e(u, p) = \min p \cdot q \quad 3.5$$

subject to,

$$u(q_1, \dots, q_n) = u \quad 3.6$$

where  $e(u, p)$  is the minimum expenditure necessary to achieve utility level  $u$  associated with the consumption of the optimal quantities  $q_i$  at prices  $p_i$ , ( $i = 1, \dots, n$ ). Expenditure minimization problem is the dual of the utility maximization problem.

The properties of the expenditure function are,

- (1) non-decreasing in prices,  $p$ ,
- (2) homogeneous of degree 1 in  $p$ ,
- (3) concave in  $p$ ,
- (4) continuous in  $p$  for all  $p \gg 0$ ,
- (5)  $h_i(u, p) = \partial C(u, p) / \partial p_i$  for  $i = 1, \dots, n$ .

If,  $m$  is the total budget to be allocated, then  $m$  is the cheapest way of reaching

whatever  $u$  can be reached at  $p$  and  $m$ , so that  $e(u,p) = m$ . The solution to the minimization problem leads to Hicksian demand function, as shown below.

$$\partial C(u,p)/\partial p_i = h_i(u,p) = q_i \text{ for all } i = 1,\dots,n \quad 3.7$$

These demand functions are constructed by compensating the consumer for varying prices to keep the consumer at a fixed level of utility. Because utility is not directly observable, the Hicksian demand functions are not directly observable. However, any cost function with the correct properties can serve as alternative to the direct utility function. Deaton (1986), has shown that utility functions can be recovered from cost functions.

Inverting the cost function  $e(u,p) = m$ , leads to indirect utility function  $u = v(m,p)$ . Substituting the indirect utility function (3.3) in (3.7) gives  $q_i$  in terms of  $p$  and  $m$ , i.e;

$$q_i = h_i(u,p) = h_i[v(m,p),p] = q_i(m,p) \quad 3.8$$

where  $q_i(m,p)$  is the Marshallian demand function. Conversely, the Hicksian demand function can be derived by substituting the cost function  $e(u,p) = m$  in (3.2).

$$q_i = q_i(m,p) = q_i(C(u,p),p) = h_i(u,p) \quad 3.9$$

Equation (3.9) shows that the Marshallian and Hicksian demand functions are equal at an appropriate level of income which is the minimum income necessary to achieve the desired level of utility at given prices. Therefore, the solution for an optimally demanded bundle can be expressed in two ways. Firstly, as a solution to the utility maximization problem and secondly as a cost minimization problem. Both these approaches would lead to identical choices.

### The Slutsky Equation

Equation 3.9 can also be used to derive the Slutsky equation. Differentiating identity 3.9 with respect to  $p_i$  and evaluating at  $p^*$  gives rise to

$$\frac{\partial q_i(m, p)}{\partial p_i} = \frac{\partial h_i(v(p, m), p)}{\partial p_i} - \frac{\partial q_i(m, p)}{\partial m} q_i \quad 3.10$$

The components of the Slutsky matrix ( $S_{ij}$ ) can be shown as,

$$S_{ij} = \frac{\partial h_i(u, p)}{\partial p_j} = \frac{\partial q_i(m, p)}{\partial p_j} + \frac{\partial q_i(m, p)}{\partial m} * q_j \quad 3.11$$

The Slutsky equation shows that the total effect of a price change can be broken into two separate effects. The first represented by the substitution effect and the second by income effect. The total price effect is the sum of substitution effect and income effect. The substitution effect is always negative. The income effect on the other hand is positive for normal goods and negative for inferior goods.

### 3.3 Properties of Demand Functions<sup>2</sup>:

The properties of demand functions take the form of restrictions on the derivatives of demand functions. These are,

- (i) adding-up,
- (ii) homogeneity,
- (iii) symmetry, and
- (iv) negativity.

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<sup>2</sup> For details refer Varian (1992) and Geoffery (1991), Thiel (1980), Deaton and Muellbauer (1980b).

### 3.3.1 Adding-up

The adding-up restriction suggests that expenditure on individual commodities must add up to total expenditure. The budget constraint defines this restriction, i.e. if the budget share of the  $i^{\text{th}}$  commodity is  $w_i = p_i q_i / m$ , it is easy to see that  $\sum w_i = 1$ , i.e. the sum of the budget shares equal one.

Differentiating the budget constraint (3.2) with respect to  $m$  gives,

$$\sum p_i \frac{\partial q_i}{\partial m} = \sum \frac{\partial(p_i q_i)}{\partial m} = 1 \quad 3.12$$

where  $p_i q_i$  is the expenditure on good  $i$ .  $\partial(p_i q_i) / \partial m$ , is called the marginal propensity to consume of good  $i$  ( or its marginal budget share). The marginal budget share,  $\theta$ , like the average budget share,  $w_i$ , sums to one, but unlike  $w_i$ , it can be negative if  $i$ , is an inferior good. This can be expressed in elasticity form by defining the income elasticity as,

$$\eta_i = \frac{\partial q_i}{\partial m} \frac{m}{q_i},$$

and,

$$w_i \eta_i = \frac{p_i q_i}{m} \frac{\partial q_i}{\partial m} \frac{m}{q_i} = p_i \frac{\partial q_i}{\partial m} = \frac{\partial(p_i q_i)}{\partial m}$$

that is,

$$w_i \eta_i = \theta_i \quad 3.13$$

$$\text{or, } \eta_i = \theta_i/w_i \quad 3.14$$

since,  $\sum \theta_i = 1$ , the sum of budget share weighted by income elasticity is equal to unity, i.e.,  $\sum_i w_i \eta_i = \sum \theta_i = 1$ . This condition is known as the engel aggregation condition.

The effect of a price change assuming other price to be constant is defined as the cournot aggregation. The partial differentiation of the budget constraint with respect to  $p_j$ , gives,

$$\sum_j p_j \frac{\partial q_i}{\partial p_j} + q_j = 0$$

or,

$$\sum_{j=1}^n p_j \frac{\partial q_j}{\partial p_j} = -q_j, \quad j = 1, \dots, n. \quad 3.15$$

Re-arranging the right hand side and left hand side of (3.15) gives the mathematical representation of cournot aggregation condition as,

$$\sum_{i=1}^n w_i e_{ij} = -w_j, \quad j = 1, \dots, n. \quad 3.16$$

where,  $e_{ij}$  is the cross elasticity of commodity  $i$  with respect to commodity  $j$ .

Thus, the engel aggregation condition states that the weighted sum of income elasticities should be equal to one, and the cournot condition states that the sum of own price and cross price elasticities of the  $j$ th commodity ( $j = 1, \dots, n$ ) all weighted by their respective budget shares, should be equal to the negative of the expenditure share of the  $j$ th commodity. The engel condition provides only one restriction on the coefficients of

the demand equations. The cournot restriction on the other hand is based on n prices and therefore, specify n conditions that must be satisfied by the parameters of the demand equation.

### 3.3.2 Homogeneity

Homogeneity implies that if prices and income change by the same proportion, the quantity demanded remains unchanged. Thus, demand functions are homogeneous of degree zero in prices and income. This assumes that there is no money illusion and all that a consumer cares about is the relative prices and real income which do not change when all prices and income change by the same proportion.

Taking a partial differential of the demand function with respect to prices and income gives,

$$\sum_{j=1}^n p_j \frac{\partial q_j}{\partial p_j} + m \frac{\partial q_j}{\partial m} = 0, \quad j = 1, \dots, n.$$

In elasticity form this restriction states that the sum of own and cross price elasticities and income elasticity of a commodity is zero.

That is,

$$\sum_{i=1}^n e_{ij} + \eta_i = 0, \quad i = 1, \dots, n$$

### 3.3.3 Symmetry

The symmetry restriction implies that the matrix, S, of Slutsky substitution terms (or compensated price derivatives), defined as  $S_{ij} = \partial h_i(u, p) / \partial p_j$  is symmetric. It also

implies that the partial derivatives are symmetric. This condition can be expressed as,

$$\frac{\partial h_i}{\partial p_j} = \frac{\partial^2 C}{\partial p_j \partial p_i} = \frac{\partial^2 C}{\partial p_i \partial p_j} = \frac{\partial h_j}{\partial p_i}$$

In elasticity form this restriction is expressed as,  $w_i (e_{ij} + \eta_i w_j) = w_j (e_{ji} + \eta_j w_i)$  for all  $i$  not equal to  $j$ .

### 3.3.4 Negativity

The negativity condition states that demand for a good always falls because of an increase in price, which accompanied by a compensating payment leaves utility unchanged. The matrix of Slutsky substitution terms must be negative semi-definite for negativity to hold. Since the cost function is a concave function of  $p$ ,  $S$  must be negative semi-definite. Negative semi-definite Slutsky matrix implies that the matrix of diagonal terms are non- positive. That is for all  $i$ ,

$$\partial h (u, p) / \partial p_i = \partial^2 C(u, p) / \partial p_i^2 \leq 0$$

The symmetry and negative semi-definiteness can be summarised using the Slutsky matrix shown in 3.11. It suggests that the effect of a change in price  $p_i$  on good  $q_i$ , implies that the consumer needs to be given an amount  $q_i(\delta q_i / \delta m)$ .

Given that all these restrictions should apply, the question that any researcher has is, whether observed behaviours satisfy the theoretical restriction? Philips (1983) argues that they need not, because theory is a simplification of reality and statistical data always contains some measurement error. The approach, therefore, should be to use a flexible form that allows the testing of theoretical restrictions.

### **3.4 Aggregation**

#### **3.4.1 Multi-stage Budgeting**

The theory of consumer behaviour hypothesises that consumers consider the prices of all goods in order to decide the quantity of a commodity to consume. In empirical analysis, this decision process is complex because it requires information on too many price parameters. Econometric analysis of all commodities entering a consumer's budget is in general not practical because of the large number of parameters to be estimated. If a demand function is specified with  $n$  commodities and income, the number of own price parameters to be estimated is  $n$ , the number of cross price parameters to be estimated is  $n^2-n$  and there are  $n$  income parameters to be estimated. If aggregation and symmetry restrictions are imposed,  $\frac{1}{2}(n^2+n) - 1$  parameters remain to be estimated. The obvious disadvantage of estimating such a system is in the low degrees of freedom and a possible multicollinearity among the price series. Thus, aggregation of commodities into groups is essential.

The multistage budgeting procedure and separability concepts can be used to aggregate commodities into distinct groups. The consumption set is partitioned into subsets that include commodities which are close substitutes or complements to each other. The total expenditure is assigned to groups of commodities like food, clothing, shelter, etc. The decision on consumption level of a specific item in a group is then made using information on the total group expenditure and prices of commodities within the group.

The necessary condition for multi-stage budgeting is the assumption of weak separability. It refers to the type of preference whereby the consumer divides goods into



aggregate bundles and ranks them into a well defined ordering that are independent of quantities of commodity consumed outside the group.

Weak separability can be represented by the following form of utility,

$$U = V(q_1, q_2) = f (V_f(q_1), V_o(q_2)) \quad 3.17$$

where,  $q_1$  and  $q_2$  represent commodity vectors, and  $f(.)$  is defined as an increasing function of substitutes  $V_f(.)$  and  $V_o(.)$ . Preferences are weakly separable if the MRS between any two commodities,  $i$  and  $j$  is independent of the quantity consumed of a third commodity,  $k$ , in any other group i.e,

$$\frac{\partial(u_i/u_j)}{\partial q_k} = 0, \text{ for } i, j \text{ in } I, K \text{ not in } I. \quad 3.18$$

where  $u_i$  and  $u_j$  are marginal utilities of commodities  $i$  and  $j$  belonging to group  $I$ ,  $q_k$  is the quantity of good  $k$  which does not belong to group  $I$ .

Maximization of utility function represented by 3.17 involves maximization of each sub-utility function. However, maximizing say  $V_o(q_2)$  subject to  $m_o$ , yields demand as a function of total group expenditure and within group prices. Thus,

$q_i = q(m_k, P_k)$  for all  $i$  in group  $k$ , where  $P_k$  is the vector of prices of commodities in group  $K$ .

The concept of weak separability is very useful for applied demand analysis<sup>3</sup>. It provides the basis for the assumption of a two or multi-stage budgeting procedure. In the first stage, the consumer is assumed to allocate the total expenditure to broad category groups and in the second stage, the consumer is assumed to optimally allocate

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<sup>3</sup> For more details on separability see Philips (1983), Johnson et al, (1984), Varian (1990).

spending on specific items within a group say food. At the second stage, the consumer decides the quantity of each food item to be purchased on the basis of the prices of food items and the total group expenditure on food. Separability, however, imposes restrictions on behaviour because it limits the possibility of substitution effects between goods in different groups. The change in total expenditure or a change in the price of any commodity outside group  $k$ , influences the demand for goods within  $k$  only through the effect on total group expenditure. Thus, total income and prices of non-food items affect the quantity demanded of food only through their effect on the total expenditure allotted to food group.

The advantage of imposing weak separability is that it reduces the number of independent price and income responses. This, however, may still leave the researcher with large number of price and income parameters to be estimated and may not be econometrically feasible. For example if cereal is considered as a sub-group within the broader group, food, it may be difficult to estimate a demand system by including all the different type of cereals separately. It is therefore necessary to form composite commodities using quantity and price measures<sup>4</sup>.

#### **3.4.2 Aggregation Across Consumers**

Neo-classical demand theory is defined in terms of an individual consumer. The real world data which could be used to test the theory are often for a group of consumers such as households. There is no obvious reason why such a theory should

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<sup>4</sup> The set of conditions necessary for the existence of a composite commodity was derived by Hicks (1936). For more detailed analysis see Thomas (1987) or Deaton & Muellbauer (1980b).

be applicable in a study of household behaviour. The quantity purchased by the individual consumers under varying prices and incomes is not generally available. More often, the researcher usually has observations on total consumption of some aggregate group of consumers. The issue of aggregation is therefore important in empirical estimations. The question is does an aggregate demand function exist? If so, does it satisfy the restrictions derived from the theory based on individual consumer? Thomas (1987), suggested that the simple condition of aggregation is to assume a demand system that has linear engel curves. This assumption is, however, too restrictive. Empirical work using household budget data suggest that non-linear engel curves exist.

Muellbauer, (1975, 1976) showed that if preferences belong to a price independent generalized linear (PIGL) class, consistent aggregation across consumers and the existence of a "representative consumer", is possible. He has shown that there is a possibility of aggregation in the case on non-linear engel curves. According to Muellbauer, a representative consumer exists if each average budget share,  $w_i$ , can be written as a function of prices,  $p$ , and a representative budget level, designated by  $x_0$ . In his work, aggregate budget shares depend upon all prices and representative expenditures. The expenditure of the representative consumer depends on all prices and the distribution of individual household expenditures. A special case of this situation is when the expenditure of the representative consumer is independent of prices and depends only on the distribution of household expenditures. This expenditure function is called the PIGL or when expressed in logarithms as price independent generalised log (PIGLOG) form. In the PIGLOG case, representative expenditure level is independent of prices and depends only on the distribution of income. In such a case it is possible

to aggregate individual household budget shares into an aggregate equation which can be regarded as being derived from the cost function of some representative utility maximizing household.

### **3.5 Functional Form**

Reliability of estimated demand parameters is considerably affected by the functional form of the estimating equation. Economic theory does not provide much guidance as to the shape of the demand structure. There are no clear guidelines on the issue of functional forms. Theory may suggest what types of variables are involved or even what forms should be excluded, but it cannot specify the exact nature of relationship. Chambers (1983), notes that theory suggest properties of the function but there are many functions that satisfy the requirements of theory. Thus, many functional forms for demand relationships have been suggested and used by researchers.

Most demand analysts either arbitrarily choose one functional form or try alternative functions and select the best one on the basis of a few predetermined criteria, such as expected magnitudes and statistical significance of parameter estimates, and goodness of fit. Several authors have compared empirical performance of different functional form specifications.

Thiel's (1967) average information accuracy measure have been used for comparisons. Deaton (1974) used maximized values of likelihood functions. Prais and Houthakker (1955) rejected the linear Engel function because it is inappropriate when variation in the variables is large and tried several forms of nonlinear functions. The income elasticities implied by linear Engel curves are too restrictive, (Philips 1983). The

economic considerations in the algebraic formulation of Engel curves were;

- (1) there is an initial income below which these commodities are not purchased,
- (2) there is a satiety level which is not exceeded however high income may rise, and,
- (3) the adding-up criteria implies that all commodities cannot have a satiety level; otherwise, for some income level total income would not be entirely spent. Different forms of Engel curves for different types of commodities is better than a single algebraic specification.

### **3.6 The Almost Ideal Demand System (AIDS) Model**

Demand analysis for this study is based on the cost function approach. The principle of duality is used to transform the consumer's problem from one of maximizing utility with given prices and income to that of minimizing the cost of attaining a given level of utility with the same prices and income. Deaton and Muellbauer (1980a) used the cost function approach to derive the Almost Ideal Demand System (AIDS) in the budget share form.

Deaton and Muellbauer start from the PIGLOG form of preferences which allows for perfect aggregation over consumers. They specified a cost function of the form,

$$\log C(u, p) = (1-u) \log\{a(p)\} + u \log\{b(p)\} \quad 3.19$$

where,  $C$  is the total cost,  $u$  is the utility level;  $u$  lies between 0 (subsistence) and 1 (bliss),  $p$  is a price vector and  $\log a(p)$  and  $\log b(p)$  are functions that have specific functional forms.

$\log a(p)$  represents the cost for the consumer to remain at the minimum or subsistence level of utility. As  $u$  increases, the total cost is a weighted average of the

cost associated with obtaining the subsistence level and of the cost of attaining additional utility determined by price index  $\log b(p)$ . Functional forms of  $\log a(p)$  and  $\log b(p)$  are given by,

$$\log a(p) = a_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j \quad 3.20$$

and,

$$\log b(p) = \log a(p) + \beta_0 \pi_k p_k^{\beta_k} \quad 3.21$$

where  $\alpha_0$  = the intercept term,  $p_i$  = prices, and  $\alpha_k$ ,  $\gamma_{kj}^*$ ,  $\beta_0$  and  $\beta_k$  are price parameters.

Barewall and Goddard (1985), suggest that equation 3.20 represent an index of the total expenditure required for a subsistence level. Equation 3.21, on the other hand represents an index of wealth, or the price of additional utility above the subsistence level.

Substituting, 3.20 and 3.21 to the cost function 3.19, results in a linearly homogeneous cost function,

$$\log C(u, p) = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log p_k \log p_j + U \beta_0 \pi_k p_k^{\beta_k} \quad 3.22$$

*where  $\alpha_0$ ,  $\alpha_1$ ,  $\beta_1$ , and  $\gamma_{ij}^*$  are parameters.*

The logarithmic differentiation of 3.22 gives the budget share as a function of price and utility:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i U \beta_0 \pi p_k^{\beta_k} \quad 3.23$$

$$\text{where, } \gamma = \frac{1}{2}(\gamma_{ij}^* + \gamma_{ji}^*) = \gamma_{ji} \quad 3.24$$

For a utility maximizing consumer,  $m = C(u, p)$ , and this equality can be inverted

to derive the indirect utility function which gives  $u$  as a function of  $p$  and  $x$ . The indirect utility function for any PIGLOG cost function is represented by,

$$u = \frac{\ln x - \ln a(p)}{\ln b(p) - \ln a(p)} \quad 3.25$$

Substitution of 3.25 in 3.23 gives the AIDS demand function in budget share form as follows,

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln(m/p) \quad 3.26$$

where  $w_i$  is the budget share of the  $i^{\text{th}}$  commodity,  $\alpha_i$ ,  $\beta_i$  and  $\gamma_{ij}$  are parameters,  $m$  is total expenditure and  $p$  is a price index defined by,

$$\log p = \alpha_0 + \sum_k \alpha_k \log p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \log p_k \log p_j \quad 3.27$$

The general restriction of consumer theory can now be expressed in terms of the parameters of the above demand system. These are,

(i) adding-up

$$\sum_i \alpha_i = 1; \sum \gamma_{ij} = 0, \sum \beta_i = 0$$

where  $i = 1, \dots, n$ .

(ii) homogeneity

$$\sum_j \gamma_{ij} = 0 \quad \text{for all } i, \text{ and}$$

(iii) Symmetry,

$$\gamma_{ij} = \gamma_{ji}$$

(iv) Monotonicity and Concavity.

The first three restrictions can be tested or imposed as a priori restrictions on the demand equation and are also termed as equality restrictions. Monotonicity and

concavity restrictions, are inequality restrictions. Although these restrictions are as important as the equality restrictions, there is a tendency to ignore these restrictions in empirical demand analysis because of difficulties in imposing them. Chalfant et al (1991), however, were successful in imposing these restrictions on a meat demand study by making use of the Bayesian approach based on Geweke's work.

Concavity holds if the matrix of second derivatives of the expenditure function, or equivalently, of elasticities of substitution, are negative semi-definite<sup>5</sup>. On the other hand monotonicity holds if the predicted budget shares fall between 0 and 1 to ensure that predicted quantities consumed are positive.

The AIDS estimating equation can be derived by substituting 3.27 into 3.26. The estimation would require the use of non linear technique because of non-linearity arising from the price index. Deaton and Muellbauer have suggested that when prices are highly correlated, a linear approximation of the estimating equation can be found by using Stone's (1954) index  $\log p^* = \sum w_k \log p_k$  where,  $p \equiv \phi p^*$ , that is  $p$  is assumed to be approximately proportional to  $p^*$ . If  $p = \phi p^*$  then 3.26 can be estimated as follows.

$$w_i = \alpha_i^* + \sum_j \gamma_{ij} \log p_j + \beta_i \log(m/p^*) \quad 3.28$$

where,  $\alpha_i^* = \alpha_i - \beta_i \log \phi$ .

Likelihood tests obtained from model using  $p$  rather than  $p^*$  on British annual data from 1954 to 1974 confirmed the empirical unimportance of the difference (Deaton and Muellbauer, 1980a).

Formally, the AIDS function states that the budget share of good  $i$  change due

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<sup>5</sup> A matrix is negative semi-definite if (a) the principal minors alternate in sign starting with a negative sign or (b) the eigen values are nonpositive.



to changes in relative prices and real expenditure. The price parameters ( $\gamma_{ij}$ ), represent the effect of change in relative prices. The effect of change in expenditure/income is measured by  $\beta_i$  .

Deaton and Muellbauer (1980a) describe the properties of AIDS as follows. " AIDS gives an arbitrary first order approximation to any demand system; it satisfies the axioms of choice exactly; it aggregates perfectly over consumers without invoking parallel engel curves; it has a functional form consistent with known household budget data; it is simple to estimate, largely avoiding the need for nonlinear estimation; and it can be used to test the restrictions of homogeneity and symmetry through linear restrictions on fixed parameters".

### 3.6.1 Elasticities

Elasticity expression for AIDS are derived as follows.

Uncompensated own price elasticity ( $e_{ii}$ )

$$\begin{aligned}
 \frac{\partial w_i}{\partial \log p_i} &= \frac{\partial(p_i q_i / m)}{\partial \log p_i} \\
 &= \frac{1}{m} \frac{\partial(p_i q_i)}{\partial \log p_i} \\
 &= \frac{p_i}{m} \frac{\partial q_i}{\partial \log p_i} + \frac{q_i}{m} \frac{\partial p_i}{\partial \log p_i} \\
 &= \frac{p_i q_i}{m q_i} \frac{\partial q_i}{\partial \log p_i} + \frac{q_i p_i}{m p_i} \frac{\partial p_i}{\partial \log p_i} \\
 &= w_i \frac{\partial \log q_i}{\partial \log p_i} + w_i \frac{\partial \log p_i}{\partial \log p_i} \\
 &= w_i e_H + w_i \\
 &= w_i (e_H + 1) \\
 \therefore, e_H &= \frac{1}{w_i} \left( \frac{\partial w_i}{\partial \log p_i} \right) - 1
 \end{aligned}$$

Due to the use of Stone's price index,

$$\begin{aligned}
 \frac{\partial w_i}{\partial \log p_i} &= \gamma_H - \beta_i w_i \\
 \text{and, } e_H &= \frac{1}{w_i} (\gamma_H - \beta_i w_i) - 1 \\
 &= \frac{\gamma_H}{w_i} - (1 + \beta_i)
 \end{aligned}$$

uncompensated cross price elasticity ( $e_{ij}$ )

$$\begin{aligned}\frac{\delta w_i}{\delta \log p_j} &= \frac{\delta(p_i q_i/x)}{\delta \log p_j} \\ &= \frac{p_i \delta q_i}{x \delta \log p_j} \\ &= \frac{p_i q_i \delta q_i}{x q_i \delta \log p_j} \\ &= w_i \frac{\delta \log p_i}{\delta \log p_j}\end{aligned}$$

$$\begin{aligned}\frac{\delta w_i}{\delta \log p_j} &= w_i e_{ij} \\ \therefore e_{ij} &= \frac{1}{w_i} \frac{\delta w_i}{\delta \log p_j}\end{aligned}$$

Since with Stone's index  $\frac{\delta w_i}{\delta \log p_j} = \gamma_{ij} - \beta_i w_j$

$$e_{ij} = \frac{1}{w_i} (\gamma_{ij} - \beta_i w_j)$$

Compensated cross price elasticity ( $e_{ij}^*$ )

$$\begin{aligned}e_{ij}^* &= \eta_i w_j + e_{ij} \\ &= \gamma_{ij}/w_i + w_j\end{aligned}$$

Compensated own price elasticity ( $e_{ii}^*$ )

$$\begin{aligned}e_{ii}^* &= \eta_i w_i + e_{ii} \\ &= \gamma_{ii}/w_i + w_i - 1\end{aligned}$$

Expenditure elasticity is given as,

$$\eta_i = 1 + \frac{\beta_i}{w_i}$$

### **3.6.2 Applications of AIDS Model**

Deaton and Muellbauer (1980), used the AIDS model to analyze the British consumption patterns for the period 1954 to 1974. Since then, a number of researchers have used the model for empirical work. Ray (1980, 1982), applied AIDS to time series and pooled cross-section household budget survey data from India. In his studies, Ray extended the AIDS model by including family size explicitly. Barewal and Goddard (1985), applied AIDS to estimate demand elasticities for Canada. Capps, Tedford and Havlicek (1985), studied the demand for convenience and non convenience foods in the United States including demographic variables in the model. Blanciforti, Green and King (1986), developed and applied a dynamic version of AIDS. Blanciforti, and Green (1983) incorporated habits in the AIDS model to analyze expenditures on food and aggregate commodity groups. Consumption patterns of urban households in Burkinafaso were analyzed by Savadogo (1986). El-Eraky (1987), used AIDS model to estimate demand system of food commodity groups in Egypt. It has been used by Alston and Chalfant (1987, 1991) on meat demand studies, and Alston and Chalfant (1993) to compare AIDS and Rotterdam models.

## **Chapter 4**

### **THE DATA**

#### **4.1 Introduction**

The Household Budget Survey (HBS), carried out in 1986-87 provided the data for estimating the demand system. The survey was conducted by the Bureau of Statistics, Government of Lesotho in association with Statistics Sweden with funding provided by the Swedish International Development Authority (SIDA). The survey was the most comprehensive carried out in Lesotho. Earlier surveys had insufficient information available on household income and expenditures (Bureau of Statistics (BOS), December 1988). Information collected in the survey included; demographics, employment, ownership of durable assets, income and expenditures. Expenditure on food was collected for the different types of food consumed by households.

#### **4.2 Sampling Design**

The survey was carried out over a period of 12 months from October 1986 to September 1987. The sampling frame used was the population census of 1986. The procedure was to first divide the country into four agro-ecological zones based on geographical location, which were further subdivided into different strata. In all there were 24 strata in the rural areas and 14 strata in the urban areas. The next step was the formation of Primary Sampling Units (PSUs), comprising 200-600 households from each

stratum. Thus, PSUs became the starting point for the selection of households.

#### **4.3 Selection of Households**

Sampling of PSUs was done with probability proportional to size where "size" was the number of households in the 1986 census. Selection of PSUs was carried out by random sampling. In all 122 PSUs were selected with 80 in the rural and 42 in the urban areas.

Households for the survey were selected by random systematic sampling from a list of the households in each PSU. For each month of the survey 640 households, 400 in the rural and 240 in the urban areas, were surveyed, therefore, in a 12 month period, information was obtained from a total of 7,680 households. The selected households were asked to record information about expenditure on food and non-food commodities, income and various socio-economic characteristics.

#### **4.4 Adjustment of Data**

Data from the survey were grouped into four different quarters. Information of households were recorded for some of the variables at the national level while for others it was done at a household level. The present study required information of expenditure on food commodities and their prices at the household level. The survey did not record information on prices explicitly, however, total quantity was recorded at the household level while total value or total expenditure for each commodity at the national level. In order to arrive at the national figures, data pertaining to individual households were multiplied by a weighting factor depending on the number of similar households in the

population. Since, this study focused on individual households, and because unit prices for food items had to be computed the totals were converted to represent an individual household. Unit price for a commodity was then calculated by dividing the household total value by total quantity. The data collected for quarter one did not have information on quantity and the unit in which the commodity was measured. Information from this quarter, therefore, was not used for the analysis because unit prices could not be calculated. The final selection of households for analysis was done from survey information contained in quarter two, three and four. Even in these, it was found that for some households only unit and total value information were recorded. In order to compute prices, quantities are required. The mean monthly prices for commodities that had information on unit, total quantity and total expenditure was used as an imputed price. A new identification number was generated for each household by combining information on RURBAN (the rural, urban code), PSU, month, ID2 (the identification code used in the survey for each food item) and unit. Creation of a code to identify each household ensured that the prices computed were representative monthly prices in a particular region, represented by the PSU. For all households that did not have information on quantity but had the unit of measurement recorded the computed price was used by matching each case (household) using the identification code that was created. These prices are a close approximation to the original because households surveyed in a particular month and a particular PSU were geographically similar. Once, prices were imputed for such households, the quantities consumed were calculated using the ratio of total expenditure to unit price.

The second procedure was to assign price levels to those households that did not

have information recorded on units. A new mean price was calculated for all households that consumed a food commodity and for which the unit recorded was of the standard form i.e gram, kilogram, millilitre, litre. As an example, if one expects the standard unit for measurement for meat to be kilograms, then an average price for all households with that unit was computed. These averages were based on the identification code developed in the first process. This information about price was imputed for all those households that were omitted using the first procedure. The corresponding quantities for these households were then recomputed in the standard unit.

#### **4.4.1 Correcting for Units**

The model specified seven broad categories of food to be used for analysis. The survey recorded information on individual items which had to be grouped and a group price index was then calculated. This required that all commodities in a particular group should be of the same unit for a valid aggregation. The survey did not record information of all quantities consumed in the same standard unit. The various list of units used are presented in Appendix 1. Thus for each group a standard unit of measurement was defined and all food items in that group were converted to it. This conversion resulted in a change in total quantity and unit prices in comparison to what was originally recorded. The total expenditure, however, remained the same. The procedure adopted for converting units is described below.

Correcting the units for a loaf of bread into kilograms (one loaf=900 grams), grams into kilograms, millilitres into litres was easily done. However, for commodities with other units the mean monthly prices were calculated in the standard unit from the



observation that were recorded in the standard unit. This price was used to replace the unit price for such commodities. As a hypothetical example, suppose the unit price per packet (weight unknown) of a commodity X is 10 maloti. It is also known that the mean monthly price in kilograms of the commodity X in that region is 5 maloti. Thus, 10 maloti will buy 2 kilograms of X and so one packet should weigh two kilogram. This procedure therefore converts packets into kilograms and the unit price is now expressed in kilograms. A similar procedure was adopted for converting all other units except fruits and vegetables.

For fruits and vegetables, the above methodology could not be used because very few observations had standard units of measurement. For such cases a list of the commodities and their units were prepared. Approximate weights for these items were then recorded by a survey conducted in a grocery store in Saskatoon, Canada. Care was taken to ensure that the items being weighed were a close approximation to the type of commodities recorded in the survey. These weights were then used to convert the units that were not in the standard form.

#### **4.4.2 Calculation of Aggregate Prices**

For each broad food group that was used in the model, individual prices of food commodities were grouped together to arrive at a group price representative of the items within the group. The commodities that had larger total expenditure in the group were assigned higher weight compared to those whose share in the total expenditure was less. The group price that was calculated was used as the representative explanatory variable in the model. The final selections of households were then made. Only those

households that recorded consumption of all the seven food groups were used for analysis.

#### **4.5 Descriptive Analysis of Data**

Expenditure on all food groups as a proportion to total expenditure was analyzed by different regional and income categories. Table 4.1 shows the expenditure patterns of households across regions. The capital Maseru, being the largest city in the country, was grouped separately from other urban areas.

The data suggests that cereals and maize meal are the staples across Lesotho with a combined share of approximately 48 percent for rural, 35 percent for urban and 29 percent for Maseru. Meat consumption is lowest in rural areas, representing 8 percent of the total expenditure on food while in urban and Maseru it is nearly 19 and 21 percent respectively. Milk, and egg consumption are relatively constant across the three regions. Use of tobacco increases as one moves from urban to the rural area.

Table 4.1 Expenditure on Food Groups as a Proportion of Total Food Expenditure by Households Based on Rural and Urban. (in Percent).

Food Groups	Rural	Urban	Maseru
Cereals	18.00	17.57	14.39
Maize Meal	30.63	17.04	12.80
Meat	8.47	18.94	21.17
Milk	5.06	5.07	6.01
Eggs	4.17	4.25	4.52
Fats & Oils	4.78	4.94	5.09
Fruits & Vegetables	8.29	10.74	9.75
Sugar	4.02	3.49	3.53
Beverages	1.72	2.04	1.84
Misc. Group	5.95	6.05	10.01
Alcoholic Beverage	4.05	5.65	6.55
Tobacco	3.19	2.60	2.74

Source: Estimated from the HBS, 1988.  
(Figures may not add up to 100 because of rounding error).

Table 4.2 shows the proportionate expenditure on food groups based on income classification. Households with monthly income less than 80 maloti were arbitrarily classified as having low incomes. Middle income group comprises households with a monthly income of 80 maloti or more but less than 399 maloti. All other households with an income above 399 maloti per month were categorized as high income. Low income households tend to spend more on cereals and maize meal than the high income households, while the expenditure on meat increases as income increases. Increase in cereals as income increases can be attributed to increased consumption of wheat. Low income group households spend nearly 46 percent of total expenditure on cereals and

maize-meal while middle and high income groups spend about 40 and 30 percent respectively. Meat consumption increases with income. The high income households spent 19 percent on meat.

Table 4.2 Expenditure on Food Groups as a Proportion to Total Food Expenditure by Households Based on Income Level. (in Percent)

Food Groups	Income Levels		
	Low	Middle	High
Cereals	15.92	17.76	15.96
Maize Meal	30.65	21.96	12.75
Meat	10.69	14.51	19.30
Milk	4.51	5.55	6.34
Eggs	3.68	3.50	2.82
Fats & Oils	3.78	3.96	3.95
Fruits & Vegetables	8.54	9.06	10.01
Sugar	5.13	5.05	4.72
Beverages	1.56	1.84	2.05
Misc. Group	6.05	6.93	11.45
Alcoholic Beverage	3.93	4.07	5.95
Tobacco	3.35	3.08	2.30

Source: Estimated from the HBS, 1988.  
(Figures may not add to 100 because of rounding)

The food consumption habits change as one moves from rural to urban areas and on the level of income. Most of the difference is, however, on staples and meat. It is fairly constant for other food groups. The analysis is focused on deriving demand parameters on the basis of dividing households on an income level basis. The food groups selected for the study were other cereals, maize-meal, meat, milk, eggs, fats and

oils and fruits and vegetables. These are based on the relative importance in the diet and also on the fact that a major share of total food expenditure is spent on them.

#### **4.6 Summary**

The Household Budget Survey of 1986/87 provided the data for analysis in this study. This was the only comprehensive survey carried out in Lesotho over a period of twelve months. The quality of the data in general was good but several modifications had to be done to carry out the analysis. This was because of the fact that units of measurement were not consistent across all observations.

The expenditures on food groups estimated from the survey data show that maize is the staple among all regional and income groups. Expenditure on maize and other cereals together account for the largest share in total food expenditure. The proportion of expenditure spent on meat increase with income while that on maize decreases.

## **Chapter 5**

### **ESTIMATION AND RESULTS**

#### **5.1 Introduction**

The purpose of this chapter is to specify the demand system model and provide the empirical results of the estimates of the parameters of food demand for Lesotho. The equations used for estimation are outlined in section 5.2 and the assumptions and limitations of the demand model are outlined in section 5.3. The parameter estimates from the demand model are discussed in section 5.4. The estimated coefficients are then used to calculate the expenditure and price elasticities which are discussed in section 5.5.

The scope of the research on household expenditure has been limited to food commodities. Food items have been classified into 12 groups and, of these, seven groups, namely, (1) other cereals, (2) maize, (3) meat, (4) milk, (5) eggs, (6) fats and oils and (7) fruits and vegetables were used in the estimation procedure. These seven groups together account for nearly 80 per cent of the total expenditures on food. Expenditure and price data generated from the HBS data set are used for the estimation of the food demand system.

#### **5.2 Specification of the Demand System**

The AIDS equation in 3.26 was modified to incorporate demographic variables.

The intercept term  $\alpha_i$  can be used to capture the effects on demand due to demographic variables. Heien and Pompelli (1989) expressed each  $\alpha_i$  as a linear function of the demographic variables.

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left( \frac{x}{p} \right) + e_i \quad 5.1$$

where  $i$  and  $j$  = food groups = 1, ..., 7 and,

$$\alpha_i = \alpha_{i0} + \sum_k \alpha_{ik} d_k$$

The estimated model therefore is,

$$w_i = \alpha_{i0} + \alpha_{i2} D_2 + \alpha_{i3} D_3 + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left( \frac{x}{p} \right) + e_i \quad 5.2$$

The binary variables  $D_2$  and  $D_3$  are defined over regions as follows,

$D_2 = 1$  if household is in region 2 ( other urban )

= 0 otherwise, and,

$D_3 = 1$  if household is in region 3 ( Maseru )

= 0 otherwise, and,

Equation (5.2) is subject to the following definitions.

1.  $w_i$  is the ratio of per capita expenditure on food group  $i$  to the total per capita expenditure on all seven food groups. This is referred to as the budget share on food group  $i$ .
2.  $\alpha_{i0}$  measures the intercept if the household is in rural area and  $D_2$  and  $D_3$  are dummy variable used to represent households in other urban and Maseru.  $\gamma_{ij}$  and  $\beta_i$  are price and income parameters respectively.

3.  $\ln p_j$  is the natural log of the weighted price of food group  $j$ .
4.  $\ln(x/p) = \ln x - \ln p$ , where  $\ln x$  is the logarithm of total per capita expenditure on the seven selected food groups, and,
5.  $e_i$  is the stochastic error term.

### **5.3 Assumptions and Limitations of the Demand System**

1. The demand system that was estimated assumes weakly separable preference ordering. The demand for each of the seven food groups included in the system depends on the location of the household, the prices of the seven food groups and total expenditure. Prices of commodities not included in the system were assumed to influence the demand system parameters only through their effect on the determination of the total expenditure proportion allocated to the seven food groups. Thus, a two-stage budgeting procedure was followed.

In the first stage, it was assumed that, households allocate total expenditure to broad categories like food, housing, clothes or other groups. In the second stage, the household allocates the food budget from the first stage allocation to different food groups or foods. The total expenditure on the selected food groups was exogenously determined, and so were the weighted prices for these food groups.

2. The influence of other non-economic factors such as education was not taken into account. It was assumed that only prices and income influence consumer demand along with regional differences. The influence of household size was in part accounted for by expressing expenditure in per capita terms.

3. Food group prices differ both spatially and inter temporally. Stone's price



index was estimated by including all prices and commodity groups. It was assumed that this index is a close approximation of the real price index.

4. The usual mean-variance assumptions were made about the stochastic error term. The disturbances were assumed to be stochastically independent of prices and total expenditures. The error term,  $e_i$ , was also assumed to be un-correlated with the disturbances of demand equations of commodities not included in the system.

#### **5.4 Estimation Procedure and Results**

The share equation 5.1 was first estimated by imposing homogeneity and symmetry restrictions. Imposing symmetry,  $\gamma_{ij} = \gamma_{ji}$ , involves cross equation restrictions unlike homogeneity restriction that is across equations. This implies that the demand model has to be estimated as a system of equations. The Full Information Maximum Likelihood (FIML) method was used to estimate the demand model. The Log-likelihood ratio test was then used to test for homogeneity and symmetry restriction. Results from this stage of estimation (unconstrained results), for each income group is shown in tables 5.1(a) to 5.1(c). To avoid singularity of the variance-covariance matrix, the share equation for fruits and vegetables was dropped for estimation purposes. The coefficients for this equation were latter obtained from the homogeneity restriction imposed on each share equation and from the adding up restriction imposed across equations. In general, low values of standard errors suggest that most of the coefficients are significant. In the model the explanatory variable is expressed in log form except for the 0-1 dummy variables. The coefficients, therefore measure the effects of a one percent change in the explanatory variable. The sign on the coefficients do not have the

same interpretation as in a demand system where the dependent variable is in quantity or expenditure form. Thus, a negative income coefficient does not necessarily imply that the commodity is inferior. It implies that the income elasticity associated with it is less than 1.

Regional differences seem to have a significant influence on demand for certain food groups. The demand for maize by low income households is affected positively by location if the households are located in rural areas(region 1) and negatively if located in other urban (region 2) or Maseru (region 3). In the case of meat all three regions have a positive effect on demand because of significant t-values in each income group. Location does not affect the demand for cereals as region 2 and 3 are not significantly different from region 1. Demand for eggs is positively influenced if the household is in region 2 or 3. In the case of milk region 2 is significantly different from region 1.

Table 5.1 (a) Unconstrained Parameter Estimates for Low Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_i$
Oth. Cereals	0.169	-0.012	-0.038	-0.018	-0.032	0.013	0.006	0.025	0.004	0.001	0.014
t-ratio	2.928	0.650	-1.542	0.582	-1.249	0.682	0.554	2.234	0.455		0.902
st.err	0.061	0.028	0.025	0.031	0.025	0.019	0.011	0.011	0.008		0.016
Maize	0.293	-0.021	-0.089		0.065	-0.032	0.020	-0.002	-0.005	-0.015	0.038
t-ratio	3.852	-2.474	-3.016		1.914	-1.566	2.115	0.190	0.681		1.967
st.err	0.071	0.033	0.029		0.034	0.020	0.010	0.010	0.007		0.019
Meat	0.139	0.058	0.096			0.062	0.001	-0.009	-0.007	-0.028	-0.023
t-ratio	2.103	2.970	4.288			2.901	0.116	-1.112	-1.225		-1.498
st.err	0.061	0.026	0.022			0.021	0.008	0.008	0.006		0.015
Milk	0.081	0.011	0.028				-0.004	-0.009	-0.002	-0.013	-0.008
t-ratio	2.751	2.597	1.800				0.405	-1.022	0.254		-1.550
st.err	0.026	0.010	0.009				0.001	0.008	0.006		0.005
Eggs	0.037	0.001	0.026					-0.011	-0.001	0.006	0.003
t-ratio	0.881	3.053	2.805					0.861	0.179		0.632
st.err	0.030	0.010	0.009					0.012	0.007		0.005
Fats & Oils	0.079	-0.013	0.002						0.014	-0.003	-0.010
t-ratio	3.851	-1.760	0.355						2.073		-2.299
st.err	0.021	0.007	0.007						0.007		0.004
Fruits & Vegetables	0.202	-0.024	-0.026							0.052	-0.015

Source: estimated

Table 5.1 (b) Unconstrained Parameter Estimates for Middle Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_1$
Oth. Cereals	0.110	-0.002	0.000	-0.034	0.004	0.028	-0.005	-0.004	0.008	0.003	0.022
t-ratio	1.978	-0.097	-1.208	-1.350	0.214	1.514	-0.562	-0.542	1.004		1.709
st.err	0.056	0.025	0.022	0.025	0.019	0.018	0.009	0.007	0.008		0.013
Maize	0.272	-0.059	-0.082		-0.005	-0.013	0.012	0.007	-0.004	0.000	0.014
t-ratio	4.252	-2.293	-3.659		-0.189	-0.631	1.088	0.810	-0.417		0.978
st.err	0.062	0.026	0.022		0.028	0.021	0.011	0.008	0.010		0.014
Meat	0.206	0.069	0.066			0.037	-0.003	-0.009	-0.017	-0.022	-0.018
t-ratio	3.138	2.520	4.010			1.420	-0.322	-1.292	-1.901		-1.242
st.err	0.066	0.027	0.023			0.026	0.009	0.007	0.009		0.014
Milk	0.097	0.010	0.010				0.006	0.000	-0.006	-0.003	-0.003
t-ratio	2.668	0.984	0.750				0.558	-0.063	-0.888		-0.579
st.err	0.029	0.010	0.009				0.011	0.008	0.007		0.005
Eggs	0.074	-0.002	0.015					0.007	0.004	-0.004	0.005
t-ratio	1.771	-0.217	2.500					0.781	0.643		1.413
st.err	0.025	0.007	0.006					0.010	0.006		0.004
Fats & oils	0.113	-0.005	0.001						0.006	0.008	-0.011
t-ratio	3.978	-0.547	0.176						0.745		-1.715
st.err	0.026	0.010	0.008						0.008		0.005
Fruits & Vegetables	0.128	-0.010	-0.010							0.019	-0.010

Source: estimated

Table 5.1 (c) Unconstrained Parameter Estimates for High Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_i$
Oth. Cereals	0.060	-0.041	-0.057	-0.023	-0.063	0.112	-0.001	0.008	-0.022	-0.011	0.029
t-ratio	0.567	-2.125	-2.752	-0.561	-2.518	3.181	-0.072	0.645	-1.426		1.306
st.err	0.088	0.038	0.028	0.040	0.025	0.035	0.015	0.012	0.015		0.022
Maize	0.242	-0.042	-0.069		0.054	-0.023	0.021	0.003	-0.012	0.021	-0.013
t-ratio	3.994	-1.914	-3.626		1.521	-0.785	1.347	0.199	-0.757		-0.867
st.err	0.068	0.027	0.021		0.036	0.030	0.016	0.013	0.015		0.015
Meat	0.277	0.067	0.109			-0.082	-0.005	0.006	0.006	-0.014	0.017
t-ratio	2.205	3.188	4.000			-1.438	-0.298	0.476	0.345		0.688
st.err	0.112	0.046	0.034			0.057	0.017	0.013	0.017		0.025
Milk	0.104	0.013	0.013				0.014	-0.022	0.001	-0.008	-0.016
t-ratio	1.885	0.866	2.359				0.930	-2.174	0.090		-1.871
st.err	0.045	0.015	0.011				0.015	0.010	0.011		0.009
Eggs	0.059	0.010	0.023					-0.008	0.015	-0.002	0.000
t-ratio	0.230	0.863	2.486					-0.612	1.579		-0.043
st.err	0.040	0.012	0.009					0.013	0.009		0.007
Fats & oils	0.136	-0.003	-0.021						-0.004	0.016	-0.013
t-ratio	3.260	-2.084	-1.867						-0.303		-1.489
st.err	0.042	0.016	0.011						0.014		0.009
Fruits & Vegetables.	0.121	-0.004	0.003							-0.001	-0.004

Source: estimated

Location has a similar effect for middle income groups except for eggs where only region 3 has a positive impact on demand. The estimates for high income groups suggest that apart from maize and meat, cereal demand is affected negatively in regions 2 and 3. Demand for fats and oils in other areas is affected negatively while there is a positive influence in the demand for milk and eggs.

### **5.5 Testing of Theoretical Restriction**

Demand equations must satisfy the condition of homogeneity, symmetry, monotonicity and concavity. The first two conditions are equality restrictions, with homogeneity being imposed on each equation and symmetry being imposed as a cross equation restriction. The latter two are inequality restrictions and are, in general difficult to impose. The sections below describe the method used to test for the equality restrictions and the methodology used to impose inequality restrictions.

#### **5.5.1 Homogeneity and Symmetry Restriction**

The unrestricted system of equations was first estimated using the FIML approach. The total number of price parameters estimated in this system was 42. This is referred to as the unrestricted system. The set of equations were re-estimated after imposing the homogeneity restriction (homogeneous system). The number of price parameters estimated in this system was 36. Finally, symmetry was imposed, given homogeneity, and the model re-estimated. This is referred to as the symmetric system. Imposition of cross equation restrictions reduced the number of price parameters to be estimated to 20.

The log likelihood function from the three systems is shown in table 5.2. It declines as the number of restrictions increase.

Table 5.2 Log Likelihood Function Value from the Three Estimated Systems

Income group	Log Likelihood Function			- 2 $\lambda$	
	Unrestricted	Homogeneous	Symmetric	Homo- geneous	Symmetric
Low	1531.56	1524.96	1515.19	13.2	19.34
Middle	2096.83	2089.15	2076.04	15.36	26.22
High	1063.06	1059.91	1049.20	6.30	21.42

Source: estimated

In table 5.2  $\lambda$  is the value of restricted log likelihood minus the value of unrestricted log likelihood. Maddala (1977), has suggested that  $- 2\lambda$  is asymptotically distributed as a chi-squared distribution with degrees of freedom equal to the number of restrictions. The number of restrictions in the homogeneous system is 6 while in the symmetric system it is 21. The critical values of chi square at 5 percent level for 6 and 21 degrees of freedom are 12.59 and 32.67. The null hypothesis of homogeneity is rejected in low and middle income groups. The null hypothesis of symmetry given homogeneity is not rejected in any income group. These results are not surprising. Barten (1977) and Ray (1982) have reported rejection and non rejection of homogeneity and symmetry restrictions.

### 5.5.2 Inequality Restrictions

In order to determine the theoretical validity of the demand model, apart from

homogeneity and symmetry properties, the conditions of concavity and monotonicity were checked. Monotonicity was checked by looking at the sign of the predicted budget shares. The estimated coefficients do not violate monotonicity because the estimated shares were all positive.

Concavity holds if the matrix of elasticity of substitution is negative semi-definite. The estimated results from the first stage was used to calculate the elasticities of substitution. The matrix of the elasticity of substitution for each income group was then checked to see whether it was negative semi-definite. The results indicated that none of the three matrices were negative semi-definite, thus violating concavity.

Concavity and monotonicity was therefore incorporated in the estimation technique. The imposition of inequality restriction is based on the technique used by Chalfant et al (1991)<sup>6</sup>. A brief outline of the methodology is discussed in Appendix 2. The estimated coefficients from the first stage were used to obtain a sample of 5,000 replications from a multi-variate t-distribution with seven degrees of freedom. The substitution matrix for each replication was then obtained and the corresponding eigen values checked for non positive values. A search was made for those substitution matrices that had non positive eigen values.

The high income group of households had the largest percentage of replications consistent with concavity (78 percent) followed by middle income group (66 percent) and low income group (62 percent). The predicted budget share was again checked for monotonicity. It was found that 85, 73 and 69 percent of the replications had positive budget shares in high middle and low income groups respectively. Thus, both

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<sup>6</sup> For details see Chalfant et al (1991).



concavity and monotonicity conditions were imposed by excluding the substitution elasticity that do not satisfy both restrictions simultaneously. This resulted in the probability ( $P^*$ ) that restrictions hold to be 73, 62 and 57 percent for high, middle and low income groups respectively.

The implication of this probability is that the demand system obtained by imposing monotonicity and concavity restrictions is well behaved. Parameter estimates, for each income group, from this stage are shown in tables 5.3(a) to 5.3(c). These are referred to as the constrained results. The two sets of results obtained from the unconstrained and constrained estimation are comparable. The computed numerical standard error (NSE) for many coefficients are small compared to the estimated coefficients and are significant according to the NSE criterion.

There is a reversal in the sign of the coefficients for the dummy variable 2 in the case of eggs for low and middle income group. In most cases the parameter values are found to be smaller than in the unconstrained estimation. The Hicksian or compensated elasticities and the corresponding Marshallian or uncompensated elasticities were then calculated from the estimated coefficients. The constrained parameter estimates were used for policy analysis because it is assumed that these estimates are consistent with theory.

Table 5.3 (a) Constrained Parameter Estimates for Low Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_1$
Oth. Cereals	0.152	-0.008	-0.000	-0.014	-0.034	0.013	0.006	0.024	0.004	0.001	0.015
nse	0.006	0.003	0.002	0.005	0.003	0.002	0.002	0.001	0.001		0.001
sd	0.060	0.028	0.022	0.034	0.027	0.019	0.013	0.010	0.009		0.014
Maize	0.303	-0.022	-0.030		0.066	-0.031	0.020	-0.001	-0.006	-0.014	0.036
nse	0.006	0.004	0.003		0.004	0.002	0.001	0.001	0.001		0.002
sd	0.068	0.037	0.029		0.035	0.018	0.010	0.009	0.008		0.018
Meat	0.147	0.052	0.029			0.063	-0.001	-0.009	-0.007	-0.028	-0.024
nse	0.003	0.002	0.003			0.002	0.001	0.001	0.001		0.001
sd	0.051	0.025	0.024			0.022	0.008	0.008	0.006		0.013
Milk	0.094	0.015	0.001				-0.004	-0.007	-0.002	-0.011	-0.008
nse	0.002	0.001	0.001				0.001	0.001	0.001		0.000
sd	0.024	0.009	0.008				0.011	0.008	0.006		0.005
Eggs	0.055	0.000	0.016					-0.010	0.000	0.004	0.004
nse	0.003	0.001	0.001					0.001	0.001		0.001
sd	0.028	0.010	0.008					0.010	0.006		0.006
Fats & Oils	0.093	-0.014	0.000						0.013	-0.003	-0.010
nse	0.024	0.001	0.000						0.001		0.000
sd	0.001	0.007	0.006						0.007		0.004
Fruits & Vegetables	0.154	-0.023	-0.015							0.050	-0.014

Source: estimated

Table 5.3 (b) Constrained Parameter Estimates for Middle Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_1$
Oth. Cereals	0.139	-0.006	-0.000	-0.038	0.003	0.027	-0.002	-0.002	0.009	0.003	0.021
nse	0.016	0.007	0.013	0.010	0.003	0.005	0.006	0.004	0.004		0.001
sd	0.050	0.021	0.029	0.026	0.014	0.015	0.014	0.010	0.010		0.009
Maize	0.261	-0.030	-0.071		-0.002	-0.015	0.013	0.006	-0.004	-0.001	0.015
nse	0.006	0.004	0.003		0.006	0.005	0.002	0.003	0.001		0.002
sd	0.041	0.020	0.015		0.021	0.016	0.009	0.007	0.007		0.010
Meat	0.202	0.043	0.056			0.040	-0.002	-0.009	-0.017	-0.023	-0.019
nse	0.005	0.005	0.007			0.009	0.002	0.001	0.001		0.006
sd	0.043	0.022	0.021			0.025	0.008	0.005	0.006		0.015
Milk	0.107	0.009	0.003				0.003	-0.002	-0.007	-0.004	-0.003
nse	0.003	0.003	0.003				0.007	0.001	0.002		0.001
sd	0.021	0.010	0.008				0.016	0.006	0.005		0.004
Eggs	0.070	-0.003	0.015					0.007	0.004	-0.004	0.006
nse	0.012	0.001	0.000					0.001	0.001		0.003
sd	0.029	0.005	0.004					0.006	0.004		0.006
Fats & Oils	0.113	-0.009	0.001						0.006	0.008	-0.011
nse	-0.002	0.002	0.001						0.002		0.000
sd	0.004	0.006	0.005						0.007		0.003
Fruits & Vegetables	0.108	-0.002	-0.004							0.021	-0.009

Source: estimated

Table 5.3 (c) Constrained Parameter Estimates for High Income Household Group

	$\alpha_{10}$	$\alpha_{12}$	$\alpha_{13}$	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables	$\beta_1$
Oth. Cereals	0.061	-0.069	-0.041	-0.023	-0.054	0.099	-0.002	0.009	-0.018	-0.009	0.029
nse	0.007	0.005	0.006	0.008	0.005	0.005	0.003	0.001	0.002		0.002
sd	0.071	0.038	0.031	0.042	0.022	0.034	0.014	0.009	0.015		0.020
Maize	0.219	-0.033	-0.008		0.031	-0.008	0.016	0.006	-0.013	0.021	-0.011
nse	0.010	0.002	0.004		0.002	0.004	0.002	0.002	0.002		0.002
sd	0.058	0.023	0.021		0.022	0.021	0.012	0.013	0.013		0.014
Meat	0.297	0.087	0.041			-0.092	0.002	0.006	0.008	-0.015	0.009
nse	0.009	0.006	0.004			0.005	0.003	0.001	0.001		0.003
sd	0.089	0.047	0.033			0.046	0.016	0.011	0.015		0.024
Milk	0.112	0.014	0.005				0.008	-0.024	0.004	-0.005	-0.012
nse	0.013	0.002	0.001				0.002	0.003	0.003		0.001
sd	0.048	0.013	0.010				0.012	0.011	0.014		0.008
Eggs	0.078	0.003	0.001					-0.005	0.011	-0.002	-0.002
nse	0.009	0.001	0.001					0.002	0.002		0.002
sd	0.041	0.011	0.008					0.011	0.008		0.008
Fats & Oils	0.124	0.002	0.003						-0.010	0.019	-0.012
nse	0.009	0.003	0.001						0.002		0.002
sd	0.001	0.015	0.011						0.014		0.011
Fruits & Vegetables	0.108	-0.003	-0.001							-0.009	-0.002

Source: estimated

## 5.6 Analysis of the Results

Demand system parameters presented in tables 5.3 were used to compute demand elasticities at the average budget share for each income group. The budget shares, marginal budget shares, expenditure elasticity, total expenditure elasticity, own and cross price elasticities were calculated for each income group.

### 5.6.1 Budget Shares

The budget share of food group ( $w_i$ ) is the expenditure on that food group divided by total expenditure on all seven food groups. These are shown in table 5.4. On a-priori grounds, it is expected that with increasing income, budget shares of preferred foods will rise and those of less preferred foods will decline.

Table 5.4 Budget Shares (in percent) on Selected Food Groups by Income Category

Income Group	Other Cereals	Maize	Meat	Milk	Eggs	Fats and Oils	Fruits and Vegetables
Low	0.1972	0.2778	0.2079	0.0618	0.0592	0.0527	0.1512
Middle	0.2141	0.2222	0.2616	0.0600	0.0475	0.0546	0.1399
High	0.2215	0.1109	0.3153	0.0662	0.0543	0.0601	0.1717

Source: estimated.

The budget share for other cereals increase slightly from 0.197 percent for the low income group to 0.222 percent for the high income group. In this food group, the increase in budget share may be because of substitution between maize and higher quality cereals. The budget shares for maize, the traditional staple declines from 0.277 percent for low income groups to 0.111 percent for the high income groups.

The budget share for meat increases with income. This suggests that as income increase households prefer higher quality cereals and meat over maize. High values on the share for meat group is a reflection of higher prices. The weighted price for meats is approximately 4.5 times greater than that for maize and 3.5 times higher than for cereal prices. The budget share for milk, eggs and fats and oils is small (5 to 6 percent) and does not change significantly across different income groups. The high income group spent most on fruits and vegetables (17 percent) compared to the middle income (14 percent) and low income groups (15 percent).

### 5.6.2 Marginal Budget Shares

The marginal budget share measures the proportionate response of a commodity's demand for a unit increase in income. If the income of a consumer increases by \$1, the results from table 5.5 would imply that, the consumer would spend \$0.21 on cereals and cereal products, \$0.31 on maize, \$0.18 on meat, \$0.05 on milk, \$0.06 on eggs, \$0.04 on fats and oils, and, 0.13 on fruits and vegetables.

Table 5.5 Marginal Budget Shares (in percent) on Selected Food Groups by Income Category

Income Group	Other Cereals	Maize	Meat	Milk	Eggs	Fats and Oils	Fruits and Vegetables
Low	0.2122	0.3142	0.1841	0.0539	0.0630	0.0428	0.1376
Middle	0.2354	0.2366	0.2426	0.0568	0.0537	0.0439	0.1306
High	0.2506	0.0992	0.3245	0.0545	0.0521	0.0486	0.1702

Source: estimated.

Since all income must be spent, the summation of individual marginal budget shares must equal one. It is expected that marginal budget shares for staples such as maize would decline as income increases. The marginal budget share of cereals and cereal products increases with income. Thus, with increased income, the expenditure on this food group will rise. The marginal budget share of maize declines with increasing income. High income households would spend 25 percent of additional expenditure on cereals, 10 percent on maize, 32 percent on meat. The other food groups show increases in the marginal budget share except for fats and oils and fruits and vegetables in the middle income group. These results show in general that the marginal budget share increases with income for preferred food groups. Also, expensive food categories tend to have larger marginal shares.

### **5.6.3 Food Expenditure Elasticities**

Food expenditure elasticity ( $\eta_i$ ) for a food group is the responsiveness in quantity demanded of the  $i^{\text{th}}$  food group with respect to change in total expenditure on all seven food groups. It, therefore, represents the percentage change on the demand for a particular food because of one per cent change in total expenditure. Since this study uses cross-sectional data, the elasticities estimated in this study are to be interpreted with certain qualifications. Income and price differences arise mainly due to regional variations. The intraregional, cultural and taste differences affect the price elasticities measured with cross-section data. Past empirical analyses have shown that cross-section data yield satisfactory estimates of income elasticities because they cover a wider dispersion of income compared to time series studies which only deal with averages over

time. Price responsiveness, however, should be interpreted with less confidence because price differences are observed with respect to spatial differences.

The estimates of food expenditure elasticities (table 5.6) show that for some food groups elasticities change little with income groups. Weisskoff (1971) reported that income elasticity of demand for broad groups of commodities may be constant over a range of income. The results obtained, therefore, are not surprising.

Table 5.6 Food Expenditure Elasticities by Income Category

Income Group	Other Cereals	Maize	Meat	Milk	Eggs	Fats and Oils	Fruits and Vegetables
Low	1.0760	1.1312	0.8852	0.8724	1.0641	0.8123	0.9102
Middle	1.1003	1.0653	0.9278	0.9466	1.1301	0.8037	0.9333
High	1.1315	0.9019	1.0295	0.8238	0.9602	0.7983	0.9912

Source: estimated.

The magnitude of expenditure elasticities of preferred food groups like cereals and meat increases with the higher income categories. This suggests that as expenditure on food increases, the high income households tend to spend more on these commodities and less on the traditional maize staple. The low income households spend most of the additional expenditure on maize and least on fats and oils. In the case of meat the response to a one percent increase in expenditure is the smallest for low income households and largest for high income households. Milk consumption is least responsive to changes in expenditure for high income households.



#### 5.6.4 Total Food Expenditure Elasticities

The total food expenditure elasticity ( $\eta_i'$ ) for a food group is the expenditure elasticity of that particular food group with respect to total expenditure on food and non-food commodities. Thus  $\eta_i' = \eta_i \eta$ , where  $\eta$  is the expenditure elasticity of total expenditure for the seven food groups with respect to total expenditure on food and non-food commodities.  $\eta$  was estimated for each income group using Working's (1943) model.  $\eta$  was estimated to be 0.805, 0.698 and 0.526 for the low, middle and high income groups respectively. Table 5.7 shows the total expenditure elasticity for each income category.

Table 5.7 Total Food Expenditure Elasticity by Income Category

Income Group	Other Cereals	Maize	Meat	Milk	Eggs	Fats and Oils	Fruits and Vegetables
Low	0.8662	0.9106	0.7126	0.7023	0.8566	0.6539	0.7327
Middle	0.7680	0.7436	0.6476	0.6607	0.7888	0.5509	0.6514
High	0.4744	0.4744	0.5415	0.4333	0.5051	0.4197	0.5214

Source: estimated.

Total food expenditure elasticity declines with an increase in income as expected. The results are more satisfactory in terms of the magnitude and direction of change between income classifications. The signs on total expenditure elasticity show that all food groups are relative necessities. However, in terms of the expenditure elasticity magnitude, cereals and maize are preferred over meat for both the low and middle income group. Maize has a lower preference than cereals and meat for high income

groups.

There is no other demand study for Lesotho against which to compare the estimates of total food expenditure elasticities for the selected food groups. Similar studies in other developing countries have reported wide variations. Comparisons, however, are difficult because most of these studies are based on different models and methods. Some use single equations while others use simultaneous models with varying commodity and functional forms. In general, these studies show that total food expenditure elasticities decline with increases in income. The present study is, therefore, comparable to other studies.

#### **5.6.5 Own and Cross Price Elasticities**

The percentage change in the quantity demanded of the  $i^{\text{th}}$  food group in response to a one per cent change in its price is given by the own price elasticity ( $e_{ii}$ ). For ordinary goods the sign of  $e_{ii}$  is negative implying that when price increases (decreases) the quantity demanded will decrease (increase). The absolute magnitude of these elasticities give a measure of the responsiveness in quantity demanded. A good is inelastic if  $e_{ii}$  is less than one, unitary elastic if  $e_{ii}$  equal to one and elastic if greater than one. The own price elasticity estimate includes both the substitution effect and income effect and for a normal good becomes less elastic as income increases. In general these elasticities should decline when household income increases. This would suggest that the poor are more responsive to price and income changes than the well-off. Table 5.8 (a), (b) and (c) show that in all income groups the own price elasticities have negative signs as expected. Demand for other cereals, milk and eggs is found to be elastic in

low income households. For middle income groups only cereals and maize are elastic. Cereals, meat, and, fats and oils are elastic in high income households.

Table 5.8 (a) Uncompensated Price Elasticities For Low Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-1.084	-0.195	0.052	0.024	0.115	0.019	-0.006
Maize	-0.149	-0.799	-0.139	0.065	-0.012	-0.028	-0.069
Meat	0.087	-0.118	-0.675	0.003	-0.036	-0.029	-0.116
Milk	0.116	0.362	0.012	-1.065	-0.109	-0.023	-0.166
Eggs	0.386	-0.036	-0.164	-0.126	-1.180	-0.010	0.066
Fats & Oils	0.121	-0.059	-0.099	-0.023	0.003	-0.736	-0.021
Fruits & Vegetables	0.025	-0.066	-0.165	-0.070	0.035	-0.012	-0.656

Source: estimated

Table 5.8 (b) Uncompensated Price Elasticities For Middle Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-1.201	-0.006	0.099	-0.016	-0.015	0.039	0.001
Maize	0.002	-1.023	-0.085	0.056	0.022	-0.021	-0.016
Meat	0.118	-0.042	-0.828	-0.003	-0.032	-0.061	-0.079
Milk	-0.024	0.235	-0.018	-0.949	-0.024	-0.110	-0.056
Eggs	-0.074	0.089	-0.231	-0.042	-0.861	0.085	-0.095
Fats & Oils	0.215	-0.028	-0.258	-0.112	0.089	-0.877	0.169
Fruits & Vegetables	0.037	0.004	-0.150	-0.023	-0.023	0.059	-0.838

Source: estimated

Table 5.8 (c) Uncompensated Price Elasticities For High Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-1.135	-0.260	0.404	-0.020	0.032	-0.091	-0.063
Maize	-0.472	-0.706	-0.038	0.151	0.059	-0.108	0.212
Meat	0.306	-0.027	-1.300	0.006	0.016	0.022	-0.053
Milk	0.003	0.261	0.093	-0.866	-0.346	0.076	-0.044
Eggs	0.169	0.112	0.117	-0.431	-1.091	0.196	-0.033
Fats & Oils	-0.256	-0.184	0.188	0.085	0.184	-1.159	0.345
Fruits & Vegetables	-0.050	0.126	-0.085	-0.028	-0.012	0.111	-1.052

Source: estimated

The compensated price elasticity estimates are shown in tables 5.9 (a,b,c) for the three income categories. The compensated own price elasticity ( $e^*_{ii}$ ) measures changes in demand from a change in its own price. It only takes into account the substitution effect. Therefore, the compensated price elasticity is smaller than the uncompensated elasticity in absolute value terms. The pure substitution effect of a price change on the quantity demanded is higher for the low income households compared to the other two income groups.

The sign of own price elasticities are all negative, as expected. The difference between the uncompensated own price elasticity and the compensated own price elasticity is the income term of the Slutsky's equation. The Slutsky equation shows the total effect of a price change as the sum of price and income effects. The absolute value of compensated price elasticity is expected to be larger for low income groups because the expenditure elasticity of low income consumers would likely be larger than

those for high income households.

Table 5.9 (a) Compensated Price Elasticity for Low Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-0.882	0.090	0.265	0.087	0.176	0.073	0.149
Maize	0.064	-0.499	0.086	0.132	0.052	0.029	0.094
Meat	0.251	0.114	-0.501	0.054	0.013	0.015	0.010
Milk	0.278	0.591	0.183	-1.013	-0.061	0.021	-0.042
Eggs	0.586	0.246	0.047	-0.063	-1.120	0.043	0.219
Fats & Oils	0.272	0.153	0.059	0.024	0.049	-0.694	0.095
Fruits & Vegetables	0.194	0.173	0.014	-0.017	0.086	0.033	-0.525

Source: estimated

Table 5.9 (b) Compensated Price Elasticity for Middle Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-0.965	0.238	0.386	0.050	0.037	0.099	0.155
Maize	0.230	-0.786	0.193	0.120	0.073	0.037	0.133
Meat	0.316	0.164	-0.585	0.053	0.012	-0.010	0.051
Milk	0.178	0.445	0.230	-0.892	0.021	-0.058	0.077
Eggs	0.168	0.340	0.065	0.026	-0.808	0.146	0.063
Fats & Oils	0.387	0.150	-0.048	-0.064	0.127	-0.834	0.281
Fruits & Vegetables	0.237	0.212	0.094	0.033	0.021	0.110	-0.707

Source: estimated

Table 5.9 (c) Compensated Price Elasticity for High Income Household Group

	Other Cereals	Maize	Meat	Milk	Eggs	Fats & Oils	Fruits & Vegetables
Oth. Cereals	-0.884	-0.135	0.761	0.055	0.094	-0.022	0.132
Maize	-0.272	-0.607	0.247	0.211	0.108	-0.053	0.367
Meat	0.535	0.086	-0.976	0.074	0.072	0.085	0.124
Milk	0.185	0.351	0.353	-0.812	-0.301	0.126	0.097
Eggs	0.381	0.218	0.420	-0.367	-1.039	0.255	0.132
Fats & Oils	-0.080	-0.096	0.439	0.137	0.227	-1.110	0.482
Fruits & Vegetables	0.170	0.235	0.227	0.038	0.042	0.171	-0.882

Source: estimated

The uncompensated and compensated cross price elasticities are shown in tables 5.8 and 5.9. A positive sign of cross price elasticities indicates that the related commodity is a substitute. Negative signs imply a complementary relationship. Cross-elasticities are not always significant or reliable but indicate the relative importance of different prices on the quantity demanded of a commodity. Other cereals and maize show a complementary relationship which is contrary to expectations. However, the magnitude of these elasticities are small in low and middle income groups. One possible reason for this result is the fact that maize is mixed with wheat in bread making in order to increase the weight. Other cereals and meat are substitutes, for households, in the high income group. The magnitude of these elasticities is a small positive or negative in all income groups. The cross-price effects are weak across commodity groups.

## 5.7 Summary

The Almost Ideal Demand System was used to estimate price and income parameters for low, middle and high income groups. The theoretical restrictions on demand were imposed and tested. The log likelihood test shows that given homogeneity, the null hypothesis of symmetry was not rejected in any of the three income groups.

The inequality restrictions of concavity and monotonicity were imposed and the results from this estimation were used to calculate the own price, cross price and food expenditure elasticities. All own price elasticities were negative. The magnitudes of total food expenditure elasticity suggest that all food groups are relative necessities and decrease as income rises.

## Chapter 6

### POLICY IMPLICATIONS

#### 6.1 Introduction

Food price and income changes can have implications on the nutritional well-being of households especially in a low income country. In the case of Lesotho, these effects are more pronounced on the urban poor and rural landless households that do not have migrant labour income. In the short run, an increase in food prices can cause a decline in the real income of low income households who depend on the market for their food supplies. These can have important effects on nutrition. On the other hand, there is an increase in the real income of large farmers who have large quantities of marketable surpluses, (Mellor 1978, Trairatvorakul 1984). Thus, both nutrition and income distribution are affected by changes in the price of food.

Among those who buy food, the effect of a price increase is more severe on low income households than those with high incomes, because the former spend a larger portion of their income on food. If the initial level of food consumption is low, a rise in food prices can cause great hardship and even nutritional hazard to the individuals in low income households. The intermediate and long run impact of food price changes on income distribution are, however, more complex.<sup>7</sup> They depend on, among other things, the extent to which higher market prices are translated into higher farm gate

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<sup>7</sup> See Pinstrup Andersen(1988), Mellor and Ahmed(1988) and Timmer(1986) for discussions of these and other price policy issues in the Third World.



prices, the supply response of higher food prices and the impact of higher food prices on rural wage rates and thereby on employment of the poor.

The estimated demand parameters for food can be used to analyze the impacts of price and income changes. The estimated demand and income elasticities have implications for food policy. In Lesotho, pricing policies, as mentioned earlier, are influenced by RSA prices. In order to provide incentives to producers the government can follow an independent pricing policy. Increased maize production has been targeted in the Food Self Sufficiency Programme (FSSP) of Lesotho. Higher producer prices would imply that prices to consumers would rise unless the government chose to keep consumer prices low through subsidies or by transferring income. On the other hand to increase production of fruits and vegetables which are high export value crops, the government may decide to keep maize prices low.

Studies on the nutritional status of Lesotho households have indicated severe malnutrition problems among the poor, especially nursing mothers and small children (FAO, 1989). Although malnutrition can be caused by a combination of factors, Sukatme (1970) in his study on India argued that protein deficiency is mainly caused because of inadequate total energy intake. Thus calorie deficiency can lead protein deficiency, especially with cereal based diets. The results from these studies have shown that income and price changes induce consumers to substitute between foods, and therefore, direction of change in the level of nutrients intake cannot be simply established from price and income elasticities. In recent years, this has led many economists to try to estimate calorie elasticities with respect to price and income changes (Pinstrup-Andersen 1988, Trairatvorakul 1984, and, Pitt 1983).

An attempt is made in this research to estimate calorie and protein elasticities from the estimated demand and income elasticities. The implications of a change in consumer prices on total calorie and protein consumed are discussed in section 6.2.

The government can also focus on methods by which households can meet nutritional norms recommended by health organizations. This can be in the form of price subsidies or income transfers. Such policies have several implications including, budgetary costs, leakages of subsidized food to unintended target groups, disincentives to local production and its consequences on employment of low income households.

The effects of an income change on total calories and proteins is discussed in section 6.3. The budgetary cost of price/income transfer policies to meet nutritional recommendations are discussed in section 6.4.

## **6.2 Nutritional Effects of Price Reform on Low Income Households**

The estimates of price coefficients are used to calculate the nutritional effects of various price policies on consumers. The calorie/protein intake of each household depends on the quantity and the per unit calorie/protein content of the commodities consumed. Consumers will respond to a price increase of commodity  $i$  by decreasing the consumption of that commodity and its complements and by increasing the consumption of substitutes of that commodity. The total nutritional effect depends therefore on (a) calories lost by decreasing the consumption of  $i$  and its complements and (b) by increasing the consumption of the substitutes of  $i$ . The net effect, however, depends on the calorie contents of all the commodities (Laraki, 1988). If substitutes are nutritionally rich in calories, total calories consumed may remain unchanged or even

increase. On the other hand, if substitutes are poor nutritionally, calorie consumption may decrease depending upon the calorie contents of commodity  $i$  and its complements. The results of this analysis may, however, lead to an over-estimation of the nutritional effects because the demand equations were specified for seven food groups and thus does not allow the possibility of substitution with other food not included in the estimation. Substitution possibilities between food and non food are also not taken into account in this analysis.

The total calories consumed ( $Q_c$ ) and the total protein consumed ( $Q_p$ ) from  $n$  goods is a function of quantity and the per unit calorie and protein content of the commodity consumed. Thus,

$$Q_c = \sum_i a_i * q_i, \text{ and} \quad 6.1$$

$$Q_p = \sum_i b_i * q_i \quad 6.2$$

Where,

$a_i$  = per unit calorie content of commodity  $i$ ,

$b_i$  = per unit protein content of commodity  $i$ ,

$q_i$  = quantity of the  $i^{\text{th}}$  commodity consumed

and  $i = 1, \dots, n$  are the different food groups.

The change in calories because of a change in price of  $i$  is therefore represented by,

$\delta Q_c / \delta P_i = \sum_i a_i (\delta q_i / \delta P_i)$ . This can be used to derive the price elasticity of calories ( $\epsilon_{ci}$ )

demand with respect to the price of  $i$ . Thus,

$$\epsilon_{ci} = (\delta Q_c / \delta P_i) * (P_i / Q_c) = \sum_j sc_j \epsilon_{ji}, \quad 6.3$$

where,  $sc_j$  is the calorie share of commodity  $j$  in total calories consumed and  $\epsilon_{ji}$  is the

price elasticity of demand for j with respect to i.

The change in protein because of a change in price of i is given by,

$\delta Q_p / \delta P_i = \sum_i b_i (\delta q_i / \delta P_i)$ . The price elasticity of protein ( $\epsilon_{pi}$ ) demanded is expressed as

$$\epsilon_{pi} = (\delta Q_p / \delta P_i) * (P_i / Q_p) = \sum_j sp_j \epsilon_{ji} , \quad 6.4$$

where,  $sp_j$  is the protein share of commodity j in total protein consumed.

The effect of a price change on calories and protein consumed can now be calculated as

$$(\delta Q_c / Q_c) = \sum_i \epsilon_{ci} (\delta P_i / P_i) \text{ and,} \quad 6.5$$

$$(\delta Q_p / Q_p) = \sum_i \epsilon_{pi} (\delta P_i / P_i) \quad 6.6$$

Two factors, therefore, determine the nutritional effect of a price change (a) the magnitude and sign of the price elasticity of demand and (b) the calorie/protein content of all commodities consumed. An increase in price of the commodity that has a high share of calorie/protein consumption can have a negative nutritional effect unless cheaper but nutritionally rich substitutes are available. Thus price elasticity of demand for calorie/protein need not be negative. The sign will depend on the magnitudes of the substitutability effects and on the calorie/protein content of the substitutes (Sahn, 1988).

Equations 6.3 and 6.4 were used to estimate calorie and protein elasticity of each food group with respect to a change in price. The calorie and protein elasticities for different food groups are shown in Table 6.1.

Magnitudes and sign of both calorie and protein elasticity for other cereals and maize are similar. This is because these two food groups contribute nearly 70 percent of total calories and protein. The sign of elasticity on all other food groups is positive because of their small share on the total calorie and protein and because of the fact that

cross price effects for substitute commodities are large and it outweighs the small negative effect of the own price component and its complements.

Table 6.1 Calorie and Protein Elasticities of Selected Food Groups For Low Income Households.

Food Group	Calorie Elasticity	Protein Elasticity
Other Cereals	-0.1114	-0.1138
Maize	-0.2581	-0.1984
Meat	0.1001	0.0529
Milk	0.0763	0.0554
Eggs	0.0641	0.0375
Fats & Oils	0.0074	0.0379
Fruits & Vegetables	0.0942	0.0860

Source: estimated

The impacts on total calorie and protein consumption because of different price policies were calculated using equations 6.5 and 6.6. The results are presented in table 6.2. A 50 percent increase in the price of maize decreases total available calories by 12.9 percent and protein by 9.92 percent. A 50 percent increase in the price of maize and milk reduces calorie consumption by 9.08 percent and protein by 7.15 percent. The percent reduction in calorie and protein is less than the reduction obtained in scenario 1 because calorie elasticity with respect to milk is positive and maize is a substitute for milk. Thus, when the price of milk increases consumption of maize rises and so there is a dampening effect of calorie and protein loss from an increase in the price of maize. A 50 percent increase in the price of all seven food groups leads to a reduction in total

calories by only 2.11 percent and protein by 2.12 percent. This result is not surprising given that all food groups except maize and other cereals contribute very little to total calorie and protein. A 50 percent reduction in the price of maize meal increases calorie consumption by 12.9 percent and protein consumption by 9.9 percent. If fruit and vegetable prices increase by 50 percent calorie availability increases by 4.7 percent and protein availability increases by 4.3 percent.

Table 6.2 Impacts of Different Price Policies on Total Calorie and Protein Consumption

Price Change Based on	Percent Change in Calorie	Percent Change in Protein
Scenario 1	-12.90	-9.92
Scenario 2	-9.08	-7.15
Scenario 3	-2.11	-2.12
Scenario 4	+4.72	+4.30
Scenario 5	+12.90	+9.92

Source: estimated

Scenario 1 - 50 percent increase in the price of maize

Scenario 2 - 50 percent increase in the price of maize and milk.

Scenario 3 - 50 percent increase in price of all food groups.

Scenario 4 - 50 percent increase in the price of fruits and vegetables.

Scenario 5 - 50 percent reduction in price of maize meal.

### 6.2.1 Welfare Effects of Price Changes

The welfare effects of price change scenarios considered in the previous section can be analyzed by calculating the income changes needed to compensate consumers for the price change. A price increase results in a decrease in purchasing power, keeping

everything else constant, and is therefore equivalent to a decrease in the real income of consumers. The effect of a price change on consumers welfare can be calculated by estimating the minimum amount of income by which the consumer must be compensated after a price increase in order to leave the consumer as well-off.

The welfare effects of changes in food prices is analyzed using the concept of compensating variation (CV) which measures the amount of money necessary to just compensate the consumer for a loss of utility due to a price change. It can be defined in terms of the consumer's cost function as,

$$CV = C ( P^1, U^0 ) - C ( P^0, U^0 )$$

where,  $C ( P^0, U^0 )$  is the cost of achieving the utility level  $U^0$  given the initial price vector  $P^0$  and  $C ( P^1, U^0 )$  is the cost of achieving the same utility level  $U^0$  at the new price levels  $P^1$ .

A Taylor series expansion around the initial value of the cost function will give,

$$c ( p^1, u^0 ) = c ( p^0, u^0 ) + \sum_i \frac{\partial c ( p^0, u^0 )}{\partial p_i} \Delta p_i + \frac{1}{2} \sum_i \sum_j \frac{\partial^2 c ( p^0, u^0 )}{\partial p_i \partial p_j} \Delta p_i \Delta p_j + H$$

where, H indicates terms that are higher than the second order derivatives. Ignoring H and using Shepard,s Lemma the expression above can be reduced to,

$$c ( p^1, u^0 ) \approx c ( p^0, u^0 ) + \sum_i q_i ( p^0, u^0 ) \Delta p_i + \frac{1}{2} \sum_i \sum_j s_{ij} \Delta p_i \Delta p_j$$

Therefore,

$$cv = \sum_i q_i(p^0, u^0) \Delta p_i + \frac{1}{2} \sum_i \sum_j s_{ij} \Delta p_i \Delta p_j \quad 6.7$$

Equation 6.7 is known as Hick's approximation to the compensating variation, (Mckenzie, 1983). If the price of commodity i changes when the other prices are held constant, equation 6.7 can be expressed as:

$$cv_i = q_i \Delta p_i \left(1 + \frac{1}{2} \frac{\Delta p_i}{p_i} e_{ii}\right) \quad 6.8$$

If the prices of two goods, i and j, change while other prices are held constant, equation 6.7 can be expressed as:

$$cv_{ij} = cv_i + cv_j + \frac{1}{2} \Delta p_i \Delta p_j \left(e_{ij} \frac{q_i}{p_j} + e_{ji} \frac{q_j}{p_i}\right) \quad 6.9$$

The compensating variations for different price scenarios are shown in table 6.3.

Table 6.3 The Compensating Variation for Low Income Households

Price Change Scenarios	Income Change (Maloti)	Percent Change from Total Expenditure
50 % increase in price of maize	3.97	15.88
50 % increase in price of maize and milk	5.08	20.32
50 % increase in price of fruits & vegetables	1.44	5.76

Source: estimated

A 50 percent increase in the price of maize, if other prices are held constant, would require an increase of income by 16 percent in order to keep the consumer as well as



before the price increase. To compensate the consumer for a 50 percent increase in the price of maize and milk, the income should increase by 20.32 percent. A similar increase in fruits and vegetable prices requires an income increase of 5.76 percent.

### 6.3 Nutritional Effects of Income Changes

The change in calorie and protein consumption because of income changes can be obtained by defining an overall calorie income elasticity based on individual income elasticities. Differentiating equation 6.1 with respect to expenditure (Y) results in,  $\delta Q_c / \delta Y = \Sigma a_i (\delta q_i / \delta Y)$ . The calorie expenditure elasticity ( $\eta_c$ ) can then be defined as

$$\eta_c = (\delta Q_c / \delta Y) * (Y / Q_c) = \Sigma_j sc_j \eta_i, \quad 6.10$$

where,

$sc_j$  = share of commodity j in total calories

$\eta_i$  = expenditure elasticity of  $i^{\text{th}}$  good with respect to change in expenditure

Similarly, by differentiating equation 6.2 with respect to Y, the protein expenditure elasticity ( $\eta_p$ ) can be defined as,

$$\eta_p = (\delta Q_p / \delta Y) * (Y / Q_p) = \Sigma_j sp_j \eta_i \quad 6.11$$

The effect on calorie and protein consumption due to change in income can be expressed as:

$$(\delta Q_c / Q_c) = \eta_c (\delta Y / Y) \text{ and,} \quad 6.12$$

$$(\delta Q_p / Q_p) = \eta_p (\delta Y / Y). \quad 6.13$$

The estimated calorie expenditure elasticity is 0.8681 and protein expenditure elasticity is 0.8608. Thus, a 10 percent increase in total expenditure will lead to 8.6

percent increase in the consumption of calories and protein. The results obtained here are comparable to studies that were done for other developing countries.

A review of calorie elasticities will, therefore, provide more information on the possible magnitudes by which income should change to meet nutritional needs of the poor. Knudsen and Scandizzo(1979, 1982) estimated calorie income elasticities of between 0.22 and 0.18 for Sri Lanka and 0.59 and 0.56 for Morocco. This implies that a 10 per cent increase in income will increase calorie intake by 2 to 6 per cent. Chaudhri and Timmer (1986), in their study on less developed countries calculated the income elasticity of food expenditure to be 0.6 and a calorie-income elasticity of 0.15. The estimated calorie-income elasticity in this study is low because national averages were used for calculations. Data from low income consumers may have provided larger values. Similarly, for rural south India, Behrman and Deolalikar (1987) have estimated the total expenditure elasticity for six food groups ranging from 0.54 (grains) to 3.27 (milk) and a calorie elasticity of 0.17.

The differences in the method of estimation and aggregation levels have resulted in a wide variation in the magnitude of calorie elasticities estimated by different authors. The order of magnitude will depend, among other things, on the choices available to the consumer and the calorific value of the substitutes. Situation-specific empirical studies are, therefore, necessary for policy formulation. The calorie-income elasticity is likely to be less than the income elasticity because taste and variety in diet are important.

#### **6.4 Budgetary Costs to Achieve Nutritional Requirements**

The objective of achieving recommended levels for calorie consumption can be

achieved either by policies of price subsidy or income transfer. The budgetary cost of subsidies, excluding administrative costs, on  $n$  goods is  $B = \sum_n s_n q_n$ , where,  $s_n = p_n^m - p_n^s$  is the level of subsidy on good  $n$  and  $q_n$  is the demand of commodity  $n$ . On the other hand, the cost of an income transfer policy can be calculated by the amount of income transfer multiplied by the total number of households eligible for the program.

In order to determine the least cost method to achieve nutritional targets, a cost minimization problem was set up. The SOLVER algorithm in Microsoft Excel was used to arrive at an optimal solution. The objective function was specified as,

$$\text{Min } B = \sum_n s_n q_n, \text{ subject to } \sum_n c_n q_n \geq C, \text{ and } \sum_n p_n q_n \geq P$$

where  $c_n$  = per unit calorie content in commodity  $n$ ,  $C$  = the minimum recommended level of calorie,  $p_n$  = per unit protein content and  $P$  = the specified level of protein requirement. The quantity demanded  $q_n$  is obtained using the parameters of the share equation that was estimated. Three different solution of the cost minimization problem were obtained. These were obtained by,

(a) allowing prices of all  $n$  commodities to vary, i.e. subsidy on  $n$  commodities with income levels fixed. The optimal solution therefore is the minimum cost of achieving targeted calorie and protein levels by subsidizing price of  $n$  goods.

(b) allowing the level of income to change and keeping prices fixed. Thus an income transfer policy is used to achieve recommended calorie and protein levels.

(c) allowing both price and income to change, i.e. finding a combination of price subsidy and income transfer to achieve nutritional objectives.

The levels of calorie and protein that have to be achieved by the cost minimizing solution was at least 2,500 calories per capita per day and 60 grams of protein per capita

per day respectively. It is assumed, that households get approximately 300 calories from other food commodities that have not been included in the analysis. Thus, with existing levels of consumption, low income groups in all regions are deficient in calories.<sup>8</sup> This group should, therefore, be targeted for nutritional improvement because the real long term goal is to provide food to all citizens at a level of nutrition that maintains good health. With nutritional requirements above the current level of consumption demand for food is high.

The results of the cost minimizing solution using scenario (a) indicate that a subsidy of 31.22 percent on maize meal is the cheapest way to achieve nutritional objectives for low income households. If this subsidy is applied only to total quantity of maize meal purchased by low income households the budgetary cost would be 24 million maloti. If, however, a general maize subsidy is put in place, the total cost will increase to 34 million maloti. This is because of the fact that the quantity of maize meal purchased by middle and high income groups is also subsidised. To keep budgetary costs at a minimum targeting of the programme is therefore essential.

The result of an income transfer policy indicate that an income expansion of 16.3 percent will allow low income consumers to achieve the nutritional targets. The total cost of such a transfer will be 36 million maloti.

The optimal solution obtained by allowing both price and income to change was a maize price subsidy policy. The budgetary implications of this, therefore, are the same as obtained in scenario (a).

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<sup>8</sup> Refer chapter 2 for existing levels of calorie and protein consumption by households in Lesotho.

The analysis above has considered caloric requirements of households. For nutrition policies this is not the only concern. Proteins play an important role in the structure and formation of cells. Proteins are composed of amino acids, and it is important to consider the availability of amino acids and not just protein. Although the major source of protein (amino acids) is from maize and cereals; meat, milk and egg consumption is essential to meet recommended levels of protein. In this study although no analysis on amino acid deficiency has been carried out, a general discussion about the importance of specific amino acids and FAO recommendations for amino acids intake for a healthy living is provided.

The nutritional needs of proteins (amino acids) vary with age and the physiological condition of individuals. Pregnant women, lactating mothers and growing children need higher quantities of essential amino acids. Adults require less overall protein than children because of the fact that protein turnover decreases with age and growth stops. Protein requirements are influenced by caloric intake. If the caloric intake is not sufficient, a part of the dietary protein is used for energy production. Thus, low income households in Lesotho that are deficient in calories would likely be deficient in some of the essential amino acid because the major source of calorie and protein in Lesotho households is from maize (mealie meal).

In developing countries the supply of food proteins in sufficient amounts for healthy living poses an enormous challenge to the agricultural and food economy. It is a problem because in less developed economies the traditional source of proteins may be more expensive to produce than carbohydrates or lipids. The recommended levels for protein intake are also very important. These levels would influence the planning

goals for national food supplies, the dietary standards for assistance programs, and the requirements for nutrition food labelling.

The daily amino acid requirements for adult men and women, for infants aged 0-6 months and for children aged 10-12 years are shown in table 6.4. These values are recommended by FAO and WHO of the United Nations and are termed as safe protein intakes for a healthy living.

Table 6.4 Recommended Levels of Essential Amino Acids and Total Proteins

Amino acid	Infant Requirement (0-6 months), mg/day per kg.	Child Requirement (10-12 years), mg/day per kg.	Adult Requirement mg/day per kg.
Histidine	28	0	0
Isoleucine	70	30	10
Leucine	161	45	14
Lysine	103	60	12
Methionine	58	27	13
Phenylalanine	125	27	14
Threonine	87	35	7
Tryptophan	17	4	3.5
Valine	93	33	10
Total Essential Amino acids	742	261	83.5
Total Protein Requirement	2000	800	550

Source: Fennema 1985.

There are eight essential amino acids that cannot be synthesized by the human body, or can be synthesized only at a negligible rate. These amino acids must be

supplied with the diet for good health. The non essential amino acids are on the other hand effectively synthesized in the body either from intermediary metabolites or from the essential amino acids.

Table 6.4 was used to calculate the amino acid requirement for an infant weighing 8 kilograms, a child weighing 35 kilogram and an adult having a weight of 70 kilograms. The results are shown in table 6.5.

Table 6.5 Recommended Levels of Essential Amino Acids for Infants, Child and Adult

Amino acid	(grams per day)		
	Infant gm/day/infant	Child gm/day/child	Adult gm/day/adult
Histidine	0.23	0	0
Isoleucine	0.56	1.08	0.70
Leucine	1.28	1.62	0.98
Lysine	0.83	2.16	0.84
Methionine	0.46	0.97	0.91
Phenylalanine	1.00	0.97	0.98
Threonine	0.70	1.26	0.50
Tryptophan	0.14	0.14	0.25
Valine	0.74	1.18	0.70

Diets deficient in one or more essential amino acids do not support proper growth and may lead to increased mortality and early brain damage. A diet of cereals with 8 to 10 percent protein content can meet the protein requirements of adults provided sufficient quantity is eaten to supply the caloric requirement. In general proteins of animal origin are of higher quality than those of plant origin.

Cereal proteins, however, are often low in lysine and sometimes tryptophan and threonine. Oilseeds and nuts are deficient in methionine and lysine. Pulse preparations are deficient in methionine. The amino acid content of maize, milk, beef and dried beans is shown in table 6.6.

Diets that are maize dominant as in Lesotho, can lead to an amino acid imbalance, especially lysine, resulting in depressed growth and increased susceptibility to diseases. Thus cereal protein in general needs to be supplemented with other forms of protein such as soy protein, milk protein or egg/meat protein.

Table 6.6 Amino Acid Content in Maize, Milk, Beef and Beans (dried)

(grams/100 grams of raw product )				
Amino acid	Maize	Milk	Beef	Beans (dried)
Histidine	0.14	0.09	0.27	0.69
Isoleucine	0.38	0.22	0.46	1.48
Leucine	0.98	0.36	1.07	2.24
Lysine	0.04	0.27	1.08	1.85
Methionine	0.10	0.09	0.32	0.26
Phenylalanine	0.34	0.18	0.53	1.39
Threonine	0.34	0.16	0.60	1.14
Tryptophan	0.40	0.00	0.10	0.23
Valine	0.46	0.24	0.81	1.61

Source: Souci et al (1986).

The amino acid availability for households in Lesotho is shown in table 6.7<sup>9</sup>. These calculations are based on the per capita consumption of maize, milk and meat

<sup>9</sup> Refer table 2.5 for the calorie and protein availability from different food groups.



estimated from the HBS data. The amino acid availability from meat and vegetables are based on the amino acid content in beef and dried beans. This is an over simplification and the results should be interpreted with caution as an upward bias is expected. That is, the actual availability of amino acids is likely to be lower when other food items such as other vegetables and other meat are considered which are lower in amino acids in comparison to beef and beans used in this analysis.

Table 6.7 Per Capita Amino Acid Availability from Maize, Milk, Meat and Vegetables for Households in Lesotho

(grams/day)					
Amino acid	Maize	Milk	Meat	Vegetables	Total
Histidine	0.64	0.02	0.05	0.17	0.88
Isoleucine	1.75	0.06	0.09	0.51	2.41
Leucine	4.53	0.10	0.22	0.85	5.70
Lysine	0.18	0.08	0.22	0.61	1.09
Methionine	0.46	0.02	0.06	0.06	0.60
Phenylalanine	1.57	0.05	0.11	0.38	2.11
Threonine	1.57	0.04	0.12	0.31	2.04
Tryptophan	1.85	0.00	0.01	0.05	1.91
Valine	2.12	0.07	0.17	0.58	2.94

The availability of most amino acids, in general, is above the recommended levels. Seventy seven percent of the total lysine availability is from meat and vegetables. The lysine availability from maize is 16 percent and from milk it is only 7 percent. Thus, if maize consumption increases and levels of meat and vegetable consumption decline it could lead to a deficiency of lysine and methionine. The major

source of these two amino acids are from meat and vegetables.

For children, however, even with the existing levels of consumption, that is, a predominantly maize based diet there is lysine and methionine deficiency. The lysine requirement for children is 2.16 grams whereas the availability from the four food groups considered here is only 1.09. There is, therefore, a need to supplement maize with some other form of food, especially meat and vegetables that are rich in specific amino acids.

### **6.5 Targeting Methods**

An effective food price subsidy or income transfer policy is only possible if the pre-identified group from a population is the major beneficiary. The success of any targeting program would depend on minimizing the leakage of program benefits to non-recipients. In general leakage depends upon the size of the program. Programs with large benefits to target families tend to encounter many leakages. In some situations a program targeted to a specific group could be expensive and could become a financial burden on tax payers.

There are two policy approaches to attacking chronic malnutrition of the poor in the short run: (1) target group-oriented income transfer policies, and (2) general food price subsidies. In the first approach specific foods are rationed to the poor at below market prices through "fair price shops" or "ration shops". Impact evaluation reports published by IFPRI in 1979 show that this method has been successful in raising nutrition and consumption levels of poor households (Ahmed 1979, Gavan and Chandrasekera 1979, George 1979, Kumar 1979). This approach costs less in terms of

direct subsidies when compared to a general price subsidy. However, the administrative cost of identifying the beneficiaries and preventing leakages to non-target groups is large.

In the second approach, specific food is sold to consumers at below market prices. In general, low income consumers spending a larger proportion of their income on food are likely to be the main beneficiaries of this approach. However, if the food commodity subsidized is a general one consumed by people of all income strata, substantial amounts of subsidies is wasted on those who do not need it.<sup>10</sup> Unlike the first approach this method involves lower administrative cost of policing the leakages. It can be an effective instrument of nutrition policy implementation if the food to be subsidized is carefully selected. The subsidized food should be one consumed by the poor but not consumed by the rich and should be priced at a level where it is not likely to be diverted to other uses.

The different ways that can be used to target the subsidy to a particular section of the population are discussed below.

1. Geographical targeting: Benefits of a program are directed to an identified location that has a uniformly high population of the poor people suffering from food inadequacy. Governments set up fair price shops in poor neighbourhoods and these shops would sell subsidized food to the households within the defined geographical area.
2. Means testing: This method involves determining an income threshold above which

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<sup>10</sup> These policies have resulted in governmental financial crisis, increasing food deficits and poverty due to depressed farmgate prices (Ghai and Smith 1987). Zebedia (1991), in his study on maize subsidies in Zambia points out that agricultural policy has become a by-product of political relations between governments and urban constituencies and usually has an urban bias.

individual families do not qualify for the program. The programs are usually designed in a way that benefits decline as income rise.

3. Commodity targeting: This involves direction of the food subsidy to a commodity that is consumed predominantly by poor people. Commodity targeting requires vast knowledge of food consumption patterns. In Lesotho, the low income households are the major consumers of inferior quality maize meal. This commodity can, therefore, serve as an efficient vehicle for transferring the subsidy intended to increase food intake of the identified population.

4. Temporal targeting: Usually, high food prices shortly before harvest can cause significant impact on low income households. The government may dampen these seasonal price peaks by the importation of food which it supplies to a target population. Typically, governments that set uniform prices also take responsibility for handling the market surplus in the form of market subsidies.

Based on the experience in other countries, all methods of targeting would involve some administrative difficulties. The relative strengths of different methods can only be assessed by further research. Such research is, however, beyond the scope of this thesis. This research shows that the government policy objective of providing food security to the needy can be achieved at a lower cost than a general type of subsidy. However, considerable attention should be paid as to how this can be implemented.

## **6.6 Summary**

The nutritional and budgetary implications of price and income change on low income households were calculated in this chapter. The existing levels of consumption

indicate that low income households are deficient in calories. The average per capita per day calorie availability for low income households was 1,844 calories. The average protein availability was 54 grams per capita per annum. The estimated price and income elasticities were used to calculate the calorie/protein price elasticities and calorie/protein expenditure elasticities.

The results indicate that price increases of staples can have significant impact on calorie and protein consumption. Thus, a FSSP that results in higher consumer price of maize will lead to further malnutrition. The results from this study indicate that income growth will result in gains in consumption. This may, however, be difficult to maintain especially if food prices are not kept under control. Achieving higher growth rates and keeping food prices low at the same time requires considerable expansion in food production through technological change. Krishna (1982), argues that higher producer prices in the absence of induced and autonomous technical change and institutional reforms will not lead to increase in agricultural productivity. A balanced price and technology policy for agricultural growth is necessary and may need government intervention in the early stages. (Schultz 1978), argues that a dual pricing structure - higher producer prices and lower consumer prices for the poor- is required at least in the initial stages of growth.

It should be noted that a higher food price is not the only way to achieve higher food production. Many developing countries have provided subsidies on inputs like fertilizers, credit and irrigation to achieve higher agricultural production. For effective agricultural growth simultaneous improvements in infrastructure facilities, such as irrigation, roads, development of appropriate high-yielding varieties of seed are needed.

Price policy, therefore, should take into account the contribution of price and non-price factors to agricultural growth (Chhibber 1988). Market reforms are crucial to agricultural development leading to higher income growth. Various approaches to market reforms in Lesotho are discussed in Mochebelele et al (1992).

The results also indicate that if prices of fruits and vegetables are increased, there are no adverse effects on either calorie or protein consumption. Because this group comprises high value export crops production incentives through higher prices can lead to higher level of income to farm households.

For the immediate future, Lesotho should try to keep the price of grain(s) consumed by the poor low. Lower grade cereals and unsifted maize meal are examples of commodities that can be selected for price subsidies. This will also help to keep the total cost of the program low. To meet amino acid requirements of children and lactating mothers such a price policy should be complemented by other nutrition programs.

## Chapter 7

### SUMMARY, CONCLUSIONS AND LIMITATIONS OF THE STUDY

#### 7.1 Summary

Development policy for a country's agri-food sector requires a comprehensive approach which requires information on both demand and supply. Agricultural policies in developing countries, in general, tend to focus on the supply side and not the demand side. The challenge is to balance the food and nutrition needs along with the development requirements of the agricultural sector. On the demand side food policy decisions, therefore, require knowledge about price and income elasticities. This information is needed to measure the impacts of various price and related policies on food consumption, especially the nutritional impacts on low income households. Reliable demand parameters facilitate policy analysis for meeting the basic food needs of the population. A major reason for the uncertainty about food requirements is due to the imperfect knowledge of these parameters.

In spite of the obvious importance of these parameters, no effort has been made to estimate a complete set of food demand and income elasticities for Lesotho. The main objective of this study was to assess the impacts of price change on the nutritional well being of households and to develop a least cost food policy. In order to achieve this a set of price and income elasticities were estimated. This will, therefore, help to fill the gap in knowledge about the demand side for food policy planning in Lesotho.

Chapter 2, provides the background information on Lesotho's agriculture, the agricultural pricing policy, income distribution and nutritional level of households. The productivity of major crops especially maize and sorghum has not changed significantly over the period 1980-1994. Wheat yields have also been relatively stagnant.

The distribution of income is uneven. Seventy five percent of the population receive only 38.9 percent of total income. The estimated Gini coefficient 0.64 also indicate the inequalities in income distribution. The main staple food is maize. Cereals account for almost 70 percent of total calorie and protein consumption among Lesotho households.

The discussion of the methodology used for empirical analysis is provided in chapter 3. The estimation of demand parameters is based on the Almost Ideal Demand System (AIDS) model of Deaton and Muellbauer. The system approach was preferred over single equation methods because of the fact that linkages of demand for various commodities can be modelled. The semi-log functional form of the AIDS model is consistent with the Engle curve theory, which implies that at constant prices the budget share on food commodities declines as the level of expenditure increases. In this study, the budget shares were used as dependent variables. The right hand side, or independent variables, were the log of prices and log of expenditure on the food groups included for analysis. Demographic variables were incorporated as dummy variables.

A consumers consumption basket contains too many goods and services that make it impossible to consider each of them separately. The assumption of weak separability, therefore provided the basis for a two stage budgeting procedure in order to allocate the consumers budget over groups of commodities. It is assumed that in the



first stage the consumer allocates a fixed proportion of income on food and then in the second stage allocates the fixed budget on different food groups based on relative price of each food group. Seven food groups were used in this analysis. These were other cereals, maize-meal, meat, milk, eggs, fats and oils, and, fruits and vegetables.

The data used for analysis is from the Household Budget Survey (HBS) of 1986/87. Chapter 4 provides a descriptive analysis of the data. This was the most comprehensive HBS survey carried out in Lesotho. Households were divided into low, middle and high income groups for estimation purposes. This desegregation was considered important for analyzing policy implications, especially for the low income households.

The estimation procedure and results are discussed in chapter 5. Demand parameters for each income group were estimated using the full information maximum likelihood approach. The dependent variable in the model was the share of each food group in the total expenditure on seven food groups. Price, income and demographic variables were the independent variables. Initial estimates were based on homogeneity and symmetry restrictions. The null hypothesis of symmetry given homogeneity was not rejected in any income group. The model was re-estimated after incorporating the inequality restrictions of concavity and monotonicity.

Parameter estimates from this stage of estimation are shown in tables 5.2(a), 5.2(b) and 5.2(c). These estimates were used to calculate the uncompensated and compensated price elasticities and the expenditure elasticities for the seven selected food groups. All uncompensated and compensated own price elasticities are negative as expected. Cross price elasticities indicate substitute and complementary relationships

but are generally small. The total expenditure elasticities decline with income. For the staple grain, maize, it varies from 0.91 for low income group to 0.47 in the case of high income group. This indicates that the poor households are more sensitive to income changes than the high income households.

One of the specific objectives of the thesis was to evaluate the impacts of price and income changes on calorie and protein availability of low income households. The results of this analysis are discussed in chapter 6. Magnitudes and sign of both calorie and protein elasticity for maize and other cereals are similar. This is because of the fact the two food groups provide for that nearly 70 percent of total calorie and protein. A surprising result in the analysis was that all other calorie and protein elasticities were positive. This is, however, explained by the fact that cross price effects on maize and other cereals are positive and they outweigh the total negative effect from own price components and its complements.

A 50 percent increase in the price of staple grain results in a 12.9 percent decline in calorie and 9.9 percent decline in protein availability for the low income group. A simultaneous price increase of 50 percent for both maize and milk results in a 9 percent and 7 percent reduction of calorie and protein. Fruit and vegetable price increase of 50 percent result in an increase of calorie and protein availability by 4.7 and 4.3 percent respectively.

Welfare measurements of the price change scenarios discussed above suggest that low income consumers need to be compensated by income ranging from 6 to 20 percent in order to be able to maintain the same level of utility as before the price change.

In terms of budgetary costs to governments, a targeted price subsidy policy is the

best. A price subsidy on maize meal for low income households results in total government expenditure of 24 million maloti.

## **7.2 Conclusions**

The results of price change scenarios indicate that increasing the price of maize will lead to substantial reductions in the calorie and protein availability. With low income households consuming below recommended nutritional levels an increase in price will lead to further malnutrition. Thus, the Food Self Sufficiency Programme (FSSP) that intends to increase the production of maize through higher producer prices can only be undertaken if consumer prices of maize are subsidized. The results, however, indicate that increase in price of fruits and vegetables do not have adverse nutritional consequences. Government incentives that will lead to increased vegetable production will on one hand increase income levels and on the other hand should lead to higher rates of employment. This would result because vegetable production tends to be more labour intensive than cereal production.

Under existing prices and levels of consumption it was found that low income households need either a price subsidy or income support to increase calorie and protein intake. Because budgetary costs are of concern to any government a least cost cheap food policy is preferred. The cost minimization results indicate that a targeted price subsidy is the cheapest way to improve nutritional standards. If a general price subsidy is implemented the budgetary costs of price subsidy and income transfer are similar.

### **7.3 Implications**

Price and income parameters are necessary to predict with confidence the impacts of food price changes that could occur from different agri-food policies. Knowledge about the food consumption patterns give an indication of the relative importance of food groups. The results show that households consume the basic staple, maize, regardless of their level of income. Since the target of the FSSP is to increase production of staples, increase in maize meal prices is justified only if low income consumers can be subsidised. This suggests that the FSSP needs to be reconsidered and nutritional objectives should be incorporated in future agricultural development policies.

In Lesotho, agricultural production of major food grains has been relatively stagnant. In order to achieve sustained economic growth the policy objective should be to produce agricultural commodities that provide the highest economic benefit to the country taking into consideration resource (land, labour, capital) endowments and trade environment.

Lesotho has followed a policy of maize self-sufficiency. This policy may not be appropriate given a potentially new relationship with the RSA coupled with food requirements and agricultural production potential. For example Lesotho needs to examine the economic feasibility of producing higher valued crops for import substitution and export, such as fruits and vegetables. This study showed that higher vegetable prices did not adversely affect nutrition. This could mean increased importation of maize. The alternative policies for agricultural development should take into account infrastructure requirements (roads, food storage and processing) as well as institutional changes, such as land entitlement rights.

#### **7.4 Limitations and Future Research Possibilities**

This study, on consumer behaviour of Lesotho households, is the first to estimate the impacts of a price and income change by using estimated price and income parameters. The set of income and price elasticities derived in this study are important policy making tools. Food and nutrition policy decisions can therefore be made without using parameters from other non Lesotho studies. Both domestic and international organizations can use the parameters to formulate specific nutrition policies.

The present research, however, does not include non-food expenditures such as those on clothing, education, housing and health care. Expenditure on these categories are important elements that determine the over all standard of living. The study has focused only on seven food groups. It would be interesting and useful to see how consumers trade-off expenditure on groups other than food.

The study could have been much more beneficial for policy planners if it were possible to include demographic characteristics of households in the model, especially the number of children. It would be expected that the number of children and lactating mothers in a household would influence proportion of food devoted to milk and protein supplements. Inclusion of demographic variables in a food demand system is therefore an important future topic.

A successful food self sufficiency programme needs reliable information on both production and consumption. The present study looked at the demand side in isolation. A household model incorporating demand and supply aspects is an important future topic. This model would recognise the fact that households in developing economies are deficit food producers and are engaged in both production and consumption. Since,

off farm employment especially work in the mines is an important economic activity, a household model that incorporates time and wage employment would give a better understanding of production and consumption.

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**APPENDIX 1**  
**LIST OF UNITS USED TO MEASURE FOOD COMMODITIES**

This appendix lists the units of measurement\* that were used to record different food commodities in the Household Budget Survey of 1986/87.

kilogram  
grams  
number  
packet  
litres  
millilitres  
value  
bundle  
spoon  
plate  
loaf  
piece  
roll  
basin  
slice  
tin

\* Source: Income, Expenditure and Consumption of Basotho Households: Methodological Report. Bureau of Statistics, 1988.

**APPENDIX 2**  
**METHODOLOGY TO IMPOSE INEQUALITY RESTRICTION**

The methodology developed by Chalfant et al (1991) to impose inequality restrictions on a demand system is summarized in this appendix. The concept of importance sampling was used to generate random samples. Importance sampling relies on the fact that when generating a random sample using a random number generator more weight should be given for the numbers that are closer to the true value than the numbers that are away from the true value. The step wise procedure used is outlined below.

(1) The parameters of a n-1 demand system is estimated and the  $\theta$  and  $V(\theta)$  are obtained.

(2) A matrix H such that  $HH' = V(\theta)$  is calculated. A random vector equal to the number of observations of  $\theta$  is drawn from a normal distribution, Y with mean 0 and variance = I, where I is a K\*K identity matrix. Random replications of  $\theta$  are then obtained by the following procedure;

$$\theta^A = \theta + Hw/v,$$

and the antithetic replication as,

$$\theta^B = \theta - Hw/v,$$

where v is obtained by taking a vector Z of  $\lambda$  draws from  $N(0,1)$  and  $v = [(Z'Z)/\lambda]^{1/2}$ .

(3) The signs of the substitution matrix for each replication is then used to check for concavity. Monotonicity can be checked by the signs of the predicted budget shares using the replications.

(4) The mean of the distribution can be obtained by, where, R signifies that the distribution is truncated.



$$\bar{\theta} = \frac{\sum_{k=1}^n \theta_k \frac{f^R(\theta_k|y)}{g^R(\theta_k|y)}}{\sum_{k=1}^n \frac{f^R(\theta_k|y)}{g^R(\theta_k|y)}}$$

The probabilities that the restrictions hold can be calculated as,

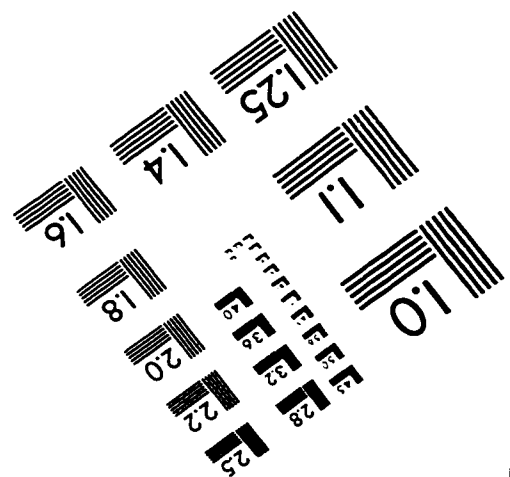
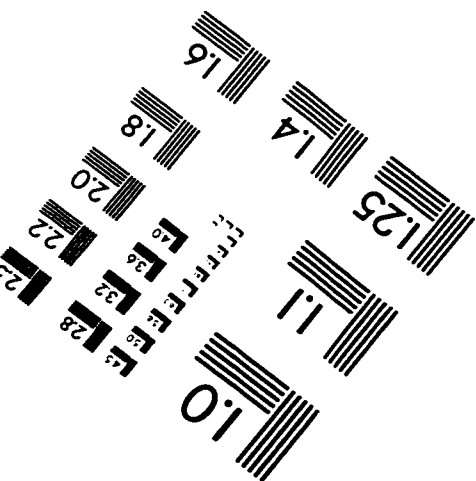
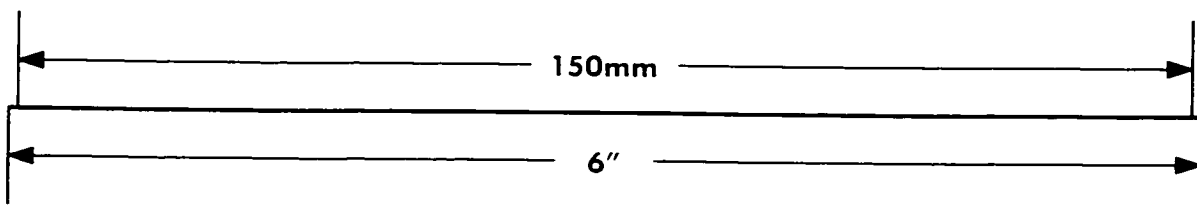
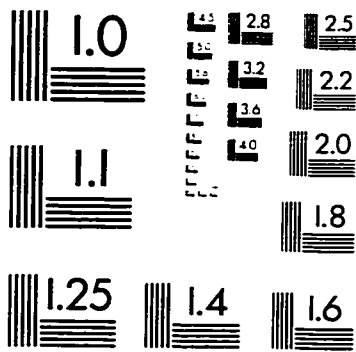
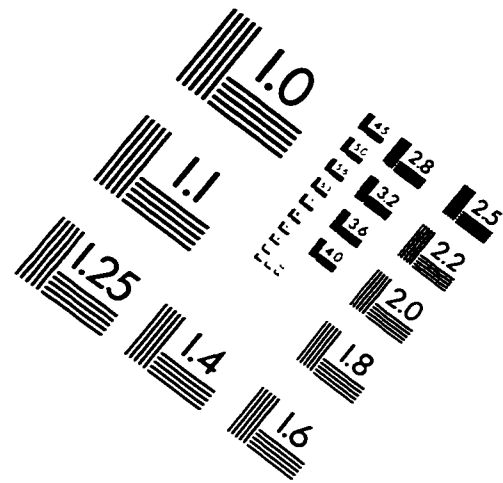
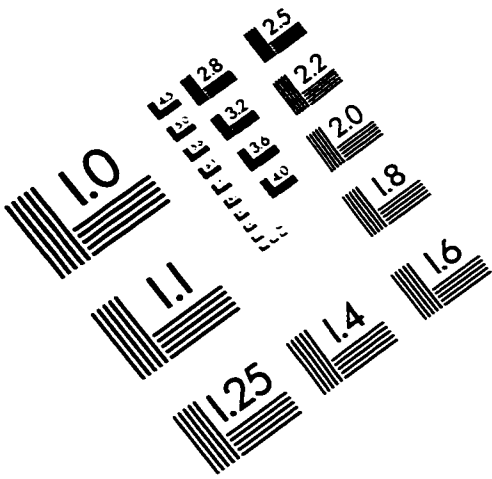
$$p^* = \frac{\sum_{k=1}^n \frac{f^R(\theta_k|y)}{g^R(\theta_k|y)}}{\sum_{k=1}^n \frac{f(\theta_k|y)}{g(\theta_k|y)}}$$

where, n is the number of replications.

The accuracy of each estimate from the replication is calculated using the numerical standard error (nse) criterion and is analogous to the standard error estimates used in classical econometrics.

$$nse(\theta) = \frac{\sum_{k=1}^N (\theta_k - \bar{\theta}_k)^2 \left[ \frac{f(\theta_k|y)}{g(\theta_k|y)} \right]^2}{\left[ \sum_{k=1}^N \frac{f(\theta_k|y)}{g(\theta_k|y)} \right]^2}$$

# IMAGE EVALUATION TEST TARGET (QA-3)



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