This is to certify that the
dissertation entitled

THE IMPACT OF SEASONAL CHANGES IN REAL INCOMES
AND RELATIVE PRICES ON HOUSEHOLDS' CONSUMPTION
PATTERNS IN BAMAKO, MALI

presented by

Oumou M. Camara

has been accepted towards fulfillment
of the requirements for the

Doctoral degree in Agricultural Economics

John M. Staatz
Major Professor's Signature

Aug. 4, 2004
Date

THE IMPACT OF SEASONAL CHANGES IN REAL INCOMES AND RELATIVE PRICES ON HOUSEHOLDS' CONSUMPTION PATTERNS IN BAMAKO, MALI

By

Oumou M. Camara

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSHOPHY

Department of Agricultural Economics

2004

ABSTRACT

THE IMPACT OF SEASONAL CHANGES IN REAL INCOMES AND RELATIVE PRICES ON HOUSEHOLDS' CONSUMPTION PATTERNS IN BAMAKO, MALI

By

Oumou M. Camara

Mali's market reforms, initiated in the 1980s, have improved the production and physical availability of cereals in most markets; however, economic accessibility remains a problem for households partly because the reforms resulted in higher and more variable food prices.

This study examines the impact of seasonal changes in real incomes, proxied by real expenditures, and relative prices on households' consumption patterns in Bamako, Mali's capital city, using the complete demand systems approach and household-level panel data. The panel data used in this study is from a survey undertaken in Bamako by the Direction Nationale de la Statistique et de l'Informatique (DNSI).

The study is organized in three essays. The first essay (chapter 2) presents a descriptive analysis of seasonal expenditure patterns and nutrient availability for households in Bamako. The results show that Bamako households' real expenditures vary considerably across seasons and that much of the observed seasonal variation in expenditures can be attributed to changes in non-food expenditures as food expenditures remain fairly stable across seasons. In

addition, the results indicate that Bamako households maintain their calorie consumption during the year by making substantial changes in the consumption of foods that contain essential micronutrients (i.e., meat, fish, and vegetables).

In the second essay (chapter 3), the Almost Ideal Demand System is applied to a three-stage demand model for different seasons in order to estimate the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako. The study finds that Bamako households' consumption patterns are responsive to changes in real incomes and relative prices in any given season and that there are seasonal changes in income and price responsiveness for all the commodities in the three demand models. In addition, the results indicate that Bamako households engage in food consumption smoothing from seasonal shocks in real incomes at the expense of non-food commodities, of non-staple foods, and through significant substitutions among and between broad commodity groups.

The third essay (chapter 4) examines the effects of seasonal changes in real incomes and relative prices on the effective demand for nutrients for Bamako households using Engel functions. The results indicate that the effective demand for nutrients is responsive to changes in real incomes and relative prices and that there is evidence of seasonal changes in income and price responsiveness. In addition, the results show that the effective demand for vitamin A and minerals is more responsive to changes in real incomes and relative prices than is the demand for calories, more specifically, calories from staples.

To my Family

ACKNOWLEDGEMENTS

I would like to thank Almighty God for giving me the dedication and strength to go through graduate school. I am deeply grateful for the sacrifices my family made so I can be where I am today. In particular, I am thankful to my parents, Kaba Camara and Haby Sylla, for teaching me that faith, hard work, and discipline are keys to living your life the way you want to. I would also like to thank my very best friend, big brother Amadou Camara, for his tough love and guidance throughout five hard years, and my little angel "Baba" for his relentless optimism.

I express my profound gratitude to the many individuals who have contributed their time and expertise to this project. I am heavily indebted to an exceptional teacher, John Staatz, my major professor, for his invaluable guidance and support from the first day I arrived at MSU. My special thanks to my committee members Eric Crawford, Kelly Raper, and Jack Meyer for their patience and whose helpful comments and suggestions improved the quality of this work.

I would also like to express my deepest gratitude to the 40 households in Mali whose generous cooperation in sharing detailed economic data made this study possible. I can just hope that some day I will be able to tangibly contribute to improving the life of at least one individual in my country. My sincere thanks to Arouna Koné and the Direction Régionale du Plan et de la Statistique (DRPS), Nango Dembelé and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA), Lamine Keita and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD), the office of the Provost at MSU, and the United States Agency for International Development (USAID) for making this study possible.

TABLE OF CONTENTS

CHAPTER 2 - ESSAY 1: SEASONAL CHANGES IN EXPENDITURE PATTERNS AND NUTRIENT AVAILABILITY FOR HOUSEHOLDS IN BAMAKO, MALI: A DESCRIPTIVE ANALYSIS

CHAPTER 4- ESSAY 3: EXAMINING THE IMPACT OF SEASONAL CHANGES IN REAL INCOMES AND RELATIVE PRICES ON HOUSEHOLDS' DEMAND FOR NUTRIENTS IN BAMAKO, MALI

CHAPTER 5: SUMMARY, POLICY IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1. Issues and Background

A key outcome of the food policy reforms initiated in the 1980s in Mali (i.e., the 1980s Structural Adjustment Programs and the 1994 Franc CFA devaluation) was the liberalization of the cereals markets. Rice and coarse grains prices were decontrolled in order to stimulate agricultural production and reduce reliance on imported rice (Dembélé et al., 1999). The production and physical availability of cereals in most markets improved with the reforms as producers responded to the higher prices that resulted from the reforms. However, economic accessibility remained a problem, especially for low-income urban households, partly because the higher food prices caused a decline in their purchasing power as their money income remained fixed (Tefft et al., 1997).[1] As a result, the impact of higher food prices on urban consumption patterns was investigated in Mali (Rogers and Lowdermilk, 1991, Reardon et al., 1994) in an effort to provide government officials with information they needed to design food safety net programs to help low-income urban households.

Furthermore, the market reforms also resulted in more variable food prices, since prices were now determined by market conditions, while before the reforms, the government fixed official producer and consumer prices for cereals. Dembélé et al. (1999) indicated that coarse grain and rice prices have shown significantly more temporal variation following the devaluation.[2] They found that the coefficient of variation of

[1] Separation of consumers and producers is assumed for this study.
[2] The Malian government fixed official cereals prices. Following the reforms, cereals' prices were allowed to vary not only across time and space but could also depend on the quality of the grain, and both local production and demand from neighboring countries (Dembélé and Staatz, 1999).

monthly prices for rice, millet and maize, increased from 7, 26, and 23 percent in the 1990-93 period to 12, 30, and 28 percent in the 1994-97 period. They also found that cereal prices were now following a seasonal trend that reflected the agricultural calendar: sorghum and maize prices begin to drop in November (harvest season) to reach their lowest in December (post-harvest season) and start increasing in January (planting season) to reach their maximum in August (lean season) (Dembélé et al. 1999).

Empirical evidence (e.g. Chambers, 1981; Sahn, 1989; Paxon, 1993) suggests that seasonal variation in food prices largely influence the effective incomes and consumption potential of households. However, the implications of seasonality in food prices for households' consumption patterns have not been explored in Bamako, Mali.

1.2. Problem Statement and Knowledge Gap

Seasonal changes in households' real income have two major consequences. First, they result in changes in the quantity (level) of food consumed in the household from one season to another. For example, Dostie (2000) found that poor Malagasy households could eat close to the nutritional threshold only after the harvest season. During the lean season, poor households' caloric intake declined by 5 percent (Dostie, 2000). Second, they affect households' seasonal consumption choices by altering the set of market baskets they can afford. For instance, households in Madagascar were found to substitute tubers for rice during the lean season when their real incomes were low and relative prices were high and increase their consumption of rice during the post harvest season when they had more purchasing power and relative prices were lowest (Dostie, 2000).

The stability of households' real incomes from one season to another is an important determinant of household food security, as it allows households to smooth their consumption levels throughout the year. The design of safety-net programs to protect at-risk households' food entitlements requires substantial knowledge, both descriptive and analytical, about households' annual and seasonal food consumption patterns and on the forces causing changes in those patterns. For example, knowledge of income elasticities can help the government in its search for self-targeting mechanisms such as those based on subsidies on "inferior" goods since the policy option of implementing general food price subsidies entails high costs (e.g. government budget and producer disincentives) (Timmer, 1979).[3] Consumer theory indicates that income elasticities are likely to vary systematically with the income of the consumer and from one price environment (set of relative prices) to another (Timmer, 1983). Most of the empirical evidence in Mali and West Africa (Rogers and Lowdermilk, 1981, Savadogo et al, 1999, and Reardon et al, 1999) has addressed the question of whether the price elasticity of demand varies with the level of income and not whether the income elasticity of demand for commodities varies with the level of relative prices faced by households. This study postulates that the consumption patterns of households in Bamako are responsive to changes in their real incomes and that the income response of demand for commodities will change from one season to another. This implies that the effectiveness of safety-net programs will depend on the season considered. The impact of seasonal changes in real incomes and relative prices on households' consumption patterns has not been investigated in Bamako, Mali.

[3] Commodities that are self-targeting (i.e., good mechanisms for transferring food to the poor) are those whose consumption declines with increasing income (also referred to as inferior goods); i.e., they have negative income elasticities.

1.3. Research Objectives

The general objective of this study is to investigate the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako. The study is based on the hypothesis that changes in the relative prices of commodities from one season to another translate into seasonal changes in households' real incomes, which in turn cause households to change their consumption patterns. This study's aim is first to examine households' consumption patterns at four different periods (seasons) within a year; second to compare how consumption patterns change across seasons; and third to identify the factors that cause changes in those patterns. The specific objectives of the study are:

1. To describe (i) seasonal changes in relative prices and households' real expenditures; (ii) households' seasonal consumption patterns; and (iii) the sources of main nutrients available for various socio-economic groups and across seasons;[4]
2. To estimate (i) income elasticities of demand for various commodities and commodity groups for different seasons in order to investigate whether there exists, in the Malian context, any self-targeting foods; and (ii) own and cross price elasticities for different seasons, thus under diverse economic conditions (supply, stocks, relative price levels), in order to identify households' seasonal substitution among and between broad commodity groups.

[4] The nutrient estimates represent nutrients in foods that are available for household consumption and not actual nutrient intakes by individuals. They are derived from the at-home food consumption data and exclude nutrients from the inedible or non-servable components of foods (e.g., bones) and losses from trimming, cooking, plate wastage, and spoilage.

3. To investigate the impact of seasonal changes in households' real incomes and relative prices on the effective demand for nutrients in Bamako.

The study will be organized in the form of three essays:

1. Essay1: Seasonal Changes in Expenditure Patterns and Nutrient Availability for Households in Bamako, Mali: A Descriptive Analysis
2. Essay 2: Examining the Impact of Seasonal Changes in Real Incomes and Relative Prices on Households' Consumption Patterns in Bamako, Mali, Using the Almost Ideal Demand System Model
3. Essay 3: Estimating the Effects of Seasonal Changes in Real Incomes and Relative Prices on Households' Demand for Nutrients in Bamako, Mali.

1.4. Research Questions and Hypotheses

The problem and the knowledge gap discussed above raise the following research questions: What is the impact of seasonal changes in households' real incomes and relative prices on their consumption patterns? More precisely:

Question 1. Do households' consumption patterns differ across season?

Hypothesis. Staples dominate at-home food purchases for all income groups during the entire year; however, households will increase their spending on non-staple commodities (e.g., meat and fish and vegetables), and thus diversify their diets, during the harvest and post-harvest seasons. The reason for this is that these are periods of greater grain availability (and lower prices) in urban markets.

Question 2. Does the impact of changes in households' real incomes and relative prices on their consumption patterns differ across seasons?

Hypothesis. Households' consumption patterns are responsive to changes in real incomes and relative prices, and the income and price elasticity of demand for food and non-food commodities will change from one season to another.

Question 3. Does the impact of changes in households' real incomes and relative prices on the effective demand for nutrients differ across seasons?

Hypothesis. Bamako households' demand for nutrients is responsive to changes in their real incomes *and* relative prices and that the magnitude of the nutrient income and price elasticities will change from one season to another.

1.5. Methodological Framework

The framework chosen for this study is the Complete Systems Approach (CSA) to estimate demand equation parameters. The process of using complete demand systems in policy analysis can be separated into three parts:

a) The choice of the appropriate complete demand system to be used;
b) The adaptation of the estimated demand model, to permit development of an empirical framework so the policy issue can be addressed; and
c) The use of an elasticity matrix to answer problems from a price and/or quantity dependent perspective (Raunikar and Huang, 1987).

The complete systems approach entails estimating a set of demand equations that result from allocating total expenditure among a group of commodities. This approach involves estimating an entire system of demand equations, one for each commodity, or commodity grouping, defined in the analysis:

$$X_{it} = f(p_{1t}, p_{2t}, \ldots, p_{nt}, y_t) \qquad i = 1,2,\ldots\ldots\ldots,n \qquad (1)$$

Complete demand systems generate estimates of own and cross price elasticities (compensated or uncompensated), income elasticities, and marginal budget shares for all commodities in the set. The CSA provides information on the degree and nature of inter-relatedness of commodities and the nature of the utility function (Raunikar and Huang, 1987). The theory of complete demand systems allows (1) the derivation of estimable functional forms of demand equations from mathematically specified models of consumer choice and (2) the imposition of constraints on demand parameters to reduce the number of independent parameters to be estimated to manageable numbers relative to the data available (Sadoulet and De Janvry, 1995).

The CSA allows incorporating the inherent simultaneity of consumer purchase decisions across the spectrum of goods and services into the estimation process (Raunikar and Huang, 1987). Policies that use prices as the instruments for change (prices are controlled, and these changes affect the quantities purchased or consumed) are well suited to being analyzed within a complete demand system framework (Raunikar and Huang, 1987). The price of any specific commodity can affect the quantity demanded of every commodity bought by the consumer and this simultaneity should be reflected in policies that require the manipulation of commodity prices to produce changes in the quantities demanded (Raunikar and Huang, 1987). The advantage of using this framework is that these effects can be traced across all demand categories. Complete demand systems include the translog system, the Rotterdam system, the addilog system, the constant elasticity of demand system, the linear expenditure system, and the almost ideal demand system (AIDS).

The AIDS model is chosen to estimate urban consumers' demand functions in this study. The AIDS is a demand system that is superior to its predecessors and is recommended as a vehicle for testing, extending, and improving conventional demand analysis for numerous reasons. First, the system is linear in the parameters and hence simple to estimate. Second, the functional form is general and flexible (Deaton and Muellbauer, 1980b, p74). Third, the model is the most satisfactory in terms of being able to test the restrictions of adding up, homogeneity and symmetry through linear restrictions on fixed parameters. Since Deaton and Muellbauer (1980) proposed the AIDS model, it has been widely applied in many empirical studies of consumer behavior using both cross-sectional and time series data (Green & Alston, 1990, Chen & Veeman, 1991, Buse, 1994). Hence, part of the reason for the popularity of this demand system is due to the considerable ease with which it can be estimated and used for testing the predictions of consumer demand theory (Chambers and Nowman, 1997).

1.6. Data

1.6.1. Source

The panel data used in this study is from a 2000-2001 survey undertaken in Bamako by the Direction Régionale du Plan et de la Statistique (DRPS) of the Direction Nationale de la Statistique et de l'Informatique (DNSI) and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA) of Michigan State University (MSU), the Assemblée Permanente des Chambres d'Agriculture du Mali (APCAM), and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD). The survey was conducted during the period August 2000 – May 2001. The funding for this project was provided by USAID/Mali under the USAID-MSU Food Security II Cooperative Agreement. The sampling frame was adapted from that developed by the Direction Nationale de la Statistique et du Plan for the 1989 national Enquête Budget Consommation (Budget Consumption Survey).

The objective of the survey was to provide a detailed understanding of procurement of food and non-food items in terms of type, quantities, source and expenditure. Along with detailed information on consumption and expenditure, the surveys also collected data on the demographic characteristics of households, their educational and employment status and ownership of assets. Detailed information on the data is available in Table A1-1 of Appendix 1.

1.6.2. Collection procedure:

The DRPS administered the survey questionnaires to households gathered in homogeneous functional entities called "unités alimentaires" or Food Consumption Units (FCU). An FCU is defined as a group of related individuals who share at least one meal together per day (DNSI, 1991). The FCU could consist of one household that prepares and consumes its meals alone, many households that prepare a common meal, or many households that eat together separately prepared meals. An FCU could consist of one individual, or a single conjugal family, or more than one conjugal family (DNSI, 1991). Five "Sections d'Enumeration" (SE), geographical units that encompass 1000 to 1500 inhabitants in urban areas, were randomly selected and then 40 FCU were also randomly chosen. One DNSI cartographer participated in delimiting the boundaries of the SE. A pre-test was performed in six FCU on June 22nd, 23rd, and 24th of 2000 to check the questionnaires' adequacy.

During the month of July 2000, 40 enumerators were chosen and trained. Five team chiefs were selected per SE to supervise the daily work of all the enumerators in their SE. Three inspectors and two supervisors, Arouna Kone (the director of the DRPS) and I, ensured that the questionnaires were properly filled out. During the data collection week, each enumerator went to the FCU three times a day, before each meal was prepared, to weigh food products and collect data on food at and away from home and non-food expenditures.

The same households were interviewed in four rounds over a period of one-year starting in August 2000 to May 2001 for the capital city, Bamako, in order to capture the seasonal variation in consumption. There was no sample attrition. Data were collected for seven consecutive days during each round. The four surveys covered 40 Food Consumption Units (FCU), the sample size in each survey round being the same. Table A1-2 of Appendix 1 contains detailed information on the sample size.

Table 1-1: Summary of Data Needs and Availability

Types of Analysis	Variables	Data Required	Where are these data Available?
Descriptive analysis of households' consumption patterns	Consumption and expenditure Nutrients available	Quantities of food Price per kg Food composition tables	DRPS/PASIDMA/ APCAM survey OMA price data DNSI price indices
Econometric analysis of demand for food and non-food commodities	Share of budget devoted to specific food groups and non food items Vector of household characteristics, prices, price index, total expenditure	Quantities of food, price per kg, household size.	DRPS/PASIDMA/ APCAM survey
Econometric analysis of nutrient demand	Nutrient availability Food prices, total expenditure, and household size	Quantities of food consumed converted to nutrients, food prices, and number of adult equivalents in each household.	DRPS/PASIDMA/ APCAM survey

1.7. Specific Types of analysis planned

The impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako will be examined using three complementary methods of analysis. First, a descriptive analysis will be conducted on the (i) seasonal changes in relative prices and households' real expenditures; (ii) households seasonal consumption patterns; and (iii) main nutrients' availability from at-home food purchases, major sources of nutrients, and the prices for kilocalorie across seasons and for various income groups.[5] Second, econometric analyses of the determinants of demand for food and non-food commodities and nutrients will be performed for each season. Third, sensitivity analyses will be performed to determine the effect of seasonal changes in real incomes and relative prices on households' budget allocation to various commodity groups or items.

1.7.1 Seasonal Changes in Expenditure Patterns and Nutrient Availability for Households in Bamako, Mali: A Descriptive Analysis

In this section, seasonal changes in expenditure patterns and nutrient availability for households in Mali are examined through a descriptive analysis of (i) seasonal changes in relative prices and real expenditures; (ii) urban households' seasonal food and non-food expenditure patterns; and (iii) seasonal availability of nutrients from at-home food purchases. The descriptive analysis is essential for food policy purposes because it provides critical information on the composition of households' basket of goods and services under different economic conditions (e.g., food supply stocks, relative prices) and on the adjustments households make between and within food and non-food

[5] The term "availability of nutrients" refers to nutrients in foods that are available for household consumption through purchases and own-supply and not availability at the market level.

commodities across seasons. Table A1-3, in Appendix 1, shows the commodity groups and specific items that will be included in the analysis.

1.7.2. Examining the Impact of Seasonal Changes in Real Incomes and Relative Prices on Households' Consumption Patterns in Bamako, Mali, Using the Almost Ideal Demand System Model

In this essay, the Almost Ideal Demand System is applied to a three-stage demand model for different seasons in order to estimate the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako. The study tests the hypothesis that households' consumption patterns are responsive to changes in their real incomes and that the relationship between household income and food and non-food consumption patterns will change from one season to another. The study assumes that consumers' preferences are weakly separable in order to allow singling out and studying only a small group of closely related goods. The reasoning behind the concept of weak separability is that the optimization problem is intractable for the consumer if the demand for every commodity is a function of the prices of all other commodities. To simplify this problem, we may assume that the consumer partitions total consumption into groups of goods, so that preferences within groups can be described independently of the other groups.

Under the assumption of weak separability, the consumers' simultaneous decision-making process is broken into three steps by adopting a three-stage budgeting process. In the first stage, households allocate their total expenditures among seven broad groups of commodities: (1) Food, (2) Durable Goods, (3) Semi-Durable Goods, (4) Health, (5) Energy and Utilities, (6) Other Non-Durables (Hygiene and Tobacco), and (7)

Services.[6] In the second stage, households allocate their food expenditure on seven food groups: (1) Staples, (2) Vegetables, (3) Meat and Fish, (4) Oil, (5) Sugar, (6) Other Foods, and (7) Food Away From Home. In the third and final stage, households allocate their staple group expenditure to (1) Rice, (2) Millet-Sorghum, (3) Maize, (4) Wheat, and (5) Roots and Tubers. Hence, it is thus assumed that preferences are weakly inter-temporally separable, that food is weakly separable from non-food commodities and that staples are weakly separable from the other food groups. It should be noted that weak separability between the goods studied and the rest of a consumer's bundle is generally assumed before the empirical specification, and not tested as a hypothesis. It is possible to test for weak separability (Eales and Unnevehr, 1988; Salvanes and DeVoretz, 1997), but it is hard to find data sets of sufficient size and richness that will allow this.

The study proceeds in three steps. First, the study estimates demand parameters using the almost ideal demand system model for each season.[7] Second, the analysis computes income elasticities for different seasons in order to determine if Bamako households' consumption patterns are responsive to changes in their real incomes. Third, the study computes own and cross-price elasticities for different seasons in order to identify Bamako households' seasonal substitution among and between broad commodity groups. Finally, the study performs sensitivity analyses on the estimated income and price elasticities using several simulation scenarios.

The Chow Test, which is simply an F test, will be performed to test the hypothesis of the constancy of the parameters of the demand system across seasons. The aim here is

---

[6] Table A1-4 of Appendix 1 presents the definition of the various commodities and commodity groups.

[7] The seasons are defined, based on the pattern of agricultural activity in Mali, as follows: August = lean, November = harvest, February = post-harvest, and May = planting.

to determine whether the estimated demand parameters are stable over seasons (corresponding to each survey round). The study will test for the stability of the coefficients under the null hypothesis that the estimated income elasticities do not vary across seasons; thus that the impact of changes in urban households' real income on consumption patterns is assumed to be constant across seasons.

1.7.3. Examining the Effects of Seasonal Changes in Real Incomes and Relative Prices on Households' Demand for Nutrients in Bamako, Mali

This section examines the impact of seasonal changes in real incomes and relative prices on households' effective demand for nutrients in Bamako.[8] This study is based on the hypothesis that Bamako households' demand for nutrients is responsive to changes in their real incomes *and* relative prices and that the magnitude of the nutrient income and price elasticities will change from one season to another. The study will address two questions. The first question pertains to whether the effective demand for nutrients is responsive to changes in Bamako households' real incomes and relative prices. The second question regards whether the magnitude and sign of the nutrient-income and nutrient-price elasticity of demand differs across seasons. These issues are analyzed using Engel functions to estimate nutrient income and price parameters and the Chow test to assess the stability of the estimated income and price coefficients across seasons. The demand functions are estimated by ordinary least squares for calories, protein, calcium, vitamin A and iron for the pooled data and for each season separately.

[8] The present study can not look at individual nutrient intake because the study has no information on the quantities consumed by each individual in the household. In addition, the consequence of excluding food away from home consumption is a systematic underestimation of households' calorie availability.

1.7.4. Sensitivity Analysis

The impact of seasonal changes in Bamako households' real incomes on the allocation of expenditure among food and non-food commodity groups and on the effective demand for nutrients is examined in this section by performing sensitivity analyses. Sensitivity analyses provide simple demonstrations of how the demand model can be used to simulate conditions in which alternative changes in relative prices and real income could be evaluated and traced through the system to determine the effect on each food group or item and on the demand for nutrients. Different scenarios (e.g., a 10 percent decrease or increase in relative price levels of rice) are simulated by manipulating relative price levels, budget shares, and real income and their effects on the reallocation of expenditures and nutrient demand are traced.

1.8. Conclusion

The objectives of this study are: 1) to examine seasonal changes in expenditure patterns and nutrient availability for households in Bamako, Mali; 2) to estimate the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako using the almost ideal demand system model; and 3) to identify the effects of seasonal changes in real incomes and relative prices on households' demand for nutrients in Bamako. The study is organized as follows. The first essay examines seasonal changes in expenditure patterns and nutrient availability for Bamako households through a descriptive analysis of (i) seasonal changes in relative prices and real expenditures; (ii) households' seasonal food and non-food expenditure patterns; and (iii) seasonal availability of nutrients.

The second essay tests the hypothesis that the relationship between Bamako households' real incomes and relative prices and their consumption patterns differ across seasons. This means that understanding the impact of seasonal changes in Bamako households' real incomes and relative prices on their households' consumption patterns is crucial to informed food policy making. Following the methodological framework pioneered by Leser (1941, 1963), Stone (1959) and Frisch (1959), this essay uses the Complete System Approach to examine the impact of seasonal changes in Bamako households' real incomes and relative prices on their consumption patterns.

The third essay uses Engel functions to examine the magnitude of the impact of seasonal changes in households' real incomes and relative prices on the effective demand for nutrients. The study tests the hypothesis that households' demand for nutrients is responsive to changes in their real incomes and relative prices and that the magnitude of the nutrient income and price elasticities will change from one season to another. This means that improvements in households' real incomes will lead to increases in the quantity (i.e. calories) and the quality (protein, minerals, and vitamins) of food available in those households and, thereby will be an effective mechanism in reducing malnutrition in Mali.

Chapter 5 summarizes the main findings of each essay and provides a discussion on the policy implications and the scope for future research on consumption analysis in Mali.

REFERENCES

Abdulai, A, D.K. Jain and A.K. Sharma, 1999. Household food demand analysis in India. *Journal of Agricultural Economics* 50: 316-327.

Anderson, G and Blundell, 1983. Testing restrictions in a flexible dynamic demand system: an application to consumers' expenditure in Canada. *The Review of Economic Studies* , pp. 397-410.

Behrman, Jere R., and Deolalikar, Anil B., 1990. The Intrahousehold Demand for Nutrients in Rural South India. *The Journal of Human Resources*, Vol. 25, No. 4 (1990), pp. 665-696.

Blundell, R, P. Pashardes and G. Weber. 1993. What do we learn about consumer demand patterns from micro data? *The American Economic Review* 83: 570-597.

Boughton, D., Reardon, T., 1997. Will the Promotion of Coarse Grain Processing Turn the Tide for Traditional Cereals In the Sahel. Recent Empirical Evidence from Mali. *Food Policy* 22(4), 307-316.

Buse, A. 1994. Evaluating the linearized almost ideal demand system. *American Journal of Agricultural Economics* 76: 781-793.

Byrne, P.J., O. Capps, Jr and A. Saha. 1996. Analysis of food-away-from-home expenditure patterns for U.S. households, 1982-1989. *American Journal of Agricultural Economics* 78: 614-627.

Carpentier, A. and H. Guyomard. 2001. Unconditional elasticities in two-stage demand systems: an approximate solution. *American Journal of Agricultural Economics* 83: 222-229.

Chen, P.Y. and M.M. Veeman. 1991. An almost ideal demand system analysis for meats with habit formation and structural change. *Canadian Journal of Agricultural Economics* 39: 223-235.

Cox, T.L. and M.K. Wohlgenant. 1986. Prices and quality effects in cross-sectional demand analysis. *American Journal of Agricultural Economics* 68: 908-919.

Dawson, P.J. and R. Tiffin. 1998. Estimating the demand for calories in India. *American Journal of Agricultural Economics* 80: 474-481.

Deaton, A and Muellbauer J. 1980a. *Economics and consumer behavior*. Cambridge Cambridge University Press

Deaton, A. 1990. Price elasticities from survey data. *Journal of Econometrics* 44 281–309

Deaton, A and J. Muellbauer. 1980. An almost ideal demand system. *The American Economic Review* 70: 312-326.

Deaton, A. 1997. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*. Baltimore, London: World Bank and the John Hopkins University Press.

Deaton, A. "Quality, Quantity, and Spatial Variation of Price." *The American Economic Review* 78 (1988b)3: 418-430.

Deaton, A. 1992. *Understanding Consumption*. Oxford University Press.

Dong, D, J.S. Shonkwiler and O. Capps, Jr. 1998. Estimation of demand functions using cross-sectional household data: the problem revisited. *American Journal of Agricultural Economics* 80: 466-473.

Ealas, J.S. and L.J. Unnevehr. 1988. Demand for beef and chicken products: separability and structural change. *American Journal of Agricultural Economic* 70: 521-532.

Edgerton, D L. 1997. Weak separability and the estimation of elasticities in multistage demand systems. *American Journal of Agricultural Economics* 79 1, 62–79.

Fafchamps, M. 1992. Cash Crop Production, Food Price Volatility, and Rural Market Integration in the Third World. *American J. of Agricultural Economics*, Vol. 74, No. 1 (1992), pp. 90-99.

Gabas, J-J. and Giri, J. (1987). *The Food Situation in the Sahel: an Assessment. In Cereals Policies in Sahel Countries.* Acts of the Mindelo Conference, eds CILSS/Club du Sahel/OECD, Paris.

Green R, and Alston J M. 1990. Elasticities in AIDS models. *American Journal of Agricultural Economics* May 442–445.

Heckman J J. 1979. Sample selection bias as a specification error. *Econometrica* 47 153–161

Heien, D. and C.R. Wessells. 1990. Demand systems estimation with microdata: a censored regression approach. *Journal of Business and Economic Statistics* 8: 365-371.

Karagiannis, G. and K. Velentzas. 1997. Explaining food consumption patterns in Greece. *Journal of Agricultural Economics* 48: 83-92.

Meenakshi, J.V. and R. Ray. 1999. Regional differences in India's food expenditure pattern: a complete demand systems approach. *Journal of International Development* 11: 47-74.

Moschini, G. 1995. Units of measurement and the stone index in demand system estimation. *American Journal of Agricultural Economics* 77: 63-68.

Moschini, G., D. Moro and R.D. Green. 1994. Maintaining and testing separability in demand systems. *American Journal of Agricultural Economics* 76: 61-73.

Nelson J A. 1991. Quality variation and quantity aggregation in consumer demand for food. *American Journal of Agricultural Economics,* November 1204–1212.

Newbery, David M, 1989. The Theory of Food Price Stabilization. *Economic Journal,* Vol. 99 (398) pp. 1065-82.

Park, J.L., R.B. Holcomb, K.C. Raper and O. Capps, Jr. 1996. A demand systems analysis of food commodities by U.S. households segmented by income. *American Journal of Agricultural Economics* 78: 290-300.

Pashardes, P. 1993. Bias in estimating the almost ideal demand system with the stone index approximation. *The Economic Journal* 103: 908-915.

Perali, F. and J.P. Chavas. 2000. Estimation of censored demand equations from large cross-section data. *American Journal of Agricultural Economics* 82: 1022-1037.

Pitt, M.M. 1983. Food preferences and nutrition in rural Bangladesh. *The Review of Economics and Statistics* 65: 105-114.

Pitt, Mark M., Rosenzweig, Mark R., and Hassan, Md. Nazmul. Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries. *American Economic Review*, Vol. 80, No. 5 (December, 1990), pp. 1139-1156.

Reardon, T. Singare, K., Y. Camara, M. Wanzala, B. Teme, O. Sanogo. 1999. Household consumption responses to the franc CFA devaluation: evidence from urban Mali. *Food Policy*, 24(5), October: 517-534.

Rogers, B.L. and Lowdermilk, M. 1991. Price Policy and Food Consumption in Urban Mali. *Food Policy*_16, 461-473.

Sadoulet, Elisabeth, and de Janvry, Alain. 1996. *Quantitative Development Policy Analysis*. Chapter 6. Baltimore, MD: The Johns Hopkins University Press, 1995.

Sen, Amartya. 1981. Poverty and Famines: An Essay on Entitlement and Deprivation. Oxford: Oxford U. P., 1981.

Singh, I., Squire, L., and Strauss, J. (eds.) *Agricultural Household Models*. Chapters 1 and 2. Baltimore, MD: The Johns Hopkins University Press, 1986.

Strauss, John and Duncan Thomas. 1995. *Empirical Modeling of Household and Family Decisions.* In Handbook of Development Economics 3, ed. Behrman and T.N. Srinivasan, pp.1883-2023. North-Holland: Amsterdam.

Strauss, John and Duncan Thomas. 1998. *Health, Nutrition and Economic Development.* Journal of Economic Literature. 36/2: 766-817

Tefft, James F. Research Methods in the MSU Food Security in Africa Project: Conceptualizing and Implementing Policy Relevant Studies. *MSU International Development Papers*, Working Paper No. 38, 1990.

Teklu, Tesfaye, 1996. Food Demand Studies in Sub-Saharan Africa: A Survey of Empirical Evidence. *Food Policy*, Vol. 21, No. 6, pp. 479-496, 1996.

Tiffin, Abigail and R. Tiffin. 1999. Estimates of food demand elasticities for Great Britain: 1972-1994. *Journal of Ag Econ* 50: 140-147.

Timmer, C. P. and H. Alderman. 1979. Estimating consumption parameters for food policy analysis. *American Journal of Agricultural Economics* 61: 982-987.

Tobin, James. 1958. Estimation of Relationships for Limited Dependent Variables. *Econometrica*. 26: 26-36.

Yen, S.T. and T.L. Roe. 1989. Estimation of a two-Level demand system with limited dependent variables. *American Journal of Agricultural Economics* 71: 85-99.

Zellner, A. 1962. An Efficient Method of Estimating Seemingly Unrelated Regressions and Tests for Aggregation Bias. *Journal of the American Statistical Association* 57:348--368.

Zellner, A. and H. Theil. 1962. Three-Stage Least Squares: Simultaneous Estimation of Simultaneous Equations. *Econometrica* 30:54--78. 3.

APPENDIX 1

Table A1-1: Topics Covered by Questionnaires in Each Survey Round

Topics	Variables
Socioeconomic status	Age
	Gender
	Education
	Marital status
	Source of revenue
	Class of revenue
	Profession
	Household composition
	Housing status
	Ownership of assets
	Years in Bamako
	Access to basic infrastructure
Daily food at-home consumption	Quantity (kg)
	Price (FCFA)
	Source (purchased, gift)
	Market of purchase
	Processing time
	Individual consumption or not of prepared meals
Daily food away from home consumption	Source
	Type (street food vendors, restaurants, individual home consumption)
	Purchases
	Unit (plate, spoon, kg)
	Quantity
Daily non-food purchases	Price (FCFA)
	Unit
	Quantity
	Household member incurring the purchase
	Household member benefiting from the purchase
	Type (health, hygiene, education, transportation service and clothing)
Monthly expenditures recall	Payments for services, energy, sacs of grains, etc…
	Household member incurring the purchase
	Household member benefiting from the purchase
	Price (FCFA)
	Unit
	Quantity

Table A1-2: Sample Size

	Phase					
	L	H	PH	P	Avg	Total
Total # AE	509	504	530	537	520	2080
# of individuals	664	660	695	706	681	2725
# of FCU	40	40	40	40	40	160

Note: The seasons are defined as follows: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.. AE = Adult Equivalents; FCU = Food Consumption Unit.

Table A1-3: Commodity Groups Definition

Commodity groups	Specific Items
Cereals	Rice, Millet-Sorghum, Maize Wheat products, Other Cereals
Roots and tubers	Atieké, Cassava, Potato Sweet Potato
Meat and Fish	Beef, Mutton, Poultry, Fish
Oil	Peanut oil, Palm oil, Sheanut oil
Sugar	
Vegetables	Leaves, Okra, Onions, Tomatoes Other vegetables: fresh All other vegatbles
Milk, Dairy,and Eggs	Butter, Buttermilk, Fresh milk Condensed sweetened milk Powdered milk, Eggs
Beverages	Coffee, Lipton tea, Green tea Quinqueliba
Fruits	Banana, Lemon, Dates Raisin, Citronella, Tamarind
Others	Nuts, Seasonings, and Spices
Food Away From Home (FAFH)	Food purchased from street vendors and Food purchased at restaurants
Durable goods	Household Appliances Equipment for entertainment, Education
Semi-Durable Goods	Clothing, Footwear, Books, Newspaper, Magazines, Jewerly, Watches, Toilet Articles, Cosmetics
Non-Durable Goods (excl. food)	Electricity, Brutane Gaz, Other Fuels, Medical and Health Care, Gasoline, Oil, Tobacco, and Hygiene
Services	Laundry, Domestic Services, Other Household Services Purchased Transportation, Recreational and Cultural Services, Communications.

Figure A1-1: Map of Mali

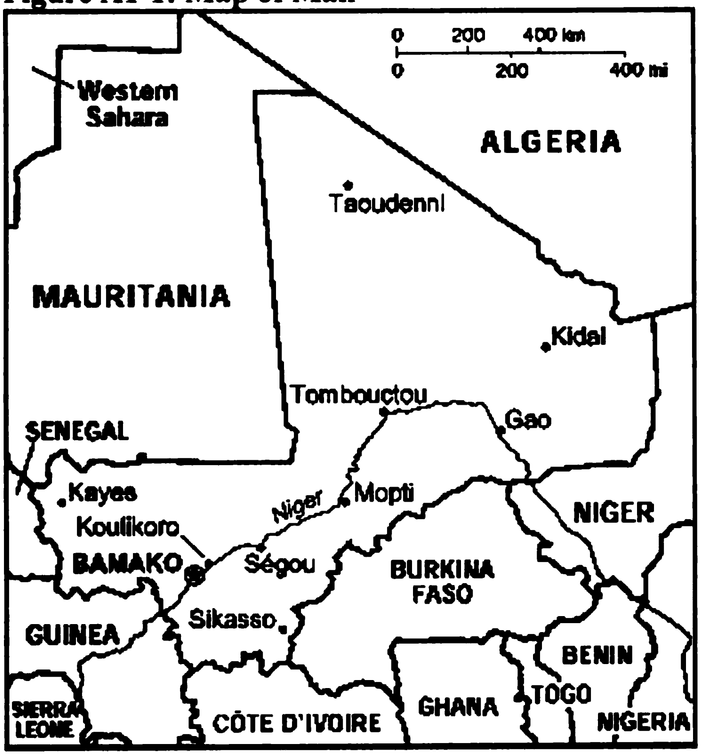
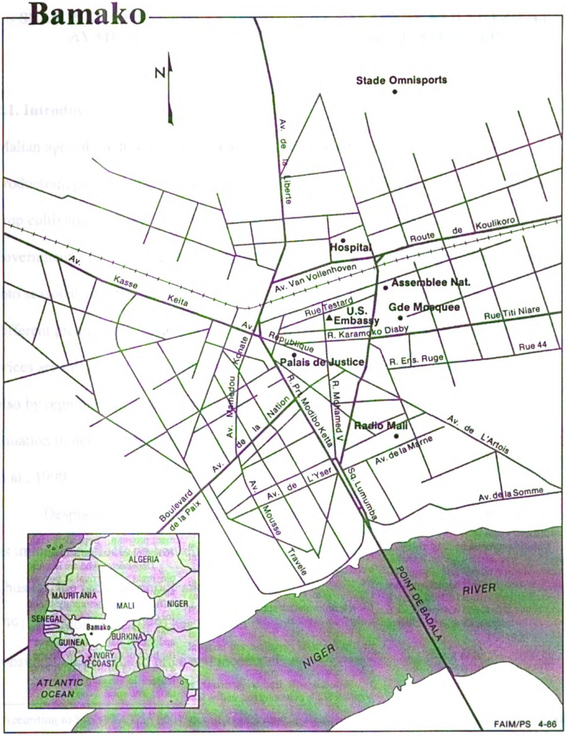


Figure A1-2: Map of Bamako



CHAPTER 2

SEASONAL CHANGES IN EXPENDITURE PATTERNS AND NUTRIENT AVAILABILITY FOR HOUSEHOLDS IN BAMAKO, MALI: A DESCRIPTIVE ANALYSIS

2.1. Introduction

Malian agriculture has long been characterized by strong seasonal variations in production, primarily because the country's economy relies predominantly on rainfed crop cultivation (FEWS, 2000).[9] Prior to the 1980s market reforms, the Malian government's price stabilization schemes restrained how the volatility in output translated into seasonal variation in grain prices (Dembélé et al., 1999).[10] However, a quite different picture has emerged now that cereals markets are liberalized. Today, grain prices are influenced not only by the seasonal pattern of production and availability but also by regional and international supply and demand conditions and by the political situation in neighboring countries such as Côte d'Ivoire (e.g., Tefft et al., 1997; Dembélé et al., 1999).

Despite the importance of seasonal grain price variation in Mali, measurements of its immediate effects on households' consumption patterns have been relatively scarce. Thus far, the focus of policy and previous consumption studies (Rogers and Lowdermilk, 1991; Reardon et al. 1999) has been on the long-term adjustment of households' consumption patterns to price and income changes. However, urban households are net

[9] According to FAOSTAT, in 2001, out of Mali's total agricultural area, 34,700,000 hectares, only 138,000 hectares (or 0.4%) were irrigated.

[10] Examples of such schemes include the Malian government fixing of official producer and consumer prices, through the official grain marketing agency (Office Malien des Produits Agricoles (OPAM)), for cereals and restrictions on inter-regional grain shipments (Dembélé and Staatz, 1999). However, official prices were not available to everyone, as OPAM handled at most 40 percent of the country's marketed grain surplus and due to the illegal private trade of grains (Dembélé and Staatz, 1999).

food purchasers (Rogers and Lowdermilk, 1991). They earn cash income, allocate 54 percent of their income on food, and spend 40 to 50 percent of their food budget on cereals (Rogers and Lowdermilk, 1991; Singare et al., 1996). Therefore, seasonal variation in grain prices is likely to affect urban households' ability to obtain adequate food through the effects of grain price fluctuations on consumers' real incomes. Recent studies (e.g. Chambers, 1981; Sahn, 1989; Paxon, 1993) have shown that the stability of urban households' real income from one season to another constitutes an important determinant of household food security. According to the Food and Agricultural Organization (FAO), food security remains a major problem in Mali. The FAO found that, in 1999, the average annual caloric intake was in the order of 2073 kilocalories per person per day (compared to the 2200 kcal minimum requirement), and the average annual per capita consumption of cereals amounted to 155 kilograms (versus the 200 kilograms recommended amount) (FAO, 1999).

This essay is based on the hypothesis that seasonal variation in the relative prices of commodities translate into seasonal changes in households' real incomes, which in turn will affect households' seasonal consumption choices by altering the set of market baskets they can afford. This would mean that seasonal changes in real incomes could affect not only the quantity but also the quality of food consumed in households in any given season. From a policy perspective, this implies that safety-net programs may be more or less effective at different periods of the year, depending on the set of relative prices faced by households and their real incomes at the time of their implementation.[11]

[11] Safety nets are formal (e.g., food aid and consumption subsidies) and informal (e.g., extended family) measures that help improve low-income households' access to food. The national food security stock program is an example of a current safety net program that is implemented in Mali. This program utilizes early warning systems to target food to the food insecure population.

This study examines (i) seasonal changes in relative prices and real expenditures, (ii) households' seasonal expenditure patterns, (iii) seasonal availability of nutrients from at-home foods, and (iv) the effects of including estimates of nutrient availability from away-from-home foods on average daily total nutrient availability using sensitivity analyses. The results will help close some of the knowledge gap in the food consumption literature in Mali.

2.2. Methodological Framework

2.2.1. The Complete Demand System Approach (CSA)

The framework chosen for this study is the Complete Systems Approach (CSA). The CSA describes the household's budget allocation among a comprehensive set of consumption categories. This framework takes into account the mutual interdependence of large number of commodities in the choices made by consumers (Raunikar and Huang, 1987). Thus, the approach provides information on the degree and nature of interrelatedness of commodities and allows incorporating the inherent simultaneity of consumer purchase decisions across the spectrum of goods and services into the analysis of households' consumption patterns (Raunikar and Huang, 1987). Table 2-1, below, depicts the commodity definitions used in this study.[12] The groupings were chosen based on our *a priori* knowledge about food consumption patterns among Bamako households and in order to keep the number of non-consuming households for the groups to be very small.[13]

---

[12] Housing expenditures are excluded from the analysis because over 90 percent of the sample households own the dwelling in which they reside and do not pay rent. In this case, rental equivalents are potentially inaccurate, and the benefits of completeness need to be weighed against the costs of error (Deaton and Zaidi (1999)).

[13] The method of commodity classification in this study is as follows: first, the classification of goods and services started with the identification of 137 specific food items and 300 non-food items; second, these goods and services were then aggregated into 12 commodity groups.

Table 2-1: Complete Demand System Approach

Major Component		Commodity		Item
1 **Food**	1	Rice	1	Rice
	2	Other Staples	2	Millet-Sorghum
			3	Maize
			4	Wheat and Fonio
			5	Atieke
			6	Cassava
			7	Potato
			8	Sweet Potato
	3	Meat and Fish	9	Beef
			10	Mutton and Poultry
			11	Dry Fish
			12	Fresh Fish
	4	Vegetables	13	Leaves
			14	Okra
			15	Onions
			16	Tomato (fresh and concentrate)
			17	Other Vegetables
			18	Beans (fresh and dried)
	5	Oil	19	Peanut Oil
			20	Palm Oil
			21	Sheanut Oil
	6	Sugar	22	Sugar
	7	Others	23	Butter and Buttermilk
			24	Fresh Milk
			25	Condensed Sweetned Milk
			26	Powdered milk
			27	Eggs
			28	Peanuts
			29	Seeds
			30	Coffee
			31	Tea Lipton
			32	Green Tea
			33	Quinqueliba and other
			34	Banana
			35	Lemon
			36	Tamarind
			37	Other Fruits (Dates, Orange, Raisins)
			38	Seasonings and Spices
	8	Food Away From Home	39	Food Away From Home
2 **Non-Food**	9	Education		
	10	Housewares		
	11	Personal Care		
	12	Health		
	13	Hygiene		
	14	Energy and Utilities		
	15	Tobacco		
	16	Transportation		
	17	Recreation		

2.2.2. The Data

The panel data used in this study is from a 2000-2001 survey undertaken in Bamako by the Direction Regionale du Plan et de la Statistique (DRPS) of the Direction Nationale de la Statistique et de l'Informatique (DNSI) and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA) of Michigan State University (MSU), the Assemblée Permanente des Chambres d'Agriculture du Mali (APCAM), and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD). Data collection took place in Bamako, the capital city of Mali. The survey was conducted in four rounds, one week in each quarter of the year, during the period of August 2000 to May 2001. The four surveys covered 40 Food Consumption Units (FCU), the sample size in each being the same. The same 40 households were tracked over time and interviewed in all four periods. There was no sample attrition. Data were collected for seven consecutive days during each survey round. The objective of the survey was to provide a detailed understanding of urban households' seasonal food and non-food items procurements in terms of type, quantities, source and expenditure.

The survey was organized in four months of equal periods. The seasons were defined based on agricultural activity in Mali. Phase 1 (August) corresponds to the lean season, Phase 2 (November) to the harvest season, Phase 3 (February) to the post-harvest season, and Phase 4 (May) to the planting season.[14] The harvest season extends from September through November for millet, sorghum, and maize; from November through December

[14] The data collection week, within each survey month, was randomly selected in order to avoid bias associated with a specific week. Furthermore, the distribution of expenditures across households was closely examined, in the data cleaning process, in order to assess whether expenditures data collected in the first week of the month was higher for salaried households. The data did not provide any supportive evidence with respect to such bias.

for rainfed rice; and from October through November for irrigated rice. In a typical year, cereals prices tend to fall during the harvest season, as surplus producers and traders unload stocks in anticipation of a good harvest. However, if the season has been a poor one, prices may remain high or even increase as stocks are withheld. The post-harvest season extends from December through February and also corresponds to the cold season. Cereals' prices are generally lowest during the post-harvest season, as granaries are full during this period and grain availability in urban markets is highest. The planting season extends from May through July for millet, maize, and sorghum, from June-July for rainfed rice and from October through December for irrigated rice. Farming activities such as planting and weeding take place in this period. The hot season extends from March through May. From this point on, grain stocks begin to gradually decrease and reach their lowest levels during the lean season, also called the "hungry" season, which occurs right before the first harvest, primarily in August.

2.2.3. Computation of Variables

2.2.3.1. Consumption and Expenditure Aggregates

Following Deaton and Zaidi (1999), the food consumption in kilograms and expenditure in CFA Francs, the non-food expenditure in CFA Francs, and the total expenditures in CFA Francs aggregates were computed using the DRPS/MSU data. Detailed information on the construction of the expenditure aggregates is provided in Appendix A2-1.

2.2.3.2. Prices

This study uses weekly cereals price data observed over the year 2000-2001 for the capital city, Bamako. The weekly cereal price data for12 markets in Bamako was obtained from the Mali Market Information System (MIS) called "Observatoire du

Marché Agricole" (OMA). The Consumer Price Index used in this analysis is from a monthly report prepared by the Statistics Bureau, Direction Nationale de la Statistique et de l'Informatique (DNSI), of Mali. The DNSI consumer price index is based on data collected from surveys of households residing in the District of Bamako and is computed using the Laspeyres methodology.

2.2.3.3. Nutrient Availability

The nutrient estimates were derived from the at-home food consumption data on the quantities of food consumed and data on the nutrient composition of foods.[15] Nutrient values exclude nutrients from the inedible or non-servable components of foods (e.g., bones). The food quantities were converted into the edible portion using conversion factors (called "refuse percentage") computed by the USDA and found in the "Composition of Foods Raw, Processed, Prepared" (USDA, 2003). Once the edible portion was computed, the amount of nutrient in the edible portion was calculated using the food composition table. Losses from trimming, cooking, plate wastage, and spoilage are not accounted for in these values. The nutrient estimates computed this way represent nutrients in foods that are available for household consumption and not actual nutrient intakes by individuals.

2.3. Results

Seasonal changes in expenditure patterns and nutrient availability for Bamako households are examined in this section through a descriptive analysis of (i) seasonal changes in relative prices; (ii) households' seasonal expenditure patterns; and (iii) seasonal availability of nutrients. The analysis ends with sensitivity analyses on the estimates of

[15] The food composition data come from the food composition table for Mali prepared by Sundberg and Adams (1998) and from the USDA's Nutrient Data Bank System (2003).

nutrient availability in order to assess how the results would change when nutrient estimates from away-from-home foods are taken into account.

The descriptive analysis is essential for food policy purposes because it provides critical information on the composition of households' basket of goods and services under different economic conditions (e.g., food supply stocks, relative prices) and on the adjustments households make between and within food and non-food commodities across seasons.

2.3.1. Seasonal Changes in Relative Prices and Real Expenditures

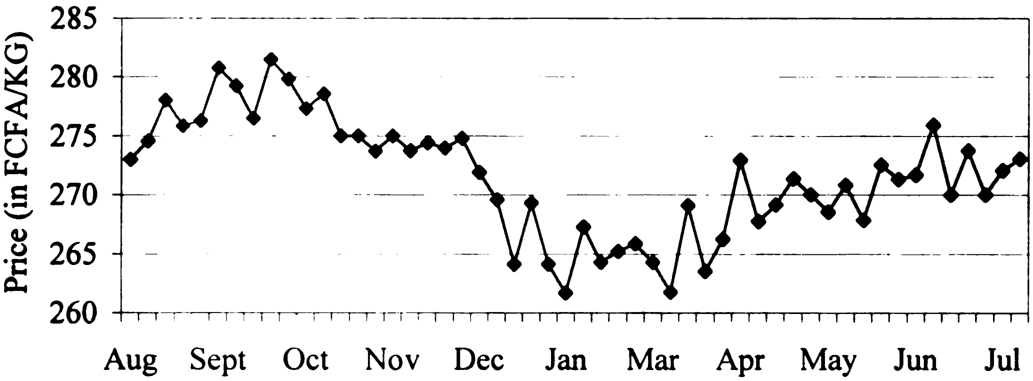
The aim of this section is to examine seasonal changes in relative prices and Bamako households' real expenditures. First, the study uses the Observatoire du Marché Agricole (OMA) price data to provide descriptive evidence on the seasonality of food prices. Second, the study describes seasonal changes in the relative prices of all-items, food and non-food components using the DNSI Consumer Price Index (CPI). Then, the CPI is used to deflate households' nominal expenditures in order to remove the effect of price changes.

2.3.1.1. Seasonal Changes in Relative Prices

Figures 2-1 and 2-2, below, present the average price of rice, millet-sorghum, and maize in Bamako markets from August 2000 to July 2001. First, the graphs show that rice is the most expensive cereal, selling at an annual average retail price of 272 CFA Francs per kilogram ($0.382). Millet-sorghum is the second most expensive staple, at 125 CFA Francs/kg ($0.176). Maize is the least expensive cereal, with an average annual retail price of 120 CFA Francs/kg ($0.168).

Second, Figure 2-1 shows that the price of rice was high during the lean season, in August, averaging about 275 CFA Francs per kilogram, *but* reached its highest level, 279 CFA Francs per kilogram, during the harvest season (November-December). In a typical year, the price of rice tends to fall during the harvest season as surplus producers and traders unload stocks in anticipation of a good harvest. However, during the year of the survey, cereal production was estimated to be 18 percent below that of the previous year (1999-2000) due to lower rainfall and an outbreak of desert locusts that began in October (FEWS, 2001). Thus, surplus producers and grain traders, expecting a bad harvest, withheld stocks; which led to an increase in cereals' prices prior to and during the harvest season (FEWS, 2001). Nevertheless, as the new harvest began to reach urban markets, the price of rice started to gradually decline and reached its lowest level, about 262 CFA Francs per kg in February, during the post-harvest season (December-February).

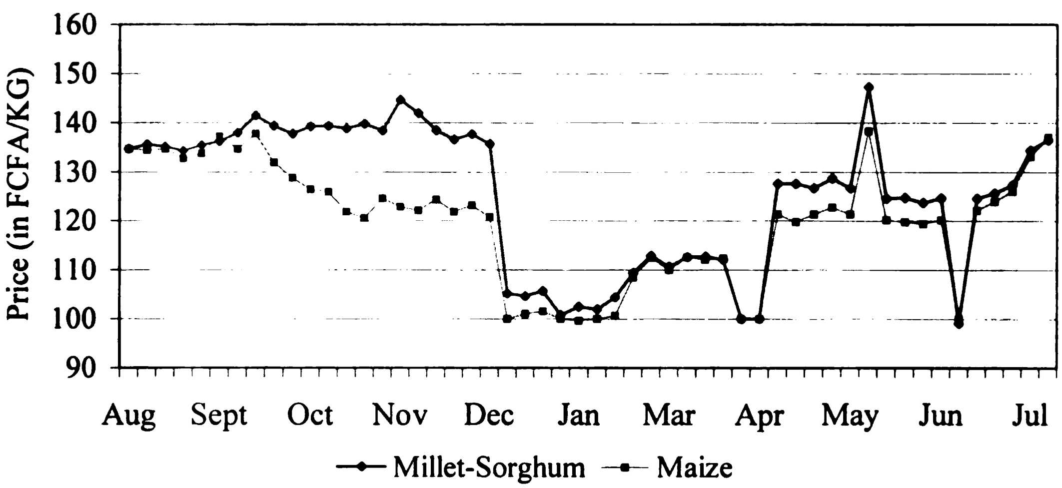
Figure 2-1: Average Retail Price of Rice in Bamako (CFA/KG) From August 2000 to July 2001



Source: Observatoire du Marche Agricole (OMA) data

Third, Figure 2-2, below, indicates that millet-sorghum and maize show similar price movements across seasons. The price of millet-sorghum averaged around 135 CFA Francs per kg during the lean season, in August, and began to gradually increase during the harvest season, between September and early December, averaging about 137 CFA Francs. The price of maize averaged around 135 CFA Francs per kg in August and, contrary to millet-sorghum, began to gradually decline at the beginning of the harvest. Maize prices declined sooner than millet-sorghum prices because maize is harvested earlier, usually beginning in August. The average price of maize during the harvest season was in the order of 125 CFA Francs per kg. Millet-sorghum and maize prices dropped sharply in the middle of December, averaging around 110 and 108 CFA Francs per kg, respectively, and remained low until mid-April. They begin to increase during the planting season (May-July), averaging around 126 and 122 CFA Francs per kg. This was partly due to depleted grain stocks, resulting in low food availability in urban markets, as significant coarse grain exports to a number of neighboring countries took place (e.g., millet supply in Bamako's market decreased from 3,229 tons in January to 2,422 tons in February (OMA, 2001)). In April 2001, 3000 tons of millet was exported to Burkina Faso, 500 tons to Niger, and 250 tons to Côte d'Ivoire (OMA, 2001).

Figure 2-2: Average Millet-Sorghum and Maize Retail Prices in Bamako (CFA/KG) from August 2000 to July 2001



Source: Observatoire du Marche Agricole (OMA) data

Table 2-2, below, presents the relative prices, as measured by the price ratio, of rice and millet-sorghum, rice and maize, and millet-sorghum and maize. First, the results indicate that Bamako households must give up, on average, about 2 kilograms of millet-sorghum and maize for 1 kilogram of rice. Second, the results indicate that the relative prices of cereals show substantial variations across seasons. For instance, the relative price of rice and millet-sorghum decreased by 5 percent between the lean and harvest seasons, increased by 28 percent between the harvest and post-harvest seasons, and dropped by 17 percent between the post-harvest and planting seasons.

Table 2-2: Seasonal Changes in the Relative Prices of Cereals

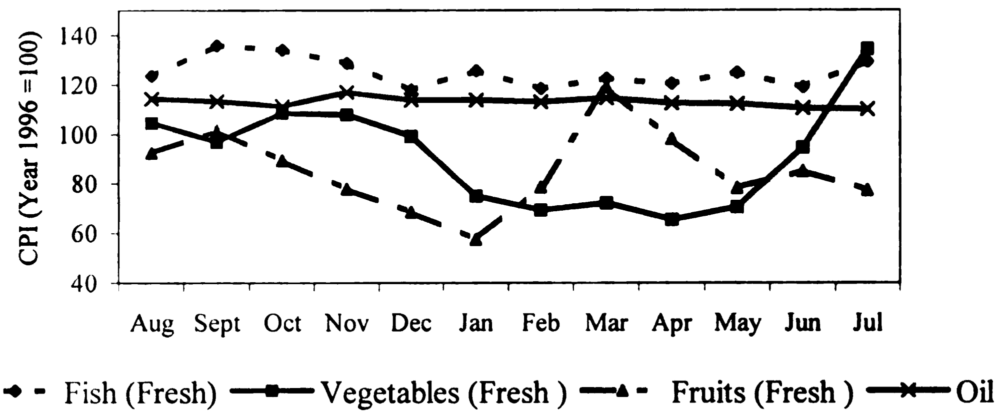
	Price Ratio					% Change Between		
	L	H	PH	P	Mean	H-L	PH-H	P-PH
Rice/Millet-Sorghum	2.041	1.944	2.483	2.051	2.130	-5	28	-17
Rice/Maize	2.054	2.239	2.527	2.149	2.242	9	13	-15
Millet-Sorghum/Maize	1.006	1.152	1.017	1.048	1.056	14	-12	3

Source: Observatoire du Marche Agricole (OMA) data
Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Figure 2-3, below shows the relative prices, as measured by the consumer price index, of fish, vegetables, fruits, and oil for Bamako markets from August 2000 to July 2001. The price of vegetables increased between September and November, as most horticultural goods, such as green beans and leafy vegetables, are planted during this period. The growing season for vegetables corresponds to the cool dry season, which extends from October to January. The price of vegetables started to gradually decline from November until May, when they began to rise again. This is the period when most horticultural crops are harvested.

Fish prices increased between August and September, dropped between September and January, and remained fairly stable until June, when they begin to increase again. Fishing activity in Mali largely depends on two hydrological seasons: rainfall and river discharge (IRD, 2002). The Niger River usually floods in July, during the rainy season. The flood recedes between November and January. The fishing campaign usually begins then and ends when water levels are low, between March and June.

Figure 2-3: Seasonal Changes in the Relative Prices of Fish, Vegetables, Fruits, and Oil



Source: Observatoire du Marche Agricole (OMA) data

Table 2-3, below, presents the relative prices, as measured by the price ratio, of rice and beef, rice and green leaves, and beef and green leaves.[16] First, the results indicate that Bamako households must give up, on average, over 3.5 kilograms of rice for 1 kilogram of beef, 1.4 kilograms of rice for 1 kilogram of green leaves, and 2.646 kilograms of green leaves for 1 kilogram of beef. Second, the results show that the relative price of rice and beef is fairly stable across seasons. The biggest change, +3 percent, in the price ratio of rice and beef occurs between the post-harvest and planting seasons, due to a drop in the price of beef over that period. Beef prices usually increase

[16] Unit values are used as proxy for prices.

during the cool dry season, as cattle weight drops due to decreased availability of grassy vegetation and bushy plants in grazing areas. The relative price of rice and green leaves and beef and green leaves both decreased by 44 percent between the harvest and post-harvest seasons. This was due to a sharp drop in the price of green leaves, which was caused by greater availability of these goods in Bamako markets. Between the post-harvest and planting seasons, the relative price of rice with respect to green leaves and beef with respect to green leaves increased by 51 and 47 percent, respectively. This was due to lower beef prices due to the arrival of the rainy season, which usually occurs between June and September, as animals gain weight. The price of green leaves also dropped between this period.

Table 2-3: Seasonal Changes in the Relative Prices of Key Foods

	Price Ratio					% Change Between		
	L	H	PH	P	Mean	H-L	PH-H	P-PH
Rice/Beef	0.274	0.272	0.271	0.279	0.274	-1	0	3
Rice/Green Leaves	0.900	0.896	0.502	0.759	0.726	0	-44	51
Beef/Green Leaves	3.278	3.293	1.851	2.716	2.646	0	-44	47

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table 2-4, below, presents estimates of the CPI for all items, food and non-food major components, and percentage change in the CPI across seasons. The all-Items CPI measures the average rate of price change for all goods and services purchased by Bamako households from one point in time to another. The all-items CPI rose by 1 percent between August and November (lean-harvest) due to increases in the price of food (1 percent), energy and utilities (1 percent), and education (1 percent). The higher costs of food during this period can be largely attributed to increases in the price of cereals (1 percent) as the price of fish, vegetables, and fruits decreased by 4, 5, and 26 percent, respectively. Cereal prices remained unusually high since the season had been a relatively poor one compared to the record production yields of 1998 and 1999 (OMA, 2001). Yet, cereal prices started to gradually decline with the arrival of the new harvest in urban markets.

Table 2-4: The Consumer Price Index (Year 1996 =100) and Percentage Change across Seasons[17]

Components	CPI (%)				Percentage Change Between		
	L	H	PH	P	H-L	PH-H	P-PH
All-Items	103	104	102	106	1	-2	4
Food	98	99	94	101	1	-4	8
Cereals (unprocessed)	87	88	86	99	1	-3	15
Fish (Fresh)	123	118	118	125	-4	0	5
Vegetables (Fresh)	105	99	69	71	-5	-30	2
Fruits (Fresh)	93	68	79	78	-26	15	0
Oil	114	114	113	112	0	-1	-1
Footwear and Clothing	105	105	108	110	0	2	2
Energy and Utilities	106	107	107	109	1	0	2
Housewares	110	110	106	107	0	-3	0
Health	102	102	102	103	0	0	1
Transport	114	114	115	115	0	1	0
Recreation	99	99	100	100	0	1	0
Education	104	106	112	112	1	6	0
Other Goods and Services	114	113	115	114	0	1	0

Source: DNSI
Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

As shown in Table 2-4, the price of cereals, vegetables, and oil fell by 3 percent, 30 percent, and 1 percent, respectively, between the harvest (November) and post-harvest (February) seasons, resulting in a 5 percent drop in food prices. The lower price of vegetables can be explained by the fact that the availability of horticultural products substantially increases in Bamako markets during this period. The price of goods and

[17] The rate of change from the previous period is calculated as follows: Rate of change (%) = [(Et - Et-1) / Et-1], where Et and Et-1 are expenditure in the current and previous period, respectively.

services decreased by 2 percent over the same period due the lower food prices and a 3 percent decline in the price of housewares. Between February and May (post-harvest-planting), the all-items CPI increased by 4 percent due to higher prices of food (+7 percent), footwear and clothing (+2 percent), energy and utilities (+2 percent), and health (+1%). Higher food prices can largely be attributed to increases in the price of cereals (13 percent), fish (2 percent), and vegetables (2 percent) over the same period. The increase in cereal prices was partly due to the low grain availability in urban markets following a period characterized by substantial coarse grain exports to a number of neighboring countries.

2.3.1.3. Seasonal Changes in Real Expenditures

Table 2-5, below, reports average monthly and annual nominal and real expenditure per adult equivalent (AE) by season and seasonal changes in real expenditure for the entire sample and by income group.[18] First, the results provide an indication of the poverty that prevails in Bamako households, as their average annual real expenditures are in the order of 280,154 FCFA/AE (US$392).[19] Low-income households spend on average 184,495 FCFA/AE (US$258) annually, followed by 249,615FCFA/AE (US$349) for the middle tercile, and 408,701 FCFA/AE (US$572) for the high-income groups.

Second, the results, presented in Table 2-4, indicate that Bamako households' mean nominal expenditures vary considerably across seasons. Households mean

[18] The sample was divided into three income groups. The low-income group's annual expenditures per adult equivalent are strictly less than 212,000 FCFA. The middle income group's annual expenditures per adult equivalent are between 212,000 and 300,000 FCFA. The high-income group's annual expenditures per adult equivalent exceeded 300,000 FCFA. The adult equivalent scales used are: male>14 years=1.0, female>14years=0.8 and children=0.5 (Duncan, 1994).

[19] The exchange rates are $1=626 FCFA in August 2000, $1=769 FCFA in November 2000; $1=708 FCFA in February 2001; and $1=760 FCFA in May 2001(OANDA, 2003). The annual average exchange rate was $1=711 FCFA.

expenditures per AE are highest in August, the lean season, 33,471 FCFA/AE (US$54), and lowest in May, the planting season, 18,793 FCFA/AE (US$24). Households' mean nominal expenditures decrease by 35 percent between the lean and post-harvest season (August and November), increase by 2 percent between the harvest and post-harvest season (November and February), and drop by 15 percent between the post-harvest and planting season (February and May).

Table 2-5: Monthly Mean Nominal and Real Expenditure per Adult Equivalent (CFA Francs) and Seasonal Changes in Expenditure (%) by Income Group

Income Group	Phase						% Change Between		
	L	H	PH	P	Avg	Yearly	H-L	PH-H	P-PH
Nominal Expenditure									
Low	25411	12642	12941	12349	15836	190030	-50	2	-5
Middle	33663	20468	17442	14128	21425	257104	-39	-15	-19
High	41323	32311	36425	30261	35080	420962	-22	13	-17
Mean	33471	21774	22149	18793	24047	288558	-35	2	-15
Real Expenditure									
Low	24671	12156	12687	11650	15375	184495	-51	4	-8
Middle	32682	19681	17100	13329	20801	249615	-40	-13	-22
High	40120	31068	35711	28548	34058	408701	-23	15	-20
Mean	32496	20936	21714	17729	23346	280154	-36	4	-18
Difference									
Low	740	486	254	699	461	5535	1	-2	3
Middle	980	787	342	800	624	7488	1	-2	3
High	1204	1243	714	1713	1022	12261	1	-2	3
Mean	975	837	434	1064	700	8405	1	-2	3

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Difference = Nominal Income – Real Income.

The seasonality of households' expenditures can be partly explained by the fact that households receive substantial financial help from migrants, relatives, and the extended family during the year. As shown in Table 2-6, below, the proportion of the sample head of households' real incomes that comes from remittances ranges from 22 percent in August and to 12 percent during the other seasons.

Table 2-6: Source of Income for the Head of Household by Season

Income Source of Head of Household	Phase					% Change Between		
	L	H	PH	P	Avg	H-L	PH-H	P-PH
Salaries	33	40	45	43	40	21	13	-4
Commercial activities	17	22	20	20	20	29	-9	0
Agricultural activities	5	5	5	8	6	0	0	60
Aid	22	12	12	12	15	-45	0	0
Other activities	23	20	17	17	19	-13	-15	0

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting

Third, the effect of seasonal price changes on households' expenditures is removed by deflating their nominal expenditures by the all-items CPI in order to assess whether seasonal changes in the relative prices of goods and services are driving the changes in total expenditures across seasons. The results, presented in Table 2-4, indicate that only a small fraction of the observed seasonal variation in expenditures can be attributed to seasonal changes in the relative prices of goods and services. During the year of the survey, the all-items CPI rose by 1 percent between August and November (lean-harvest), decreased by 2 percent between November and February (harvest-post-harvest), and increased by 4 percent between February and May (post-harvest-planting).

2.3.2. Households' Seasonal Expenditure Patterns

In this sub-section, a descriptive analysis of Bamako consumers' expenditure patterns with special emphasis on the differences observed between seasons and income groups is performed. The allocation of households' total nominal expenditures between and within two major expenditure groups, food versus non-food, is closely examined for each season and annually in order to uncover the source of the observed seasonal variation in expenditures. Tables A2-1 through A2-4 of Appendix 2 provide detailed results on

Bamako households' food consumption in kilograms per adult equivalent and food and non-food expenditures in FCFA per adult equivalent by season and by income group.

2.3.2.1. Expenditure Patterns: Food vs. Non Food

Figure 2-5, below, shows the average weekly expenditure per adult equivalent on food and non-food commodity groups by income group. Households allocate on average annually 37 percent of their total budget to food (or 2201FCFA/AE) and 63 percent of their total budget to non-food commodities (or 3810 FCFA/AE). The food budget share declines with rising income levels (Engel's Law): 47 percent, 41 percent, and 29 percent among the low, middle, and high expenditure groups, respectively.

Figure 2-5: Weekly Mean Food Expenditure Levels (FCFA/AE) and Food Budget Shares (%) by Income Group

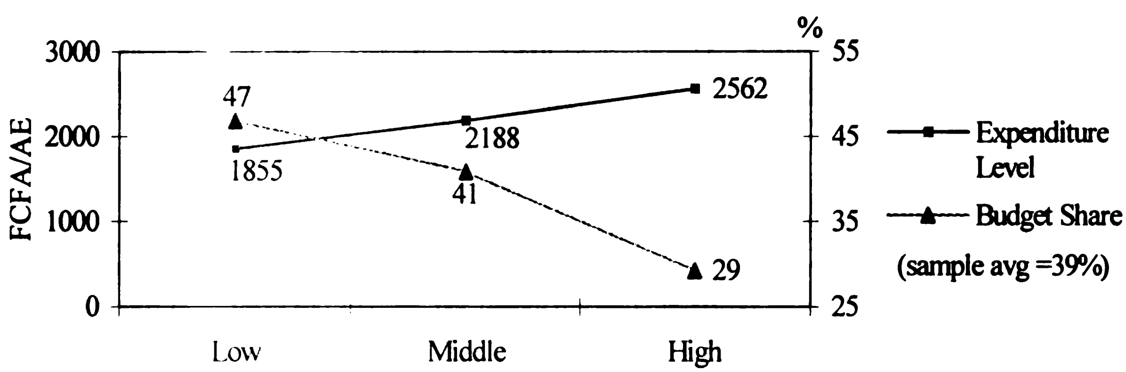


Table 2-7, below, shows the average weekly mean nominal food and non-food expenditure per adult equivalent by season, budget shares, and percentage change in expenditures across seasons. The results indicate that much of the observed seasonal variation in expenditures can be attributed to changes in non-food expenditures, as food expenditures remain fairly stable across seasons. For instance, between August and November, urban households' average weekly expenditures on non-food commodities decrease by 46 percent (from 5990 FCFA/AE ($9) to 3241 FCFA/AE ($4)), whereas food expenditures decrease by 7 percent (from 2377 FCFA/AE ($4) to 2202 FCFA/AE ($3)).

Table 2-7: Weekly Mean Nominal Food and Non-Food Expenditure per Adult Equivalent by Season (CFA Franc/AE), Budget Shares (%), and Percentage Change in Expenditures across Seasons (%)

Commodities	L	H	PH	P	Annual
			Mean Expenditure/AE		
Food	2375	2204	2101	2127	2202
Non Food	5991	3248	3467	2601	3827
Total	8366	5452	5567	4728	6028
			Budget Share		
Food	29	44	43	50	39
Non Food	71	56	57	50	61
Total	100	100	100	100	100
			Percentage Change From		
		Nov	Feb	May	
Food		-7	-5	1	
Non Food		-46	7	-25	
Total		-35	2	-15	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Between November and May, households reduce their non-food expenditures by 25 percent (from 3467 FCFA/AE to 2601 FCFA/AE) while food expenditures increase by 1 percent (from 2101 FCFA/AE to 2127 FCFA/AE). There are two possible explanations, which are not mutually exclusive, for the observed seasonal variation in non-food expenditures. The first is that households may attempt to smooth their food consumption levels across seasons by incurring large changes in their non-food budget. This can be explained by the fact that these households, especially poor households, consume near subsistence levels of food, thus are more likely to make large cutbacks in their non-food expenditures because this is the only way for them to maintain their food consumption levels. However, the observed seasonal variation in non-food expenditures could also be due to the seasonality of demand for non-food commodities. For instance, households' expenditures on clothing and footwear are generally highest in August as they prepare for the school year, which begins in September, and during periods of religious festivities, such as the Tabaski. Similarly, households' expenditures on traditional and formal health services are high during the lean and planting seasons, as often-fatal illnesses such as malaria and diarrhea are prevalent during those periods. Hence, the issue for households could either be one of smoothing consumption in the face of variable income and/or one of meeting seasonally high expenditure requirements in the face of relatively stable income. One must keep in mind that, given the extreme poverty that prevails in Bamako, households will have limited scope for discretion with respect to their spending.

2.3.2.2. Food Expenditure Patterns

Table 2-8, below, presents the mean weekly expenditure per AE and food budget share. The three most important food commodities for Bamako households are staples, food away from home, and meat and fish. Staples constitute the dominant part, 32 percent, of the food budget share. However, rice expenditures alone account for about 21 percent of the food budget, as Bamako households spend on average weekly 465 FCFA/AE ($0.65) on this item.

Table 2-8: Mean Weekly Expenditure (FCFA/AE) and Budget Share (%) Allocated to Individual Food Commodities

Commodities	Expenditure (FCFA/AE/Week)	Budget Share (%)
Rice	465	21
Other Staples	242	11
Meat and Fish	353	16
Vegetables	272	12
Oil	76	3
Sugar	136	6
All Others Food At-Home	238	11
Food Away From Home	419	19
Total	2201	100

Note: **FAFH:** Food Away From Home; **Other Staples:** Millet-Sorghum, Maize, Wheat, Fonio, Sweet Potato, Potato, Atieke, Cassava; **Others:** Fruits, Beverages, Legumes, Nuts, Seeds, Seasonings and Spices.

The second most important expenditure category is food away from home. Bamako households allocate on average 19 percent (or 419 FCFA/AE ($0.59)) of their food budget to food away from home. Away-from-home expenditures are those incurred at restaurants, purchases from street vendors and foods purchased for individual consumption. Street vendors are the most predominant source in the food away from home category for all income groups mainly because they provide inexpensive, accessible service and varied foods. The food away from home data indicates that a substantial proportion, on average about 86 percent, of food away from home expenditures, are incurred by household members who are employed, suggesting that young children are largely excluded from this consumption. Also, the data shows that on average about 20 percent of food away from home expenditures are made by the head of household, while, on average, the household head accounts for only 6 percent of the household population (The average household in Bamako is composed of 17 members).

Table 2-9, below, presents the mean weekly expenditure per AE and food budget share by income group. Staples account for the largest share of the food budget for all terciles, ranging from 36 percent for the lowest to 30 percent for the highest. The proportion of the food budget devoted to staples in fact declines with rising expenditure levels: 36 percent, 31 percent, and 30 percent for the low, middle, and high income groups, respectively. In contrast, the proportion of the food budget devoted to meat and fish, vegetables, and oil tend to increase with rising income levels. This is an illustration of Bennett's law, which holds that expensive sources of calories (i.e., meat and fish) are substituted for cheaper ones (i.e., staples) with rising income levels. These results suggest that Bamako households tend to diversify their diets as their income increase.

Table 2-9: Mean Weekly Expenditure (FCFA/AE) and Budget Share (%) Allocated to Individual Food Commodities by Income Group

Commodities	Expenditure (FCFA/AE/Week)			Budget Share (%)		
	Low	Middle	High	Low	Middle	High
Rice	454	462	477	24	21	19
Other Staples	226	210	293	12	10	11
Meat and Fish	250	317	495	13	14	19
Vegetables	216	278	324	12	13	13
Oil	65	72	92	3	3	4
Sugar	109	139	158	6	6	6
All Others Food At-Home	200	223	291	11	10	11
Food Away From Home	336	486	431	18	22	17
Total	1855	2188	2562	100	100	100

Note: **FAFH:** Food Away From Home; **Other Staples:** Millet-Sorghum, Maize, Wheat, Fonio, Sweet Potato, Potato, Atieke, Cassava; **Others:** Fruits, Beverages, Legumes, Nuts, Seeds, Seasonings and Spices.

Table 2-10, below, presents the mean weekly expenditure per AE, mean food budget share, and percentage change in expenditures and the budget shares across seasons. The results indicate that Bamako households make sizable changes in the composition of their food basket across seasons. Between August and November (lean-harvest), households' increase their expenditures on rice and other staples by 6 percent and 1 percent, respectively, while they reduce their expenditures on all other foods. In terms of budget shares, the results show that households increase the proportion of their food budget devoted to rice (+15 percent), other staples (+9 percent), and meat and fish (+6 percent) while reducing the proportion allocated to all other foods over the same period. The reduction in the consumption of other foods can be attributed to higher vegetable prices that prevail during this period, as the availability of leafy vegetables and many horticultural goods is low in Bamako markets during their growing season.

Table 2-10: Mean Weekly Expenditure (FCFA/AE), Budget Share (%), and Percentage Change across Seasons

Commodities	Phase				% Change Between		
	L	H	PH	P	H-L	PH-H	P-PH
	Expenditure (FCFA/AE/Week)						
Rice	457	485	476	440	6	-2	-8
Other Staples	242	243	222	262	1	-9	18
Meat and Fish	381	374	365	293	-2	-2	-20
Vegetables	320	266	261	242	-17	-2	-7
Oil	103	69	76	57	-33	9	-25
Sugar	146	132	125	140	-10	-5	11
Others	284	226	223	218	-20	-1	-2
FAFH	444	407	356	471	-9	-12	32
Total	2377	2202	2103	2123	-7	-5	1
	Budget Share (%)						
Rice	19	22	23	21	15	3	-8
Other Staples	10	11	11	12	9	-5	17
Meat and Fish	16	17	17	14	6	2	-21
Vegetables	13	12	12	11	-10	3	-8
Oil	4	3	4	3	-28	14	-25
Sugar	6	6	6	7	-2	0	10
Others	12	10	11	10	-14	3	-3
FAFH	19	18	17	22	-1	-8	31
Total	100	100	100	100	0	0	0

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; FAFH: Food Away From Home; Other Staples: Millet-Sorghum, Maize, Wheat, Fonio, Sweet Potato, Potato, Atieke, Cassava; Others: Fruits, Beverages, Legumes, Nuts, Seeds, Seasonings and Spices.

Between November and February (harvest-post-harvest), with the exception of oil, households reduce their expenditures on all food commodity groups. During this period, households increase the proportion of the food budget allocated to rice (+3 percent), meat and fish (+2 percent), vegetables (+3 percent), oil (+14 percent), and other foods (+3 percent) while they decrease the proportion spent on other staples (-5 percent) and food away from home (-8 percent). Thus, Bamako households increase the proportion of their food budget devoted to non-staple commodities, and diversify their diets, only during periods characterized by low grain prices.

Between February and May (post-harvest-planting), households decrease the proportion of the food budget allocated to rice (-8 percent) for the first time during the entire year and that of meat and fish (-30 percent), vegetables (-9 percent), oil (-22 percent), and other foods (-10 percent). At the same time, they increase the budget share for other staples (+14 percent), sugar (+10 percent), and food away from home (+24 percent). These changes can be attributed to the high prices of grains, vegetables, and fish, as shown in Table 2-4, that prevail during the planting season due to low food availability. A possible explanation for the boost in the food share devoted to other staples and sugar is an attempt by households to maintain their calorie levels by preparing meals such as porridge, usually made with millet, sorghum, or maize flour, that are consumed in the morning and evening. The increase in the budget share of food away from home (i.e. street vendors) may reflect the head of household "individualizing" consumption in this period of high food costs by consuming foods that are too expensive to provide to the entire household (Reardon et al., 1999).

Tables 2-11 and 2-12, below, present the mean weekly expenditure per AE, mean food budget share allocated to food commodity groups, and percentage change in expenditures and the budget shares across seasons by income group. The results also indicate that the income groups show great similarities in their allocation of the food budget among food commodities as the relative importance of foods in their diets remains uniform. However, they do exhibit strikingly different adjustments in the proportion of their food budget allocated to individual food commodities in any given season. For instance, between August and November (lean-harvest), the biggest increase in the proportion of the food budget devoted to individual food commodities is other staples (31 percent) for the low income group and food away from home (12 percent) for the high income group.

Table 2-11: Mean Weekly Expenditure by Season and by Income Group (FCFA/AE), and Percentage Change across Seasons

	Expenditure (FCFA/AE/Week)						
	Phase				% Change Between		
Commodities	L	H	PH	P	H-L	PH-H	P-PH
Rice							
Low	458	477	440	443	4	-8	1
Middle	465	488	490	405	5	0	-17
High	448	491	496	474	9	1	-4
Other Staples							
Low	182	236	218	268	29	-8	23
Middle	251	192	176	222	-23	-9	27
High	292	306	275	300	5	-10	9
Meat and Fish							
Low	268	272	227	232	2	-17	2
Middle	350	270	388	259	-23	44	-33
High	527	587	477	389	11	-19	-18
Vegetables							
Low	256	202	205	199	-21	1	-3
Middle	314	275	288	234	-12	5	-19
High	391	320	288	295	-18	-10	2
Oil							
Low	99	51	57	52	-48	11	-9
Middle	85	67	82	55	-21	22	-34
High	127	89	88	65	-29	-2	-26
Sugar							
Low	125	104	93	114	-17	-10	22
Middle	152	129	135	140	-15	4	4
High	160	162	147	164	2	-9	11
All Others							
Low	239	197	175	189	-18	-11	8
Middle	299	217	197	180	-27	-9	-8
High	312	266	299	289	-15	12	-3
FAFH							
Low	395	285	253	409	-28	-11	61
Middle	546	487	443	468	-11	-9	6
High	384	441	365	536	15	-17	47

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; FAFH: Food Away From Home; Other Staples: Millet-Sorghum, Maize, Wheat, Fonio, Sweet Potato, Potato, Atieke, Cassava; Others: Fruits, Beverages, Legumes, Nuts, Seeds, Seasonings and Spices.

Table 2-12: Mean Budget Shares by Season and by Income Group (%), and Percentage Change across Seasons (%)

	Budget Share (%)						
	Phase				% Change Between		
Commodities	L	H	PH	P	H-L	PH-H	P-PH
Rice							
Low	23	26	26	23	16	1	-12
Middle	19	23	22	21	22	-3	-8
High	17	18	20	19	9	10	-7
Other Staples							
Low	9	13	13	14	43	1	8
Middle	10	9	8	11	-11	-12	42
High	11	12	11	12	4	-2	6
Meat and Fish							
Low	13	15	14	12	13	-9	-10
Middle	14	13	18	13	-11	39	-25
High	20	22	20	15	10	-11	-21
Vegetables							
Low	13	11	12	10	-12	11	-15
Middle	13	13	13	12	1	1	-9
High	15	12	12	12	-19	-1	-1
Oil							
Low	5	3	3	3	-43	21	-20
Middle	3	3	4	3	-8	18	-26
High	5	3	4	3	-30	7	-28
Sugar							
Low	6	6	6	6	-8	-2	7
Middle	6	6	6	7	-1	1	16
High	6	6	6	7	1	-1	8
All Others							
Low	12	11	11	10	-9	-3	-6
Middle	12	10	9	9	-16	-12	3
High	12	10	12	11	-16	23	-6
FAFH							
Low	20	16	15	21	-20	-3	41
Middle	22	23	20	24	3	-12	18
High	15	17	15	21	14	-10	42

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; FAFH: Food Away From Home; Other Staples: Millet-Sorghum, Maize, Wheat, Fonio, Sweet Potato, Potato, Atieke, Cassava; Others: Fruits, Beverages, Legumes, Nuts, Seeds, Seasonings and Spices.

2.3.2.3. Non-Food Expenditure Patterns

Table 2-13, below, presents the mean weekly non-food expenditure per AE and non-food budget share allocated to individual non-food items. The three most important non-food commodities for Bamako households are personal care, health, and housewares. Households allocate on average 20 percent (or 761 FCFA/AE/week ($1.07)) of their non-food budget to personal care (i.e., clothing and footwear). Health expenditures include expenditures on service items (i.e., formal public or private doctors, traditional healers and pharmacists) and medicine from both formal and informal sources and occupy on average about18 percent (or 698 FCFA/AE/week ($0.98)) of the non-food budget. Households allocate on average during the year 17 percent (or 642 FCFA/AE/week ($0.90)) of their non-food budget to housewares and to energy and utilities. Education expenditures (i.e., school fees and supplies) occupy on average only 3 percent (or 129 FCFA/AE/week ($0.18)) of households' non-food budget.

Table 2-13: Mean Weekly Non-Food Expenditure (FCFA/AE) and Budget Share (%)

Commodities	Expenditure (FCFA/AE/Week)	Budget Share (%)
Education	129	3
Housewares	642	17
Personal Care	761	20
Health	698	18
Hygiene	169	4
Energy and Utilities	638	17
Tobacco	92	2
Transportation	557	15
Recreation	124	3
Total	3810	100

Note: Education (fees, school supplies); Housewares (cooking items, housing maintenance and repairs, household appliances); Personal Care (clothing and footwear); Energy and Utilities (electricity, gas, wood, charcoal), Health (medical and health care); Hygiene (soaps, cleaning supplies), Transportation (purchased and private transportation, maintenance, repairs, insurance).

Table 2-14, below, presents the mean weekly non-food expenditure per AE and non-food budget share by income group. The proportion of the non-food budget devoted to education (2 percent for the low versus 5 percent for the high-income group), housewares (14 versus 21 percent), health (11 versus 17 percent), and recreation (2 versus 4 percent) tends to increase with rising income levels. In contrast, the non-food budget share allocated to personal care (24 for the low versus 16 percent for the high-income group), energy and utilities (23 versus 16 percent), and transportation (18 versus 15 percent) decreases with higher income levels.

Table 2-14: Mean Weekly Non-Food Expenditure (FCFA/AE) and Budget Share (%) Allocated to Individual Non-Food Commodity Groups by Income Group

Commodities	Expenditure (FCFA/AE/Week)			Budget Share (%)		
	Low	Middle	High	Low	Middle	High
Education	33	58	302	2	2	5
Housewares	292	287	1374	14	9	22
Personal Care	592	685	1011	28	22	16
Health	218	897	964	10	28	16
Hygiene	98	151	261	5	5	4
Energy and Utilities	397	541	984	19	17	16
Tobacco	17	147	107	1	5	2
Transportation	394	362	930	19	11	15
Recreation	63	40	276	3	1	4
Total	2104	3168	6208	100	100	100

Note: Education (fees, school supplies); Housewares (cooking items, housing maintenance and repairs, household appliances); Personal Care (clothing and footwear); Energy and Utilities (electricity, gas, wood, charcoal), Health (medical and health care); Hygiene (soaps, cleaning supplies), Transportation (purchased and private transportation, maintenance, repairs, insurance).

Table 2-15, below, shows the mean weekly expenditure and budget share by season and percentage changes in both across seasons. The results suggest that Bamako households' expenditures on many non-food goods and services tend to be highly seasonal. For instance, households' expenditures on traditional and formal health services are high during the lean and planting seasons, as often-fatal illnesses such as malaria and diarrhea are prevalent during those periods.

Table 2-15: Mean Weekly Non-Food Expenditure (FCFA/AE) and Budget Share (%) Allocated to Individual Non-Food Commodity Groups by Season and Income Group

Commodities	Phase				% Change Between		
	L	H	PH	P	H-L	PH-H	P-PH
	Expenditure (FCFA/AE/Week)						
Education	244	180	42	51	-26	-77	22
Housewares	1159	687	442	279	-41	-36	-37
Personal Care	1522	438	901	182	-71	106	-80
Health	1061	409	520	803	-61	27	54
Hygiene	211	168	155	143	-20	-8	-7
Energy and Utilities	827	546	641	538	-34	17	-16
Tobacco	79	120	74	93	51	-38	25
Transportation	722	565	530	412	-22	-6	-22
Recreation	166	127	129	75	-23	2	-42
Total	5990	3241	3434	2575	-46	6	-25
	Budget Share (%)						
Education	4	6	1	2	37	-78	62
Housewares	19	21	13	11	9	-39	-16
Personal Care	25	14	26	7	-47	94	-73
Health	18	13	15	31	-29	20	106
Hygiene	4	5	5	6	48	-13	24
Energy and Utilities	14	17	19	21	22	11	12
Tobacco	1	4	2	4	180	-42	67
Transportation	12	17	15	16	45	-12	4
Recreation	3	4	4	3	41	-4	-23
Total	100	100	100	100			

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Similarly, mean weekly transportation expenditures are highest, 722 FCFA/AE (US$1.16), during the lean season due to the fact that males often migrate to rural areas because of the increased agricultural labor requirements during the harvest season. Finally, households mean weekly expenditures on personal care are highest during the lean (August), 1,522 FCFA/AE (US$2.44), and post-harvest season (February), 901 FCFA/AE (US$1.44). Expenditures on clothing and footwear are generally highest towards the beginning of the school year, in August, and during periods of religious festivities, such as the Tabaski, which occurred in February during the survey year.

Furthermore, the results also indicate that Bamako households' expenditures on education, health, and personal care vary considerably across seasons. For instance, households' expenditures on education decrease by 26 percent between August and November, drop again by 77 percent between November and February, and increase by 22 percent between February and May. Health expenditures decrease by 61 percent between August and November, increase by 27 percent between November and February, and rise again by 54 percent between February and May. These results suggest that the demand for these non-food commodities is highly seasonal.

Table 2-16 and 2-17, below, present mean weekly expenditure on non-food commodities and budget shares by season and by income group and percentage changes in both across season. The results indicate the income groups have different adjustment patterns in the proportion of the non-food budget devoted to individual non-food commodity groups in any given season. For instance, between August and November, low-income households reduce the non-food budget share allocated to personal care (-56 percent), housewares (-54 percent), and recreation (-45 percent). In contrast, high-income households incur the largest reductions in the non-food budget share devoted to education (-39 percent) and hygiene (-23 percent). These results also suggest that low-income households may use the timing of their purchases of non-food items as a mechanism to minimize fluctuations in their food consumption levels across seasons.

Table 2-16: Mean Weekly Non-Food Expenditure (FCFA/AE) by Season and Income Group

Income Groups	Phase				% Change Between		
	L	H	PH	P	H-L	PH-H	P-PH
Low							
Education	5	94	6	28	1879	-93	351
Housewares	655	92	161	258	-86	75	60
Personal Care	1584	216	358	211	-86	66	-41
Health	392	115	251	115	-71	118	-54
Hygiene	129	96	87	80	-25	-10	-8
Energy and Utilities	476	356	462	293	-25	30	-37
Tobacco	30	23	3	11	-23	-89	303
Transportation	877	312	223	163	-64	-29	-27
Recreation	182	31	17	23	-83	-45	34
Total	4330	1336	1567	1181	-69	17	-25
Middle							
Education	68	161	3	1	138	-98	-49
Housewares	437	449	80	182	3	-82	128
Personal Care	1710	314	620	95	-82	97	-85
Health	2364	725	269	229	-69	-63	-15
Hygiene	127	200	133	143	57	-33	7
Energy and Utilities	647	485	540	491	-25	11	-9
Tobacco	142	193	121	132	36	-37	9
Transportation	408	410	356	275	0	-13	-23
Recreation	50	54	38	20	7	-29	-47
Total	5954	2991	2161	1568	-50	-28	-27
High							
Education	672	288	120	127	-57	-58	6
Housewares	2442	1538	1112	404	-37	-28	-64
Personal Care	1256	793	1747	246	-37	120	-86
Health	326	362	1059	2109	11	193	99
Hygiene	382	206	246	208	-46	19	-15
Energy and Utilities	1372	803	930	832	-42	16	-11
Tobacco	61	139	95	133	128	-32	40
Transportation	905	985	1023	808	9	4	-21
Recreation	275	302	340	185	10	12	-46
Total	7690	5416	6672	5054	-30	23	-24

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table 2-17: Mean Budget Share (%) Allocated to Individual Non-Food Commodity Groups by Season and Income Group

	Phase				% Change Between		
Income Groups	L	H	PH	P	H-L	PH-H	P-PH
Low							
Education	0	7	0	2	N/A	N/A	N/A
Housewares	15	7	10	22	-54	49	113
Personal Care	37	16	23	18	-56	41	-22
Health	9	9	16	10	-5	86	-39
Hygiene	3	7	6	7	142	-23	21
Energy and Utilities	11	27	29	25	143	11	-16
Tobacco	1	2	0	1	150	N/A	N/A
Transportation	20	23	14	14	15	-39	-3
Recreation	4	2	1	2	-45	-53	78
Total	100	100	100	100			
Middle							
Education	1	5	0	0	373	N/A	N/A
Housewares	7	15	4	12	105	-75	214
Personal Care	29	11	29	6	-63	173	-79
Health	40	24	12	15	-39	-49	17
Hygiene	2	7	6	9	212	-8	48
Energy and Utilities	11	16	25	31	49	54	25
Tobacco	2	6	6	8	170	-13	51
Transportation	7	14	16	18	100	20	6
Recreation	1	2	2	1	113	-2	-26
Total	100	100	100	100			
High							
Education	9	5	2	3	-39	-66	41
Housewares	32	28	17	8	-11	-41	-52
Personal Care	16	15	26	5	-10	79	-81
Health	4	7	16	42	57	138	163
Hygiene	5	4	4	4	-23	-3	12
Energy and Utilities	18	15	14	16	-17	-6	18
Tobacco	1	3	1	3	223	-45	85
Transportation	12	18	15	16	55	-16	4
Recreation	4	6	5	4	56	-9	-28
Total	100	100	100	100			

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

2.3.3. Seasonal Nutrient Availability

The purpose of this section is to examine nutrient availability from at-home foods by season and by income group.[20] The nutrients included in the analysis are calories, protein, carbohydrate, vitamin A, vitamin C, iron, and calcium. The results will show primary food sources for each type of nutrient and the prices per Kcal paid by households in various socio-economic groups and by season. Tables A2-5 through A2-10 of Appendix 2 provide detailed results on nutrient availability and main sources of nutrients by season and by income group.

The main question addressed in this analysis is whether the consumption choices Bamako households make in any given season translate into changes in the quantity, as measured by calorie availability, and quality, as measured by protein and micronutrient availability (vitamins and minerals), of food consumed in the households.[21] The study also investigates whether nutrient availability at the household level improves with rising income levels. This is important for policy analysis, as it would mean that policies that aim at increasing households' real incomes might also improve their nutrition.

2.3.3.1. Nutrient Availability

Table 2-18, below, presents the average daily availability per adult equivalent of calories, carbohydrates, protein, vitamin A, vitamin C, iron, and calcium and the nutrient adequacy ratios by income group. The results show that the only nutrient that is consumed in adequate amounts by all income groups of the sample population during the entire year is carbohydrates. Average annual carbohydrate availability is on the order of 408 grams per

[20] The results presented are estimates of nutrient availability from at-home foods and not actual nutrient intake. The FAO estimates that about 10 percent of the edible portion of food is wasted by the household before ingestion. This means that the present figures underestimate actual nutrient intakes.

adult equivalent per day, which is higher than the FAO recommended dietary allowance (RDA) of 300 grams per adult equivalent per day.

Table 2-18: Daily Nutrient Availability per Adult Equivalent by Income Group and Nutrient Adequacy Ratios (%)

Income Group	Food Energy	Carbo-hydrate	Protein	Vitamins		Minerals	
				Vit A	Vit C	Calcium	Iron
	Kcal	Grams		Micrograms	Milligrams	Milligrams	
Low	2082	391	55	234	27	390	22
Middle	2051	382	51	315	32	354	20
High	2495	452	67	532	40	510	25
Mean	2209	408	57	360	33	418	23
				Nutrient Adequacy Ratios (%)			
Low	95	130	87	39	59	39	38
Middle	93	127	81	52	72	35	34
High	113	151	106	89	89	51	43
Mean	100	136	91	60	73	42	38

Note: The Nutrient Adequacy Ratio (NAR) measures the extent an adult equivalent is satisfying the recommended daily allowance (RDA). It is computed as a ratio of nutrient availability per adult equivalent to RDA. The FAO's RDA for an adult equivalent are 2200 kilocalories for energy, 300 grams for carbohydrates, 63 grams for protein, 600 micrograms for vitamin A, 45 milligrams for vitamin C, 1000 milligrams for calcium, and 59 milligrams for iron (FAO, 1998).

The results indicate that there are some significant nutrient and micronutrient (vitamin A, vitamin C, iron, and calcium) deficiencies persisting in Bamako. Average annual calorie availability in Bamako households is on the order of 2,209 calories per day per adult equivalent. Although this amount slightly exceeds the FAO's minimum daily energy requirement of 2,200 kcal per adult equivalent, it conceals the fact that only households in the high-income group attain this availability level. The low and middle-income groups' calorie availability levels never exceed the recommended levels during the entire year.

[21] Micronutrients are vitamins are minerals needed in small amount by the body for optimal human growth, development, and healthy maintenance of the body (FA0, 1999).

Vitamin A availability amounts to 360 micrograms per adult equivalent per day compared to the recommended daily allowance (RDA) of 600 micrograms; thus Bamako households can satisfy about 60 percent of the RDA. Concerning vitamin C, urban households are only able to meet 73 percent of the daily recommended intake level; with an average availability in the order of 33 micrograms per adult equivalent per day compared to the RDA of 45 micrograms. Average iron and calcium availability is about 23 and 418 milligrams, respectively, (or 38 and 42%, respectively, of the RDA) per adult equivalent per day.

The protein content of the average Bamako household diet is 57 grams per adult equivalent per day, which is close to the recommended daily protein allowance of 63 grams per adult equivalent per day. However, as shown in Table 2-19 below, only 18 percent of the total protein available for consumption comes from animal sources. In general, animal proteins tend to be of higher quality than vegetable and grain proteins because they are easily digestible and more "complete" as they contain all essential amino acids. Moreover, the results indicate that the proportion of protein obtained from animal sources tends to increase with rising income levels: 16 percent, 17 percent, and 21 percent for the low, middle, and high-income groups, respectively.

Table 2-19: Protein Contributed by Major Food Groups (%) by Income Group

	Protein Contributed by Major Food Groups (%)			
Commodities	Low	Middle	High	Mean
Rice	30	33	26	30
Other Staples	33	28	30	30
Meat and Fish	16	17	21	18
Vegetables	8	6	8	7
Oil	0	0	0	0
Sugar	0	0	0	0
All others	14	15	15	14

2.3.3.2. Income and Nutrient Availability

The results, presented in Table 2-18, also indicate that higher income levels are associated with greater availability of nutrients in Bamako households. For instance, the average daily availability of calories, protein, vitamin C, and iron per adult equivalent increase by 17 percent, 18 percent, 32 percent, and 13 percent, respectively, as household income increases from the lowest to the highest income tercile. However, significant micronutrient deficiencies persist even at high-income levels. For instance, the high-income group satisfies only about 51 percent of the recommended daily allowance for calcium and 41 percent of the RDA for iron (Table 2-18). These findings, consistent with those of Rogers and Lowdermilk (1981), point to the fact that as households' income increase, the immediate concern is to increase the quantity of food consumed. This underscores the fact that in Mali the consumption patterns of the poor and rich are very similar. High-income households tend to consume more of the same type of foods that poor households eat, even if some diversification of the diet is evidenced at higher income levels.

2.3.3.3. Seasonal Fluctuations in Nutrient Availability

Figure 2-5, below, shows the distribution of calorie availability across households and across seasons. The results are quite alarming, as 48 percent of Bamako households are unable to meet the 2200 minimum daily calorie requirement during the lean season. During the planting season, the results indicate that about 68 percent of Bamako households can't achieve the minimum calorie availability levels.

Figure 2-5: Distribution of Calorie Availability across Households by Season

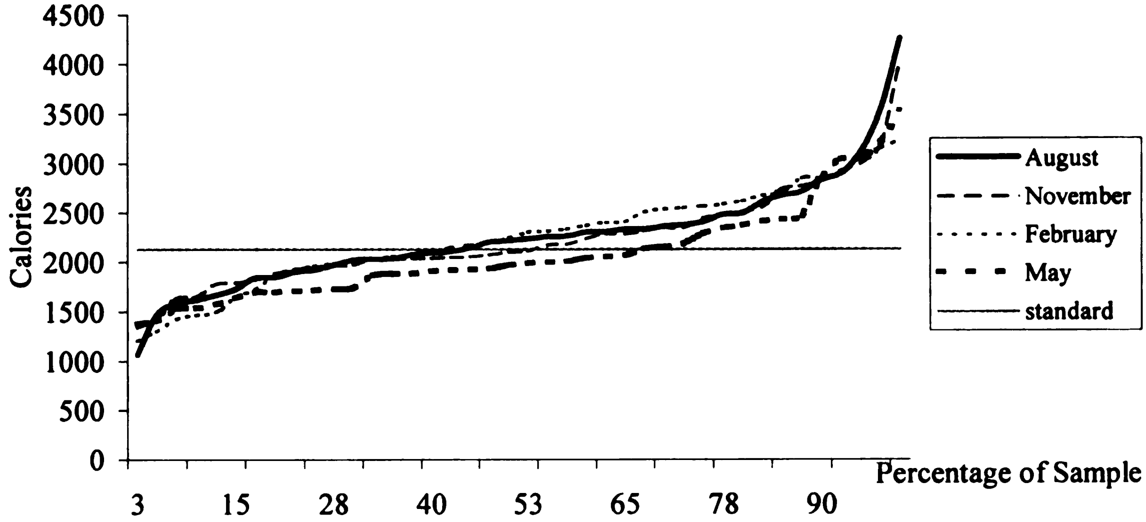


Table 2-20, below, shows the mean daily nutrient availability, nutrient adequacy ratios, and percentage change in nutrient availability by season. Bamako households' mean calorie availability is highest (2,263 kilocalorie/day/AE) during the lean season (August) and lowest (2087 kcal/AE/day) at the beginning of the rainy season (May), when it falls well below the recommended intake levels of 2,200 kcal/day/AE. Calorie availability, thus, remains fairly stable from the lean (August) to the post-harvest (February) season: decreases by 1 percent between August and November and then increases by 1 percent between November and February. However, the greatest percentage change (-8 percent), in calorie availability levels is observed between the post harvest (February) and the planting season (May).

The results, presented in Table 2-20, also indicate that the availability of nutrients, as manifested in the nutrient adequacy ratios, is greatest in Bamako households during the lean season (August): 103 percent for calories, 136 percent for carbohydrates, 96 percent for proteins, 71 percent for Vitamin A, 84 percent for vitamin C, 40 percent for iron, and 49 percent for calcium. This finding can be explained by the fact that Bamako households receive substantial financial help from migrants, relatives, and the extended family during the month of August.

Table 2-20: Nutrient Availability, Nutrient Adequacy Ratios, and Percentage Change in Nutrients Availability across Seasons

Phase	Food Energy	Carbo-hydrate	Protein	Vitamins		Minerals	
				Vit A	Vit C	Calcium	Iron
	Kcal	Grams		Microgram	mg	mg	
L	2263	409	61	428	38	490	23
H	2236	413	59	338	32	396	23
PH	2251	414	58	392	36	431	22
P	2087	398	52	284	26	355	22
			Nutrient Adequacy Ratios (%)				
L	103	136	96	71	84	49	40
H	102	138	93	56	70	40	39
PH	102	138	92	65	80	43	37
P	95	133	83	47	58	36	37
			Percentage Change (%)				
H-L	-1	1	-3	-21	-17	-19	-1
PH-H	1	0	-1	16	13	9	-5
P-PH	-7	-4	-10	-28	-27	-18	-1

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

The results, presented in Table 2-20, indicate that average daily nutrient availability is lowest during the planting season (May): 95 percent for calories, 133 percent for carbohydrates, 83 percent for proteins, 47 percent for vitamin A, 58 percent for vitamin C, 37 percent for iron, and 36 percent for calcium. The greatest variation in nutrients availability is observed between the post-harvest and planting seasons when, a general decline is registered: -7 percent for calories, -4 percent for carbohydrates, -10 percent for protein, -28 percent for vitamin A, -27 percent for vitamin C and –21 percent for calcium. The smallest variations are registered between the harvest and post-harvest seasons.

The results in Table 2-20 also reveal that seasonal variations in the availability of micronutrients (vitamin A, vitamin C, and calcium) are much more pronounced than that of calories. For instance, calorie availability decreases by 1 percent between the lean and post-harvest season, increases by 1 percent between the harvest and post-harvest season, and drops by 7 percent between the post-harvest and planting season. However, vitamin A availability decreased by 21 percent, increased by 16 percent, and decreased by 28 percent over the same period.

A possible explanation for this pattern is that households are aware of shortfalls in their calorie intake (they feel hungry). Thus, they attempt to maintain the amounts of calories available for consumption somewhat constant during the year by reducing the consumption of foods that contain essential micronutrients but few calories (e.g., meat, fish, and vegetables). The results in Tables 2-21 and 2-22, below, support this explanation. For instance, the 1 percent drop in calorie availability between the lean and harvest seasons is achieved through a 25 percent decrease in the contribution vegetables and oil, as shown in Table 2-21, and through substitutions of beef for dry fish within the meat and fish commodity group category (Table 2-22).

Table 2-21: Calories Contributed by Major Food Groups (%) by Season and Percentage Change across Seasons

	Share (%)				% Change Between		
Food Groups	L	H	PH	P	H-L	PH-H	P-PH
Rice	39	41	42	42	5	2	0
Other Staples	29	29	27	31	0	-7	15
Meat and Fish	5	5	5	4	0	0	-20
Vegetables	4	3	4	3	-25	33	-25
Oil	8	6	7	5	-25	17	-29
Sugar	7	7	7	8	0	0	14
All others	7	8	8	7	14	0	-13

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table 2-22: Contribution of Meat and Fish to Calorie Availability (kcal/AE/day) and Budget Shares (%) by Season

Items	Mean Daily Caloric Availability (kcal/AE)				Nutrient Source (%)			
	L	H	PH	P	L	H	PH	P
Beef	68	75	67	58	61	71	65	70
Mutton	3	0	8	1	2	0	8	1
Poultry	2	0	1	0	2	0	1	1
Dry Fish	29	22	25	19	26	21	24	23
Fresh Fish	10	8	2	5	9	8	2	6
Total	111	105	103	82	100	100	100	100

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

2.3.3.4. Sources of Nutrients

Table 2-23, below, shows the sources of nutrients by income group and for the entire sample. Staples are by far the leading source of calories, providing on average annually 70 percent of the total calories available for consumption. They are followed by all other foods (dairy products, fruits, seasonings and spices, and beverages) at 8 percent; oil and sugar, at 7 percent each; and meat and fish and vegetables, at 4 percent each.

Table 2-23: Sources of Nutrients (%) by Income Group

	Nutrients Contributed by Major Food Groups (%)						
At-Home Foods	Calories	Carbs	Protein	Vit A	Vit C	Calcium	Iron
Rice							
Low	42	50	30	0	0	16	19
Middle	44	53	33	0	0	19	23
High	37	46	26	0	0	14	18
Mean	41	50	30	0	0	16	20
Other Staples							
Low	31	35	33	6	12	14	49
Middle	26	30	28	4	11	12	43
High	29	34	30	6	16	13	45
Mean	29	33	30	5	13	13	46
Meat and Fish							
Low	4	0	16	4	0	22	5
Middle	4	0	17	3	0	21	6
High	5	0	21	3	0	22	8
Mean	4	0	18	3	0	22	7
Vegetables							
Low	4	4	8	59	85	35	17
Middle	3	4	6	58	85	36	18
High	4	5	8	65	79	35	20
Mean	4	4	7	61	83	35	19
Oil							
Low	6	0	0	26	0	0	0
Middle	7	0	0	30	0	0	0
High	8	0	0	21	0	0	0
Mean	7	0	0	26	0	0	0
Sugar							
Low	6	8	0	0	0	0	0
Middle	8	11	0	0	0	0	0
High	8	12	0	0	0	0	0
Mean	7	11	0	0	0	0	0
All others							
Low	7	2	14	6	3	13	9
Middle	8	2	15	5	4	13	10
High	8	2	15	5	4	16	9
Mean	8	2	14	5	4	14	9

The results, in Table 2-23, indicate that the contribution of rice to calorie availability decreases from 42 to 37 percent while that of other staples increases from 31 percent to 29 percent, as households' income increases. The results in Table A2-1 of Appendix 2 show that households reduce their consumption of millet-sorghum and increase that of wheat, maize, and sweet potato, as their income increases.

Moreover, the results in Table 2-23, reveal that the share of calories derived from meat and fish (4 percent for the low and 5 percent for the high-income group), sugar (6 percent and 8 percent), and other foods (7 percent and 8 percent) tend to be higher for high-income households. Thus, as Bamako households' income increase, the proportion of the calories they obtain from more expensive sources increases while that of cheaper sources such as staples decreases (Bennett's Law). These findings suggest that households tend to diversify their diets as they attain higher income levels.

The three most important sources of carbohydrates are rice (50 percent), other staples (33 percent), and sugar (11 percent). Vegetables provide on average 35 percent of the total calcium available in urban households. They are followed by meat and fish (22 percent), rice (16 percent), all others (14 percent) and other staples (13 percent). The two most important sources of Vitamin C for Bamako households are vegetables (83 percent) and other staples (13 percent), combining to provide on average 96 percent of the total vitamin C available in households. The leading source of Vitamin A for all income groups across all seasons are vegetables (61 percent), followed by oil (26 percent), and other staples (5 percent) and other foods (i.e., fruits, beverages, and nuts) (5 percent). The main sources of protein in urban households are staples (60 percent), followed by meat and fish (18 percent), all others foods (dairy products, fruits, seasonings and spices, and beverages) (14%), and vegetables (7%).

Table 2-24, below, reports the mean daily protein availability from meat and fish sources and the contribution of specific types of meat and fish to animal protein availability by season. The results show that on average 49 percent of the total animal protein available for consumption comes from beef, followed by dry fish, at 39 percent, and fresh fish, at 9 percent. The contribution of mutton to protein availability is greatest, 5 percent, during the post-harvest, which corresponded to the period when the Tabaski, a religious festivity, occurred during the survey year. Hence, the period of heaviest mutton consumption is likely to shift from year to year as the date of the Tabaski shifts in accordance with the lunar calendar.

Table 2-24: Mean Daily Animal Protein Availability in Grams/AE/day and Contribution of Specific Types of Meat and Fish to Animal Protein Availability (%) by Season

Items	Mean Daily Protein Availability (g/AE)					Nutrient Source (%)				
	L	H	PH	P	Avg	L	H	PH	P	Avg
Beef	5	6	5	4	5	43	52	49	52	49
Mutton	0	0	1	0	0	1	0	5	1	2
Poultry	0	0	0	0	0	2	0	1	1	1
Dry Fish	5	4	4	3	4	41	36	41	38	39
Fresh Fish	2	1	0	1	1	12	11	4	9	9

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

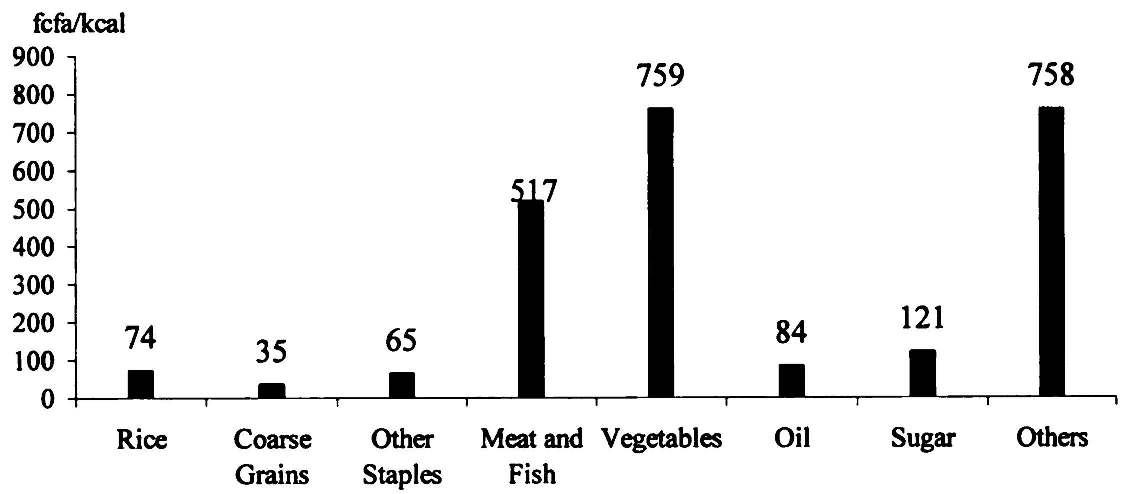
2.3.3.5. The Cost of Calories

The results, presented in Figure 2-8 below, indicate that coarse grains (millet-sorghum and maize), rice, and other staples are by far the cheapest sources of calories: 35, 65, and 74 CFA Franc per 1000 calories, respectively.[22] In contrast, vegetables, other foods (i.e., fruits, nuts), and meat and fish are the most expensive sources of calories: 759, 758 and 517 CFA Franc per 1000 calories, respectively. Rice dominates Bamako households' diets despite the fact that it constitutes a more expensive source of calories than other staples. Bamako households' preference for rice is largely attributed to taste factors and to the fact that rice takes less time, fuel, and labor to prepare. Hence, the price per calorie

[22] The price of calories is computed as a ratio of households' total expenditures and total calorie availability.

for rice may actually be lower than that of the other staples when the preparation costs are taken into account.

Figure 2-6: Average Cost of Calories (CFA Francs/1000 calories)



The price paid per 1000 calories by different income groups can provide an indication of whether quality upgrading occurs as households' income increases. Generally, poor households tend to consume food items of lower quality and as a result the price per kilocalorie paid by these households is lower than that paid by high-income households. Reardon et al. (1999) have argued that rich households consume the better quality locally produced rice while poor households eat more of the cheap imported Asian rice.[23] Table 2-5, below, presents the average cost of calories for at-home foods by season and by income group. The results provide no supportive evidence of quality upgrading with respect to rice as households' income increase. In fact, the price paid per 1000 calories of rice decreases slightly with rising income levels: 74 FCFA per 1000 calories for the low versus 73 FCFA per 1000 calories for the high income group.

[23] High-quality rice has a low percentage of broken grains (less than 10%) whereas low quality rice has more than 10% of broken kernels.

Table 2-25: Average Cost of Calories (FCFA/1000 kcal) for At-Home Foods by Season and by Income Group

Food Group	Price per 1000 calories				
	L	H	PH	P	Avg.
Rice					
Low	75	76	73	74	74
Middle	76	76	71	72	74
High	72	76	72	73	73
Mean	74	76	72	73	74
Coarse Grains					
Low	39	39	37	48	41
Middle	35	35	31	40	35
High	28	29	27	38	31
Mean	34	34	32	42	35
Other Staples					
Low	49	52	34	38	43
Middle	62	87	66	60	69
High	80	75	83	93	83
Mean	64	72	61	64	65
Meat and Fish					
Low	401	501	535	492	482
Middle	623	436	547	529	534
High	519	554	516	553	536
Mean	514	497	533	525	517
Vegetables					
Low	878	641	634	787	735
Middle	1062	708	704	653	782
High	951	833	594	666	761
Mean	963	727	644	702	759
Oil					
Low	75	102	98	74	87
Middle	94	79	76	75	81
High	81	87	83	78	82
Mean	83	90	86	76	84
Sugar					
Low	128	120	131	132	128
Middle	147	112	104	126	122
High	109	128	104	113	114
Mean	128	120	113	124	121
Others					
Low	780	607	600	727	679
Middle	972	681	652	597	725
High	1059	877	872	672	870
Mean	937	722	708	665	758

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Similarly, the results reveal that the price paid for 1000 calories of coarse grains (millet-sorghum and maize) tends to decrease with households' income: 41, 35, and 31

FCFA per 1000 calories for the low, middle, and high-income groups, respectively. Thus, the evidence here suggests that poor households pay slightly more for 1000 calories of cereals than rich households, and this is consistent across all seasons. The results, however, show that the price paid per 1000 calories for other staples (wheat and roots and tubers) tends to increase with income (43, 69, and 83 FCFA per 1000 calories for the low, middle and high income group, respectively). Therefore, suggesting that higher income households perhaps consume better quality of other staples.

However, these findings may well be due to the fact that rich households often purchase rice in bulk and consequently, pay lower per unit costs than poor households. The income groups were divided into groups that reported having purchased rice in bulk versus those that didn't, in order to assess to what extent the differences in the prices paid per 1000 calories reflect quality upgrading. Table 2-26, below, shows the average price paid per 1000 calories for rice by type of purchase, season, and income group.

Table 2-26: Average Price Paid Per 1000 Calories for Staples by Type of Purchase

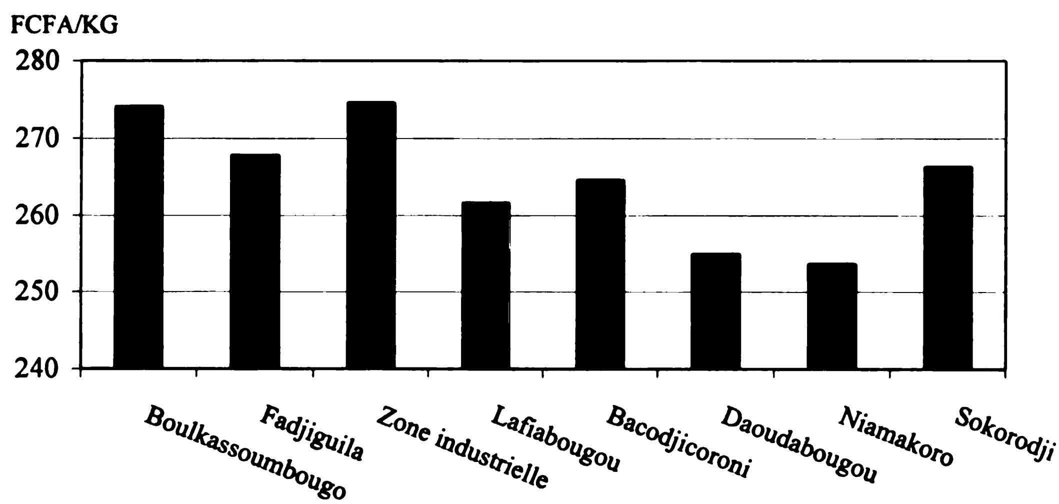
Bulk Purchase	Phase									
	L		H		PH		P		Avg	
	Low	High	Low	High	Low	High	Low	High	Low	High
No	74	72	77	75	73	70	74	72	75	72
Yes	82	73	73	77	73	73	74	74	75	74

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting. NA: Not Available.

The results, in Table 2-26, indicate that on average, even among households that reported having purchased rice in bulk, low-income households still tend to pay more (75 FCFA) per 1000 calories than high-income households (74 FCFA). The harvest season is the only time during the entire year when high-income households that purchased rice in bulk paid more per 1000 calories than low-income households (73 for the low versus 77 for the high tercile). Thus, only during that period do the results provide supportive evidence of rich households buying rice of higher quality.

It is also possible that the observed grain price variation reflects locational differences (i.e., the area of residence), as households residing in the city periphery may pay more per unit costs than those in city center. Figure 2-7, below, shows the average price paid for rice by area of residence. The results show that households who live close, or who have transportation means, to the Niamakoro market, which is the largest wholesale market in Bamako and is located in the center of the city, pay the lowest price for rice, 254 CFA Francs per kilogram. In contrast, households living in Boulkassoumbougo, which is located in the city periphery, and who are unable to incur search costs (e.g., information costs and transportation costs), pay the highest unit price, 274 CFA Francs, for rice.

Figure 2-7: Average Price Paid for Rice (CFA Francs/kg) by Area of Residence



2.3.4. Sensitivity Analysis

The estimates of nutrient availability presented in the previous section were solely based on the at-home food consumption data. In this section, rough estimates of nutrient availability from away-from-home foods were computed to provide an idea of how the results would change when these items are taken into account. Following Subramanian and Deaton (1996), the away-from-home nutrient estimates were derived based on the assumption that the average cost per unit of nutrient of away-from-home foods is 50 percent more than at-home foods. The 50 percent premium is assumed to reflect processing margins (Subramanian and Deaton (1996)). Then, the average away-from-home nutrient availability is computed using the following formula:

$$N_{FAFH} = (P*W) * N_{FAH}, \tag{1}$$

Where N is nutrient availability, FAFH is food away from home (FAFH), FAH is food at home (FAH), P is the premium (e.g., 50 percent), and W is the average budget share allocated to food away from home. P*W represents the percentage change in nutrient availability.

The problems with this approach are the implicit assumptions that (1) foods consumed at-home are of the same quality as those consumed away-from-home and that (2) nutrient availability from away-from home foods is distributed equally within the household. However, foods consumed away from home generally include meals that are very labor intensive and time consuming to prepare (i.e., fonio and atieke) and foods that provide some diversity to households' diets (i.e., dairy products, fruits, and nuts). Mangoes, for instance, are an important source of vitamin A. It would be too costly for the household to provide these foods to every single one of its members. Table A2-11, presented in appendix 2, shows that households allocate on average 0.7 percent of their at-home food budget to fruits whereas fruits occupy 5.4 percent of the away-from-home food budget. Similarly, dairy products take up on average 2.2 percent and 5.9 percent of food at home and food away from home budgets, respectively. It is hard to assess whether households allocate a greater proportion of their away-from-home food budget to meat and fish commodities, since meals taken away from home are often in form of dishes. The food away from home data indicates that a substantial proportion, on average about 86 percent, of food away from home expenditures, are incurred by household members who are employed, suggesting that young children are largely excluded from this consumption. Also, the data shows that on average about 20 percent of food away from home expenditures are made by the head of household, while, on average, the household head accounts for only 6 percent of the household population (The average household in Bamako is composed of 17 members). Hence, the benefits of away-from-home consumption, in terms of nutrient content, would be skewed in the households, benefiting mainly the head of household and household members who have a source of income.

Table 2-27, below, shows the baseline values (e.g., nutrient availability from at-home foods and nutrient adequacy ratios) and the effect of including estimates of nutrient availability from away-from-home foods on average daily nutrient availability per adult equivalent and the nutrient adequacy ratios by income group. The results, in Table 2-27, show that if away-from-home foods were taken into account, average nutrient availability in Bamako households would increase by 9.5 percent. The results also indicate that the availability of nutrients, as manifested in the nutrient adequacy ratios, would increase to: 110 percent for calories, 149 percent for carbohydrates, 100 percent for proteins, 66 percent for Vitamin A, 80 percent for vitamin C, 46 percent for iron, and 42 percent for calcium. One should note that these results are upper-end estimates, as they assume zero wastage of both at-home and away-from-home nutrients.

Table 2-27: Effects of Including Estimates of Nutrient Availability from Away-From-Home Foods on Total Nutrient Availability by Income Group

Income Group	Food Energy	Carbo-hydrate	Protein	Vitamins		Minerals	
				Vit A	Vit C	Calcium	Iron
	Kcal	g	g	μg	mg	mg	mg
Baseline Values:							
Nutrients from at-home foods							
Low	2082	391	55	234	27	390	22
Middle	2051	382	51	315	32	354	20
High	2495	452	67	532	40	510	25
Mean	2209	408	57	360	33	418	23
Nutrient Adequacy Ratios (%)							
Low	95	130	87	39	59	39	38
Middle	93	127	81	52	72	35	34
High	113	151	106	89	89	51	43
Mean	100	136	91	60	73	42	38
Simulation:							
% Change in Nutrient Availability							
Low	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Middle	11.1	11.1	11.1	11.1	11.1	11.1	11.1
High	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Mean	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Total Amounts of Nutrients Available (FAH+FAFH)							
Low	2269	427	60	255	29	425	24
Middle	2279	425	57	350	36	394	22
High	2705	490	72	577	43	553	28
Mean	2419	447	63	395	36	458	25
Nutrient Adequacy Ratios (%)							
Low	103	142	95	43	64	43	41
Middle	104	142	90	58	80	39	38
High	123	163	115	96	96	55	47
Mean	110	149	100	66	80	46	42

Once the effects are disaggregated by income group, the results indicate that the average daily availability of nutrients per adult equivalent increase by 9 percent, 11.1 percent, and 8.4 percent respectively, as household income increases from the lowest to the highest income tercile. Hence, middle-income households would experience the greatest increase in nutrient availability since, as shown in section 2.3.2.2., they allocate the greatest percentage (22 percent versus 18 and 17 percent, respectively, for the low and high-income groups) of their food budget to food away from home.

The results also show that all income groups would now be able to meet minimum daily calorie requirements but only the high-income group would be able to satisfy the recommended dietary allowance (RDA) for protein. Moreover, the increase in the amounts of vitamin A, vitamin C, calcium, and iron would not be enough for households in all income groups to meet the RDA for these nutrients.

Table 2-28, below, shows the baseline values (e.g., nutrient availability from at-home foods and nutrient adequacy ratios) and the effect of including estimates of nutrient availability from away-from-home foods on average daily nutrient availability per adult equivalent and the nutrient adequacy ratios by season. The results, in Table 2-28, show that if away-from-home foods are taken into account, average nutrient availability in Bamako households would increase by 9.4, 9.2, 8.5, and 11.1 percent during the lean, harvest, post-harvest, and planting seasons, respectively. The results also indicate that Bamako households would now be able to meet minimum daily calorie requirements during all seasons; however, they would still not be able to satisfy the recommended dietary allowance (RDA) for vitamin A, vitamin C, calcium, and iron in all seasons considered.

Table 2-28: Effects of Including Estimates of Nutrient Availability from Away-From-Home Foods on Total Nutrient Availability by Season

Income Group	Food Energy	Carbo-hydrate	Protein	Vitamins		Minerals	
				Vit A	Vit C	Calcium	Iron
	Kcal	g	g	µg	mg	mg	mg
Baseline Values:							
Nutrients from at-home foods							
L	2263	409	61	428	38	490	23
H	2236	413	59	338	32	396	23
PH	2251	414	58	392	36	431	22
P	2087	398	52	284	26	355	22
Avg	2209	408	57	360	33	418	23
Nutrient Adequacy Ratios (%)							
L	103	136	96	71	84	49	40
H	102	138	93	56	70	40	39
PH	102	138	92	65	80	43	37
P	95	133	83	47	58	36	37
Avg	100	136	91	60	73	42	38
Simulation:							
% Change in Nutrient Availability							
L	9.3	9.3	9.3	9.3	9.3	9.3	9.3
H	9.2	9.2	9.2	9.2	9.2	9.2	9.2
PH	8.5	8.5	8.5	8.5	8.5	8.5	8.5
P	11.1	11.1	11.1	11.1	11.1	11.1	11.1
Avg	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Total Amounts of Nutrients Available (FAH+FAFH)							
L	2474	447	66	468	42	536	26
H	2442	451	64	369	35	433	25
PH	2442	449	63	425	39	468	24
P	2318	442	58	316	29	395	24
Avg	2420	447	63	395	36	458	25
Nutrient Adequacy Ratios (%)							
L	112	149	105	78	92	54	43
H	111	150	102	61	77	43	43
PH	111	150	100	71	87	47	40
P	105	147	92	53	64	39	41
Avg	110	149	100	66	80	46	42

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

2.4. Conclusions

This essay has examined Bamako households' seasonal consumption patterns through a descriptive analysis of seasonal changes in expenditure patterns and seasonal availability of nutrients. The results show that seasonal changes in the price of cereals induce households to incur substantial adjustments in their budget allocation pattern among and within major food and non-food components in any given season. The findings suggest that households are willing to allocate the marginal increase in their income to diversifying their diets and to acquiring more non food commodities only during periods of greater food availability in urban markets, thus when lower food prices prevailed, such as during the post harvest season.

The results also show households' incur significant substitutions among and within food commodity groups in order to attempt to smooth their calorie availability across seasons. Such adjustments often result in large variations in the quality, as measured by protein, carbohydrate, and micro-nutrients' availability, of food available in the household. Evidence of significant nutrient and micronutrient deficiencies persisting in the households surveyed was indeed brought to light.

REFERENCES

Chambers, R. (1981). *Introduction. In Seasonal Dimensions to Rural Poverty*, pp. 1-8, ed. R. Chambers, R. Longhurst, and A. Pacey. London: Frances Pinter.

Deaton, A and Muellbauer J. *Economics and consumer behavior*. Cambridge, Cambridge University Press: 1980a.

Deaton, A. "Price elasticities from survey data." Journal of Econometrics 44 (1990) 281–309.

Deaton, A. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy.* World Bank. The John Hopkins University Press. Baltimore, London: 1997.

Deaton, A. Quality, Quantity, and Spatial Variation of Price. *AER.* 78 (1988b) 3: 418-430.

Deaton, A. *Understanding Consumption.* Oxford University Press, 1992.

Deaton, A. and A. Tarozzi. 2000. *Prices and Poverty in India.* Research Program in Development Studies. Princeton University.

Deaton, A. & Zaidi, S., 1999. *Guidelines for Constructing Consumption Aggregates for Welfare Analysis.* Papers 192, Princeton, Woodrow Wilson School - Development Studies.

Dembélé, N. N. and J.M. Staatz, June 1999. *The Impact of Market Reform on Agricultural Transformation in Mali.* MSU Agricultural Economics Staff Paper No. 99-29.

Direction Nationale De La Statistique Et De L'informatique (DNSI), Avril - Juillet 1996. *Enquête Sur Les Dépenses Des Ménages De Bamako.*

FAOSTAT. 2003. Available on the internet at: http://apps.fao.org/page/collections

FAO.2002. *Food Energy: Methods of Analysis and Conversion Factors* - Report of a technical workshop. FAO FOOD AND NUTRITION PAPER 77

FAO. 1999. *Aperçus Nutritionnels par Pays - MALI 26 janvier 1999.*

FAO. 1998. *Human Vitamin and Mineral Requirements* - Report of a Joint FAO/WHO Expert Consultation held in Bangkok, Thailand, September 1998.

FAO. 1997. *Carbohydrates in Human Nutrition* - Report of the Joint FAO/WHO Expert Consultation 14-18 April 1997

FAO. 1997. Calcium throughout life *Food, Nutrition and Agriculture*, No. 20, 1997.

FAO. 1993. *Fats and oils in human nutrition* - Report of a joint FAO/WHO expert consultation 19-26 October 1993.

FEWS 2000. *Mali Evaluation de La Vulnérabilité Courante: Février 2000.* Agence Américaine Pour Le Développement International, Associates In Rural Development, Inc., and Famine Early Warning System.

FEWS 2000. Document available online at: http://www.afrol.com/News2000/mal001_grain_prod.htm

FEWS 2000. Document available online at: http://www.reliefweb.int/w/rwb.nsf

Gabas, J-J. and Giri, J. (1987).The Food Situation in the Sahel: an Assessment. In *Cereals Policies in Sahel Countries: Acts of the Mindelo Conference*, Eds CILSS/Club du Sahel/OECD, Paris.

OANDA's exchange rates. Retrieved November 21, 2003, from http://www.oanda.com/

Newbery, David M, 1989. The Theory of Food Price Stabilization. *Economic Journal*, Vol. 99 (398) pp. 1065-82.

Paxon, Christina H., 1993. Consumption and Income Seasonality in Thailand. *Journal of Political Economy*, 101(1): 39-72.

Pitt, M.M. 1983. *Food preferences and nutrition in rural Bangladesh.*The Review of Economics and Statistics 65: 105-114.

Raunikar, Robert and Huan, Chung-Liang. *Demand Analysis: Problems, Issues, and Empirical Evidence*. Ames: Iowa State University Press, 1987.

Reardon et al. Household Consumption Responses to the Franc CFA Devaluation: Evidence from Urban Mali. *Food Policy* 24 (1999), 517-534.

Rogers, B.L. and Lowdermilk, M. (1991). Price Policy and Food Consumption in Urban Mali. *Food Policy* 16, 461-473.

Sadoulet, Elisabeth, and de Janvry, Alain. *Quantitative Development Policy Analysis*. Chapter 6. Baltimore, MD: The Johns Hopkins University Press, 1995.

Sahn, E. 1989. *Seasonal Variability in Third World Agriculture: The Consequences for Food Security.* Baltimore and London: John Hopkins University Press.

Sen, Amartya. *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford: Oxford U. P., 1981.

Singare, K., T. Reardon, Y. Camara, M. Wanzala, B. Teme, O. Sanogo. 1999. Household consumption responses to the franc CFA devaluation: evidence from urban Mali. *Food Policy*, 24(5), October: 517-534.

Sundberg, Shelly and Alayne Adams. *Food Composition Table for Mali*. September 1998. Michigan State University/USAID.

Teklu, Tesfaye, 1996. Food Demand Studies in Sub-Saharan Africa: A Survey of Empirical Evidence. *Food Policy*, Vol. 21, No. 6, pp. 479-496, 1996.

Timmer, C. P. and H. Alderman. 1979. Estimating consumption parameters for food policy analysis. *American Journal of Agricultural Economics* 61: 982-987.

Timmer et al. 1983. *Food Policy Analysis*. Published for the World Bank. John Hopkins University Press.

United States Department of Agriculture Agricultural Research Service (2003). *Nutritive Value of Foods*. Home and Garden Bulletin Number 72. Susan E. Gebhardt and Robin G. Thomas.

USDA. (2003). *Composition of Foods: Raw, Processed, Prepared*. U.S. Department of Agriculture, Agricultural Research Service, Nutrient Data Laboratory, Beltsville, Maryland.

U.S. Department of Agriculture. *Nutritive Value of Foods*. Home and Garden Bulletin No. 72. Washington: U.S. Department of Agriculture, 1971.

Wu Lueng, Woot-Tsuen, Felix Busson, and Claude Jardin. *Food Composition Table for Use in Africa*. Bethesda, Maryland: U.S. Department of Health, Education, and Welfare and FAO, 1968.

APPENDIX 2

Appendix A2-1 Summary of Deaton and Zaidi (1999) Methods for Constructing Expenditure Aggregates

Net Food Expenditure Aggregate

The households' total food expenditure aggregates were computed by adding expenditure on food at-home to expenditures incurred on meals away from home. The net food expenditure was calculated as the total value of food purchases minus the value of foods that the household donated (foods that were not for the household's own consumption). Gifts and remittances to other households are excluded, as their inclusion would involve double counting if the transfers show up in the consumption of other households.

Net Non-Food Expenditure Aggregate

The non-food expenditure aggregate was constructed by excluding the following items: work related expenses, taxes paid, purchase of assets (i.e. car, motorcycle), and lumpy expenditures such as marriages and births (Deaton, 2000). Taxes are excluded because they are not part of consumption but a deduction from income. Gifts and remittances to other households are excluded as their inclusion in the consumption aggregate would involve double counting if the transfers show up in the consumption of other households. Lumpy expenditures were also excluded because while almost all households incur these types of expenditures at some stage, only a few of them are likely to make such expenditures during the week of the survey. Unlike food items, for which consumption was recorded daily, data on purchases of non-food items are often collected from different recall periods (i.e., past 15 days or past month).

Figure A2-1: Agricultural Calendar in Mali

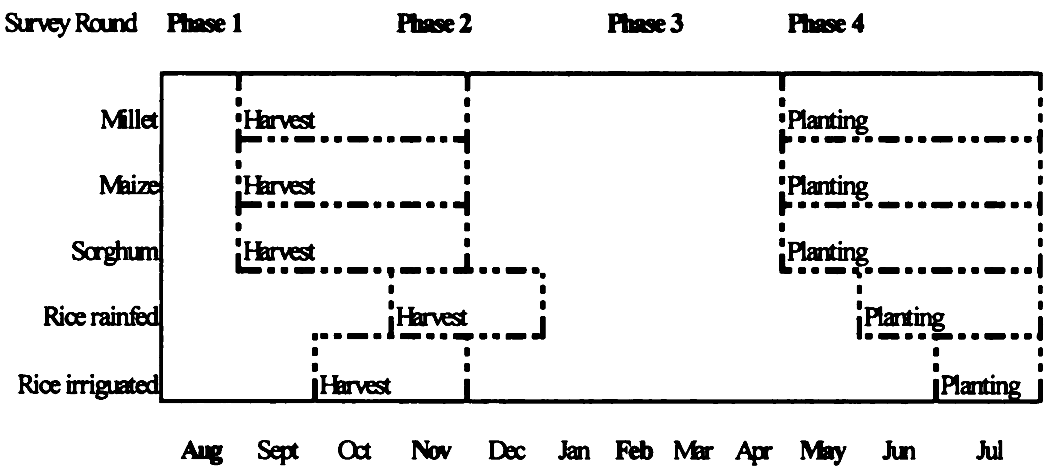


Table A2-1: Mean Weekly At-Home Food Consumption (kg/AE) by Season and by Income Group

Items	Income Group											
	Low				Middle				High			
	L	H	PH	P	L	H	PH	P	L	H	PH	P
Staples												
Rice	1.674	1.736	1.673	1.676	1.715	1.776	1.868	1.558	1.720	1.795	1.889	1.819
Millet-Sorghum	1.010	1.190	1.388	1.409	1.016	0.948	0.770	1.028	1.293	1.304	1.108	1.057
Maize	0.112	0.121	0.022	0.018	0.159	0.089	0.175	0.094	0.165	0.102	0.119	0.216
Wheat	0.035	0.035	0.043	0.034	0.105	0.053	0.034	0.022	0.169	0.109	0.168	0.152
Fonio	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.011	0.025
Atieke	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.000	0.011	0.015
Cassava	0.000	0.032	0.000	0.000	0.024	0.000	0.000	0.000	0.000	0.076	0.032	0.008
Potato	0.014	0.012	0.017	0.014	0.034	0.000	0.136	0.029	0.008	0.000	0.143	0.027
Sweet Potato	0.024	0.042	0.000	0.007	0.013	0.046	0.003	0.005	0.005	0.188	0.007	0.004
Meat and Fish												
Beef	0.187	0.204	0.138	0.143	0.186	0.183	0.196	0.190	0.302	0.354	0.335	0.238
Mutton	0.000	0.000	0.004	0.001	0.009	0.000	0.084	0.003	0.021	0.000	0.003	0.004
Poultry	0.000	0.000	0.021	0.003	0.005	0.005	0.004	0.000	0.033	0.000	0.000	0.006
Dry Fish	0.076	0.043	0.059	0.056	0.056	0.055	0.055	0.037	0.093	0.079	0.080	0.054
Fresh Fish	0.041	0.063	0.016	0.023	0.065	0.017	0.010	0.019	0.099	0.079	0.027	0.048
Vegetables												
Leave	0.159	0.134	0.095	0.078	0.157	0.122	0.056	0.079	0.161	0.114	0.115	0.098
Okra	0.222	0.033	0.027	0.103	0.274	0.060	0.032	0.097	0.246	0.070	0.026	0.062
Onion	0.085	0.091	0.190	0.139	0.086	0.099	0.219	0.186	0.174	0.137	0.272	0.260
Tomato	0.070	0.169	0.135	0.182	0.090	0.209	0.230	0.214	0.141	0.200	0.273	0.261
Beans	0.100	0.027	0.084	0.041	0.046	0.033	0.036	0.025	0.129	0.094	0.043	0.067
Other Vegetables	0.126	0.114	0.170	0.053	0.166	0.245	0.375	0.151	0.141	0.280	0.380	0.121
Oil												
Peanut Oil	0.134	0.047	0.049	0.065	0.077	0.077	0.131	0.065	0.131	0.098	0.107	0.066
Palm Oil	0.014	0.007	0.008	0.005	0.023	0.009	0.007	0.011	0.020	0.011	0.005	0.017
Sheanut Oil	0.007	0.020	0.035	0.017	0.012	0.026	0.018	0.013	0.045	0.044	0.036	0.020
Sugar	0.265	0.232	0.191	0.224	0.287	0.308	0.354	0.315	0.396	0.371	0.401	0.380
Others												
Butter	0.001	0.000	0.000	0.000	0.001	0.003	0.000	0.000	0.000	0.000	0.000	0.002
Buttermilk	0.026	0.007	0.030	0.017	0.008	0.003	0.017	0.010	0.050	0.034	0.020	0.026
Fresh Milk	0.003	0.000	0.000	0.000	0.001	0.000	0.002	0.000	0.001	0.005	0.000	0.000
Condensed Sweet Milk	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.015	0.001	0.000	0.000
Powdered Milk	0.019	0.011	0.010	0.013	0.020	0.011	0.003	0.007	0.016	0.021	0.089	0.023
Eggs	0.006	0.000	0.000	0.000	0.046	0.005	0.000	0.000	0.003	0.001	0.005	0.000
Peanuts	0.127	0.196	0.137	0.110	0.150	0.162	0.158	0.137	0.157	0.207	0.183	0.184
Seeds	0.023	0.019	0.023	0.020	0.015	0.024	0.019	0.015	0.014	0.011	0.012	0.014
Other Nut&Seed	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Coffee	0.003	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.003	0.000	0.001	0.001
Tea Lipton	0.001	0.000	0.012	0.000	0.001	0.000	0.000	0.000	0.005	0.001	0.005	0.006
Green Tea	0.000	0.000	0.000	0.000	0.000	0.004	0.002	0.003	0.009	0.002	0.000	0.001
Quinqueliba	0.001	0.000	0.000	0.000	0.001	0.002	0.009	0.001	0.003	0.005	0.003	0.003
Other Beverage	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000
Banana	0.000	0.030	0.000	0.000	0.011	0.009	0.000	0.002	0.006	0.000	0.040	0.000
Citronella	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Dates	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.000
Lemon	0.012	0.043	0.002	0.002	0.022	0.068	0.023	0.003	0.014	0.078	0.001	0.000
Raisins	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Tamarind	0.018	0.002	0.023	0.020	0.033	0.000	0.026	0.043	0.018	0.000	0.037	0.027
Orange	0.018	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.008	0.000	0.000	0.000
Seansonings and Spices	0.102	0.107	0.126	0.187	0.130	0.119	0.110	0.109	0.124	0.124	0.141	0.161

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table A2-2: Weekly Mean At-Home Food Items Consumption (kg/AE) by Phase

Items	Phase				
	L	H	PH	P	Avg
Staples					
Rice	1.703	1.769	1.812	1.681	1.741
Millet-Sorghum	1.104	1.142	1.081	1.162	1.122
Maize	0.145	0.104	0.107	0.109	0.116
Wheat	0.103	0.065	0.080	0.068	0.079
Other Cereal	0.007	0.000	0.003	0.008	0.005
Atieke	0.004	0.001	0.004	0.005	0.003
Cassava	0.008	0.035	0.010	0.002	0.014
Potato	0.019	0.004	0.100	0.024	0.037
Sweet Potato	0.014	0.091	0.003	0.005	0.028
Meat and Fish					
Beef	0.224	0.246	0.222	0.190	0.221
Mutton	0.010	0.000	0.032	0.003	0.011
Poultry	0.013	0.002	0.008	0.003	0.006
Dry Fish	0.075	0.059	0.065	0.049	0.062
Fresh Fish	0.068	0.052	0.017	0.029	0.042
Vegetables					
Leave	0.159	0.123	0.088	0.085	0.114
Okra	0.248	0.054	0.029	0.087	0.105
Onion	0.114	0.109	0.227	0.195	0.161
Tomato	0.100	0.193	0.213	0.219	0.181
Other Vegetable: Fresh	0.145	0.214	0.310	0.110	0.195
All Other Vetegable	0.090	0.051	0.054	0.044	0.060
Oil					
Peanut Oil	0.113	0.074	0.097	0.065	0.087
Palm Oil	0.019	0.009	0.006	0.011	0.011
Sheanut Oil	0.021	0.030	0.029	0.017	0.024
Sugar	0.315	0.304	0.317	0.306	0.310
Others					
Butter	0.001	0.001	0.000	0.001	0.001
Buttermilk	0.028	0.014	0.022	0.018	0.020
Fresh Milk	0.002	0.002	0.001	0.000	0.001
Condensed Sweetened Milk	0.006	0.000	0.000	0.000	0.002
Powdered Milk	0.019	0.015	0.033	0.014	0.020
Eggs	0.019	0.002	0.002	0.000	0.006
Peanuts	0.145	0.188	0.159	0.144	0.159
Seeds	0.017	0.018	0.018	0.016	0.017
Other Nut&Seed	0.000	0.000	0.000	0.000	0.000
Coffee	0.002	0.001	0.001	0.001	0.001
Tea Lipton	0.002	0.000	0.006	0.002	0.003
Green Tea	0.003	0.002	0.001	0.001	0.002
Quinqueliba	0.002	0.002	0.004	0.001	0.002
Other Beverage	0.001	0.000	0.002	0.000	0.001
Banana	0.006	0.013	0.013	0.001	0.008
Citronella	0.000	0.000	0.000	0.000	0.000
Dates	0.000	0.001	0.000	0.000	0.000
Lemon	0.016	0.063	0.009	0.002	0.023
Raisins	0.000	0.000	0.000	0.000	0.000
Tamarind	0.023	0.001	0.028	0.030	0.021
Orange	0.009	0.000	0.000	0.000	0.002
Seansonings and Spices	0.119	0.117	0.125	0.151	0.128

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table A2-3: Mean Budget Shares (%) Allocated to Individual At-Home Food Items by Season and by Income Group

	Share (%)														
	Lean			Harvest			Post-Harv			Planting			Average		
Food	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Staples	**29**	**29**	**26**	**40**	**34**	**29**	**40**	**30**	**30**	**37**	**31**	**30**	**37**	**31**	**29**
Rice	68	61	59	65	68	61	65	67	61	60	64	59	65	65	60
Millet-Sorghum	22	22	22	23	23	25	28	18	20	34	29	28	27	23	24
Maize	4	3	5	5	3	3	1	5	3	1	3	3	3	4	3
Wheat	4	11	12	3	5	8	5	4	10	4	3	6	4	6	9
Fonio	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0
Atieke	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0
Cassava	0	1	0	2	0	3	0	0	1	0	0	0	0	0	1
Potato	1	1	0	1	0	0	1	5	4	1	1	1	1	2	1
Sweet Potato	1	0	0	1	1	2	0	0	0	0	0	0	0	0	1
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Meat and Fish	**16**	**16**	**21**	**17**	**13**	**23**	**16**	**21**	**22**	**15**	**13**	**16**	**16**	**16**	**20**
Beef	66	55	61	69	63	66	48	36	81	57	72	66	60	57	68
Mutton	0	5	2	0	0	0	5	48	1	0	2	1	1	14	1
Poultry	0	1	7	0	5	0	7	1	0	3	0	2	2	2	2
Dry Fish	22	19	15	20	20	12	33	12	14	24	19	20	25	17	15
Fresh Fish	12	19	15	11	13	22	7	3	4	16	8	11	11	11	13
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Vegetables	**12**	**12**	**14**	**11**	**12**	**12**	**13**	**11**	**12**	**11**	**11**	**12**	**12**	**11**	**12**
Leave	13	11	14	13	13	7	10	7	8	12	9	9	12	10	9
Okra	21	26	19	13	11	10	11	8	7	26	22	13	18	17	12
Onion	18	21	23	31	25	27	32	24	25	23	24	29	26	24	26
Tomato	19	18	18	22	24	23	20	23	26	21	21	23	21	21	22
Beans	16	15	13	13	19	21	17	26	25	13	19	16	15	20	19
Others	12	9	13	8	8	12	10	13	10	5	5	10	9	9	11
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Oil	**5**	**3**	**5**	**3**	**3**	**3**	**4**	**4**	**3**	**3**	**3**	**3**	**4**	**3**	**4**
Peanut Oil	86	77	76	73	74	70	66	86	86	77	74	70	76	78	75
Palm Oil	10	13	13	16	10	10	19	3	3	14	19	18	15	11	11
Sheanut Oil	3	10	11	12	15	20	15	11	11	8	8	13	10	11	14
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Sugar	**6**	**6**	**6**	**6**	**6**	**6**	**5**	**7**	**6**	**5**	**7**	**6**	**6**	**6**	**6**

Note: Non-bolded figures refer to budget shares within each commodity group while bolded figures represent budget shares across commodity groups.

Table A2-3: Mean Budget Shares (%) Allocated to Individual At-Home Food Items by Season and by Income Group (continued)

	Share (%)														
	Lean			Harvest			Post-Harv			Planting			Average		
Food	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H
Others	**13**	**13**	**10**	**10**	**11**	**10**	**11**	**9**	**12**	**10**	**9**	**11**	**11**	**10**	**11**
Butter	3	1	0	0	2	0	0	0	0	0	0	0	1	1	0
Buttermilk	3	3	9	1	1	8	6	4	5	4	6	5	3	3	7
Fresh Milk	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0
Cond.Sweet Milk	0	1	2	0	0	2	0	0	0	0	0	0	0	0	1
Powdered Milk	13	15	7	5	6	8	7	2	22	11	5	21	9	7	14
Eggs	2	3	1	0	0	0	0	0	2	0	0	0	0	1	1
Peanuts	25	27	27	37	31	30	30	33	25	33	37	30	31	32	28
Seeds	6	4	3	6	7	3	9	7	3	7	6	3	7	6	3
Other Nut&Seed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coffee	3	4	2	4	2	0	1	1	1	1	2	1	2	2	1
Tea Lipton	2	2	4	0	0	0	1	0	1	0	0	1	1	1	1
Green Tea	0	0	5	0	3	5	0	3	0	0	1	1	0	2	3
Quinqueliba	0	0	1	0	0	2	0	2	1	0	0	1	0	1	1
Other Beverage	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Banana	0	1	1	1	2	0	0	0	3	0	0	0	0	1	1
Citronella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dates	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Lemon	1	1	2	4	3	3	0	2	0	0	0	0	1	2	1
Raisins	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tamarind	2	3	3	0	0	0	5	3	3	3	5	3	3	3	2
Orange	2	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Seas. and Spices	33	33	32	40	40	36	41	41	35	38	38	35	38	38	35
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Total FAH	**81**	**79**	**83**	**87**	**79**	**83**	**89**	**80**	**84**	**81**	**74**	**77**	**85**	**78**	**82**
FAFH	**19**	**21**	**17**	**13**	**21**	**17**	**11**	**20**	**16**	**19**	**26**	**23**	**15**	**22**	**18**
Total Food	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Note: Non-bolded figures refer to budget shares within each commodity group while bolded figures represent budget shares across commodity groups.

Table A2-4: Mean Daily Nutrient Availability per AE from At-Home Foods by Season and by Income Group

Season	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	µg	mg	mg	mg	mg	mg	mg	mg
Lean												
Low	2100	379	56	46	292	33	1	1	17	22	463	22
Middle	2101	390	55	41	449	39	1	1	17	24	429	21
High	2588	458	71	60	543	43	1	1	20	31	579	27
Mean	2263	409	61	49	428	38	1	1	18	26	490	23
Harvest												
Low	2121	399	56	39	231	26	1	1	19	19	367	23
Middle	2058	386	51	41	315	28	1	1	17	20	357	21
High	2528	454	69	56	466	41	1	1	21	34	466	26
Mean	2236	413	59	46	338	32	1	1	19	24	396	23
Post-Harvest												
Low	2091	397	56	37	264	26	1	1	17	14	396	23
Middle	2134	390	51	45	255	36	1	1	17	17	333	19
High	2530	456	67	55	657	46	1	1	20	29	564	24
Mean	2251	414	58	46	392	36	1	1	18	20	431	22
Planting												
Low	2014	391	51	33	149	22	1	1	16	16	336	21
Middle	1911	363	46	35	240	27	1	1	15	18	300	19
High	2334	439	59	45	463	30	1	1	19	25	430	25
Mean	2087	398	52	38	284	26	1	1	17	20	355	22
Average												
Low	2082	391	55	39	234	27	1	1	17	18	390	22
Middle	2051	382	51	40	315	32	1	1	16	20	354	20
High	2495	452	67	54	532	40	1	1	20	30	510	25
Mean	2209	408	57	44	360	33	1	1	18	22	418	23

Note: The FAO's RDA for an adult equivalent are 2200 kilocalories for energy, 300 grams for carbohydrates, 63 grams for protein, 600 micrograms for vitamin A, 45 milligrams for vitamin C, 1.2 milligrams for thiamin, 1.3 milligrams for riboflavin, 45 milligrams for folic acid, 1000 milligrams for calcium, and 59 milligrams for iron (FAO, 1998). The units are: Kcal = kilocalories, g = grams, mg = milligrams, and µg = micrograms.

Table A2-5: Mean Nutrients Contributed by At-Home Food Groups (%) by Income Group

At-Home Foods	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	µg	mg	mg	mg	mg	mg	mg	mg
Rice												
Low	42	50	30	3	0	0	26	11	39	0	16	19
Middle	44	53	33	3	0	0	30	13	42	0	19	23
High	37	46	26	2	0	0	24	10	35	0	14	18
Mean	41	50	30	3	0	0	27	11	39	0	16	20
Other Staples												
Low	31	35	33	18	6	12	50	50	27	12	14	49
Middle	26	30	28	14	4	11	44	45	22	14	12	43
High	29	34	30	14	6	16	47	43	24	30	13	45
Mean	29	33	30	15	5	13	47	46	24	19	13	46
Meat and Fish												
Low	4	0	16	12	4	0	6	10	9	7	22	5
Middle	4	0	17	14	3	0	7	12	10	8	21	6
High	5	0	21	16	3	0	9	14	13	9	22	8
Mean	4	0	18	14	3	0	8	12	11	8	22	7
Vegetables												
Low	4	4	8	1	59	85	9	18	5	80	35	17
Middle	3	4	6	2	58	85	8	19	5	77	36	18
High	4	5	8	1	65	79	9	18	6	60	35	20
Mean	4	4	7	1	61	83	8	18	5	72	35	19
Oil												
Low	6	0	0	36	26	0	0	0	0	0	0	0
Middle	7	0	0	38	30	0	0	0	0	0	0	0
High	8	0	0	39	21	0	0	0	0	0	0	0
Mean	7	0	0	38	26	0	0	0	0	0	0	0
Sugar												
Low	6	8	0	0	0	0	0	0	0	0	0	0
Middle	8	11	0	0	0	0	0	0	0	0	0	0
High	8	12	0	0	0	0	0	0	0	0	0	0
Mean	7	11	0	0	0	0	0	0	0	0	0	0
All others												
Low	7	2	14	29	6	3	9	11	20	0	13	9
Middle	8	2	15	29	5	4	11	11	22	2	13	10
High	8	2	15	28	5	4	11	15	21	1	16	9
Mean	8	2	14	29	5	4	10	12	21	1	14	9

Note: The units are: Kcal = kilocalories, g = grams, mg = milligrams, and µg = micrograms.

Table A2-6: Nutrients Contributed by At-Home Food Groups (%) in August by Income Group

At-Home Foods	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	µg	mg	mg	mg	mg	mg	mg	mg
Rice												
Low	41	51	29	3	0	0	26	10	40	0	13	20
Middle	42	51	30	3	0	0	27	11	40	0	15	21
High	34	44	24	2	0	0	21	9	33	0	11	16
Mean	39	49	28	3	0	0	25	10	38	0	13	19
Other Staples												
Low	27	31	29	13	5	11	47	41	24	11	10	42
Middle	29	33	31	16	3	12	49	46	25	15	12	46
High	30	36	31	13	3	10	49	44	26	22	11	46
Mean	29	33	30	14	4	11	48	44	25	16	11	45
Meat and Fish												
Low	4	0	18	12	3	0	7	11	11	6	24	7
Middle	4	0	17	13	3	0	7	11	10	7	20	6
High	6	0	24	16	5	0	10	15	15	9	25	8
Mean	5	0	20	13	3	0	8	12	12	7	23	7
Vegetables												
Low	5	6	10	2	51	87	12	24	7	82	40	22
Middle	3	4	6	2	41	84	6	18	5	72	40	19
High	5	6	10	2	61	86	11	23	7	68	42	21
Mean	4	5	9	2	51	86	10	22	6	74	41	21
Oil												
Low	9	0	0	47	36	0	0	0	0	0	0	0
Middle	6	0	0	36	43	0	0	0	0	0	0	0
High	10	0	0	46	30	0	0	0	0	0	0	0
Mean	8	0	0	43	36	0	0	0	0	0	0	0
Sugar												
Low	7	10	0	0	0	0	0	0	0	0	0	0
Middle	7	10	0	0	0	0	0	0	0	0	0	0
High	8	12	0	0	0	0	0	0	0	0	0	0
Mean	7	11	0	0	0	0	0	0	0	0	0	0
All others												
Low	7	2	14	24	5	2	9	13	19	1	13	10
Middle	8	2	15	30	10	4	11	14	21	6	13	9
High	7	2	12	21	2	3	9	10	18	2	10	8
Mean	7	2	13	25	6	3	10	12	19	3	12	9

Note: The units are: Kcal = kilocalories, g = grams, mg = milligrams, and µg = micrograms.

Table A2-7: Nutrients Contributed by At-Home Food Groups (%) in November by Income Group

At-Home Foods	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	μg	mg	mg	mg	mg	mg	mg	mg
Rice												
Low	42	51	30	3	0	0	26	12	37	0	17	20
Middle	45	54	34	3	0	0	30	13	41	0	18	22
High	37	46	25	2	0	0	22	10	34	0	15	18
Mean	41	50	30	3	0	0	26	11	37	0	17	20
Other Staples												
Low	31	36	32	17	10	18	49	50	25	21	15	48
Middle	26	29	28	13	7	13	44	44	22	18	11	42
High	30	36	30	13	18	30	47	47	25	48	16	47
Mean	29	33	30	15	12	20	47	47	24	29	14	46
Meat and Fish												
Low	4	0	17	15	6	0	7	11	10	8	18	6
Middle	4	0	16	12	2	0	7	11	9	6	22	6
High	6	0	23	17	4	0	10	15	14	9	25	9
Mean	5	0	18	15	4	0	8	12	11	8	21	7
Vegetables												
Low	3	3	5	1	48	75	6	16	4	70	36	16
Middle	3	4	6	2	62	80	8	21	6	75	36	19
High	4	5	8	1	56	64	9	16	5	43	31	17
Mean	3	4	7	1	55	73	8	18	5	63	35	18
Oil												
Low	4	0	0	27	22	0	0	0	0	0	0	0
Middle	7	0	0	38	21	0	0	0	0	0	0	0
High	8	0	0	39	19	0	0	0	0	0	0	0
Mean	6	0	0	34	21	0	0	0	0	0	0	0
Sugar												
Low	6	8	0	0	0	0	0	0	0	0	0	0
Middle	8	11	0	0	0	0	0	0	0	0	0	0
High	8	12	0	0	0	0	0	0	0	0	0	0
Mean	7	10	0	0	0	0	0	0	0	0	0	0
All others												
Low	9	2	16	37	14	7	12	12	25	0	14	11
Middle	8	2	16	32	7	8	12	11	22	1	13	11
High	8	2	14	28	2	7	11	12	23	0	13	9
Mean	8	2	15	32	8	7	11	12	23	0	13	10

Note: The units are: Kcal = kilocalories, g = grams, mg = milligrams, and μg = micrograms.

Table A2-8: Nutrients Contributed by At-Home Food Groups (%) in February by Income Group

At-Home Foods	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	μg	mg	mg	mg	mg	mg	mg	mg
Rice												
Low	41	49	29	3	0	0	24	11	38	0	16	19
Middle	47	57	37	3	0	0	34	17	45	0	22	26
High	39	48	27	2	0	0	25	10	37	0	13	20
Mean	42	51	31	3	0	0	28	12	40	0	17	22
Other Staples												
Low	34	38	35	20	3	11	53	54	30	8	15	51
Middle	21	25	23	10	2	12	37	40	18	15	10	37
High	27	32	28	12	1	15	44	37	23	30	11	43
Mean	27	31	29	14	2	13	45	44	23	17	12	44
Meat and Fish												
Low	3	0	14	11	3	0	5	9	8	8	22	5
Middle	5	0	19	15	3	0	8	15	10	9	25	8
High	6	0	21	16	2	0	10	13	13	10	21	9
Mean	5	0	18	14	3	0	8	12	11	9	23	7
Vegetables												
Low	4	5	8	1	68	88	9	17	5	84	35	18
Middle	4	5	7	1	73	85	8	18	5	76	32	18
High	4	4	6	1	79	81	8	15	6	60	28	18
Mean	4	5	7	1	73	84	9	17	5	73	32	18
Oil												
Low	6	0	0	35	25	0	0	0	0	0	0	0
Middle	8	0	0	45	21	0	0	0	0	0	0	0
High	7	0	0	38	6	0	0	0	0	0	0	0
Mean	7	0	0	39	17	0	0	0	0	0	0	0
Sugar												
Low	5	7	0	0	0	0	0	0	0	0	0	0
Middle	8	12	0	0	0	0	0	0	0	0	0	0
High	8	13	0	0	0	0	0	0	0	0	0	0
Mean	7	10	0	0	0	0	0	0	0	0	0	0
All others												
Low	7	2	13	29	1	2	9	9	19	0	12	8
Middle	7	2	15	26	1	3	12	10	22	0	11	10
High	9	3	18	30	12	4	13	25	22	1	27	10
Mean	8	2	15	29	5	3	11	15	21	0	17	9

Note: The units are: Kcal = kilocalories, g = grams, mg = milligrams, and μg = micrograms.

Table A2-9: Nutrients Contributed by At-Home Food Groups (%) in May by Income Group

At-Home Foods	Food Energy	Carbo-hydrate	Protein	Fat	Vitamins						Minerals	
					Vit A	Vit C	Thiamin	Riboflavin	Niacin	Folic Acid	Calcium	Iron
	Kcal	g	g	g	µg	mg	mg	mg	mg	mg	mg	mg
Rice												
Low	43	50	32	4	0	0	27	12	41	0	18	20
Middle	42	50	33	3	0	0	29	13	40	0	19	21
High	40	47	29	3	0	0	26	11	37	0	16	18
Mean	42	49	31	3	0	0	28	12	40	0	18	20
Other Staples												
Low	34	37	35	21	5	8	53	55	30	8	16	54
Middle	29	32	31	16	2	7	46	49	24	7	13	47
High	30	34	31	16	2	11	47	45	24	22	12	44
Mean	31	34	32	17	3	9	48	50	26	12	14	48
Meat and Fish												
Low	3	0	15	12	4	0	5	9	8	7	24	5
Middle	4	0	16	14	3	0	8	11	10	8	18	6
High	4	0	18	15	3	0	8	12	11	8	19	6
Mean	4	0	16	14	3	0	7	11	10	8	20	6
Vegetables												
Low	3	3	6	1	68	90	7	15	4	85	29	14
Middle	3	4	6	2	58	91	7	18	5	85	36	16
High	4	5	6	2	63	87	7	19	5	70	39	23
Mean	3	4	6	1	63	89	7	17	5	80	35	18
Oil												
Low	5	0	0	36	20	0	0	0	0	0	0	0
Middle	6	0	0	35	35	0	0	0	0	0	0	0
High	6	0	0	33	28	0	0	0	0	0	0	0
Mean	5	0	0	35	28	0	0	0	0	0	0	0
Sugar												
Low	6	8	0	0	0	0	0	0	0	0	0	0
Middle	9	12	0	0	0	0	0	0	0	0	0	0
High	9	12	0	0	0	0	0	0	0	0	0	0
Mean	8	11	0	0	0	0	0	0	0	0	0	0
All others												
Low	6	1	12	27	3	2	7	9	16	0	13	7
Middle	7	2	15	29	1	2	11	10	21	0	13	9
High	8	2	15	32	3	2	11	13	23	0	15	9
Mean	7	2	14	30	3	2	10	10	20	0	14	8

Note: The units are: Kcal = kilocalories, g = grams, mg = milligrams, and µg = micrograms.

Table A2-10: Contribution of At-Home Food Commodities to Protein Availability

At-Home Food Coomodity Groups	Mean Daily Protein Availability (Grams/AE)					Nutrient Source (%)				
	L	H	PH	P	Avg	L	H	PH	P	Avg
Staples	**35**	**35**	**34**	**33**	**34**	**58**	**59**	**59**	**63**	**60**
Rice	17	17	18	16	17	47	50	52	49	50
Millet-Sorghum	15	15	14	14	15	43	43	41	43	42
Maize	2	1	1	2	2	6	4	4	5	5
Wheat	1	1	1	1	1	3	2	3	2	3
Other Cereal	0	0	0	0	0	0	0	0	0	0
Atieke	0	0	0	0	0	0	0	0	0	0
Cassava	0	0	0	0	0	0	0	0	0	0
Potato	0	0	0	0	0	0	0	1	0	0
Sweet Potato	0	0	0	0	0	0	1	0	0	0
Meat and Fish	**12**	**11**	**11**	**9**	**11**	**20**	**19**	**18**	**16**	**18**
Beef	5	6	5	4	5	43	52	49	52	49
Mutton	0	0	1	0	0	1	0	5	1	2
Poultry	0	0	0	0	0	2	0	1	1	1
Dry Fish	5	4	4	3	4	41	36	41	38	39
Fresh Fish	2	1	0	1	1	12	11	4	9	9
Vegetables	**5**	**4**	**4**	**3**	**4**	**9**	**7**	**7**	**6**	**7**
Leave	1	1	1	1	1	19	18	12	16	17
Okra	1	0	0	1	1	16	12	9	16	13
Onion	1	1	1	1	1	9	14	17	18	14
Tomato	0	0	0	0	0	5	9	9	11	8
Beans	0	0	1	0	0	6	11	15	8	10
Others	2	1	2	1	2	44	37	37	31	38
Oil	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Peanut Oil	0	0	0	0	0	0	0	0	0	0
Palm Oil	0	0	0	0	0	0	0	0	0	0
Sheanut Oil	0	0	0	0	0	0	0	0	0	0
Sugar	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All others	**8**	**9**	**9**	**7**	**8**	**13**	**15**	**15**	**14**	**14**
Butter	0	0	0	0	0	0	0	0	0	0
Buttermilk	0	0	0	0	0	2	1	1	1	1
Fresh Milk	0	0	0	0	0	0	0	0	0	0
Condensed Sweetened M	0	0	0	0	0	1	0	0	0	0
Powdered Milk	1	1	1	1	1	8	6	14	7	9
Eggs	0	0	0	0	0	4	0	0	0	1
Peanuts	5	7	6	5	6	64	74	64	70	68
Seeds	1	1	1	1	1	9	9	9	9	9
Other Nuts and Seeds	0	0	0	0	0	0	0	0	0	0
Coffee	0	0	0	0	0	0	0	0	0	0
Tea Lipton	0	0	0	0	0	0	0	0	0	0
Green Tea	0	0	0	0	0	0	0	0	0	0
Quinqueliba	0	0	0	0	0	0	0	0	0	0
Other Beverage	0	0	0	0	0	0	0	0	0	0
Bananas	0	0	0	0	0	0	0	0	0	0
Citronella	0	0	0	0	0	0	0	0	0	0
Dates	0	0	0	0	0	0	0	0	0	0
Lemon	0	0	0	0	0	0	0	0	0	0
Raisins	0	0	0	0	0	0	0	0	0	0
Tamarind	0	0	0	0	0	1	0	1	1	0
Orange	0	0	0	0	0	0	0	0	0	0
Seas. and Spices	1	1	1	1	1	11	9	10	11	11
Total	**60**	**58**	**58**	**52**	**57**	**100**	**100**	**100**	**100**	**100**

Note: Non-bolded figures refer to budget shares within each commodity group while bolded figures represent budget shares across commodity groups. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Table A2-11: Mean Budget Share Allocated to Fruits, Nuts, and Dairy Products At and Away From Home

Commodities	L	H	PH	P	Avg.
Nuts					
At-Home	3.9	3.9	3.5	4.4	3.9
Away-From-Home	0.8	0.5	1.7	0.4	0.9
Fruits					
At-Home	1.0	0.6	0.7	0.5	0.7
Away-From-Home	3.8	10.1	3.8	3.8	5.4
Dairy					
At-Home	2.8	1.5	2.0	2.4	2.2
Away-From-Home	6.9	6.1	6.2	4.4	5.9
Others					
At-Home	92.3	94.0	93.8	92.7	93.2
Away-From-Home	88.5	83.2	88.3	91.4	87.8

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

CHAPTER 3

ESTIMATING THE IMPACT OF SEASONAL CHANGES IN REAL INCOMES AND RELATIVE PRICES ON HOUSEHOLDS' CONSUMPTION PATTERNS IN BAMAKO, MALI, USING THE ALMOST IDEAL DEMAND SYSTEM MODEL

3.1. Introduction

In 2000, more than 58 percent of the Malian urban population lived below the poverty line, and urban unemployment approached 70 percent (USAID, 2000). Urban households have faced higher and more variable food prices, lower real wages, growing unemployment, and reductions in social services (e.g., health and education) since the inception of the early 1980s structural adjustment reforms (Tefft et al., 1997). Such economic environments have resulted in urban households having real incomes that can vary significantly across seasons. As shown in the previous essay, in 2000-2001, Bamako households' mean real expenditures decreased by 38 percent between the lean and post-harvest season, increased by 4 percent between the harvest and post-harvest season, and dropped by 18 percent between the post-harvest and planting season.

Concerns about real income stability, which is an important determinant of household food security, have drawn the attention of policy makers towards the design of safety net programs to protect at-risk households' food entitlements (Sahn, 1989). However, the formulation of such programs requires substantial knowledge about urban households' seasonal food consumption patterns and the forces causing changes in those patterns. To date, two empirical consumption studies (Rogers and Lowdermilk, 1981 and Reardon and al, 1999) have been conducted in urban areas of Mali. These consumption studies have focused mainly on estimating the Engel relationship between food expenditure and income using cross-sectional data. This study uses the complete systems approach to estimate demand parameters using household-level panel data in order to provide a clear understanding of households' consumption patterns in Bamako. Panel data, unlike cross-sectional data, which tends to reflect long-run adjustment processes, allows estimation of short-run income and price elasticities (Timmer, 1983).

This study hypothesizes that Bamako households' consumption patterns are responsive to changes in their real incomes and that the relationship between household income and food and non-food consumption patterns will change from one season to another. This implies that the effectiveness of specific programs or policies will depend on the economic conditions prevailing at their time of implementation (Skoufias, 2002).[24] The impact of seasonal changes in real income and relative prices on households' consumption patterns has not been investigated in Bamako, Mali, prior to this study.

The general objective of this study is to examine the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako. The specific objectives of this essay are as follows. First, the study seeks to estimate demand parameters using the almost ideal demand system model for each season.[25] Second, the analysis aims at computing income elasticities for different seasons in order to determine if households' consumption patterns are responsive to changes in their real incomes. Third, the study derives own and cross-price elasticities for different seasons in order to identify households' seasonal substitutions among and between broad

[24] Temporal targeting mechanisms, such as seasonal income transfers to low-income households and seasonal imports of rice, are examples of programs or policies that are season-specific.
[25] The seasons are defined as follows: August = lean, November = harvest, February = post-harvest, and May = planting.

commodity groups. Finally, the study performs sensitivity analyses on households' consumption by varying estimated income and price elasticities.

3.2. Methods

3.2.1. Commodity Aggregates and Weak Separability

This study will assume that consumers' preferences are weakly separable in order to simplify the modeling of the consumers' consumption decisions. The reasoning behind the concept of weak separability is that the optimization problem is intractable for the consumer if the demand for every commodity is a function of the prices of all other commodities (Deaton and Muellbauer, 1980a). To simplify this problem, we may assume that the consumer partitions total consumption into groups of goods, so that preferences within groups can be described independently of the other groups (Pollak and Wales, 1992). Price changes in one good will then affect only other goods in the same group directly. Commodities in any other group will only be affected through the change in total expenditure as the price change makes the consumer richer or poorer.

Under the assumption of weak separability, the consumers' simultaneous decision-making process is broken into three steps by adopting a three-stage budgeting process, as depicted, below, in Figure 3-1. In the first stage, households allocate their total expenditures among seven broad groups of commodities: (1) Food, (2) Durable Goods, (3) Semi-Durable Goods, (4) Health, (5) Energy and Utilities, (6) Other Non-Durables (Hygiene and Tobacco), and (7) Services. [26] In the second stage, households allocate their food expenditure on seven food groups: (1) Staples, (2) Vegetables, (3) Meat and Fish, (4) Oil, (5) Sugar, (6) Other Foods, and (7) Food Away From Home. In the third and final stage, households allocate their staple group expenditure to (1) Rice,

(2) Millet-Sorghum, (3) Maize, (4) Wheat, and (5) Roots and Tubers. Hence, it is thus assumed that preferences are weakly inter-temporally separable, that food is weakly separable from non-food commodities and that staples are weakly separable from the other food groups.[27]

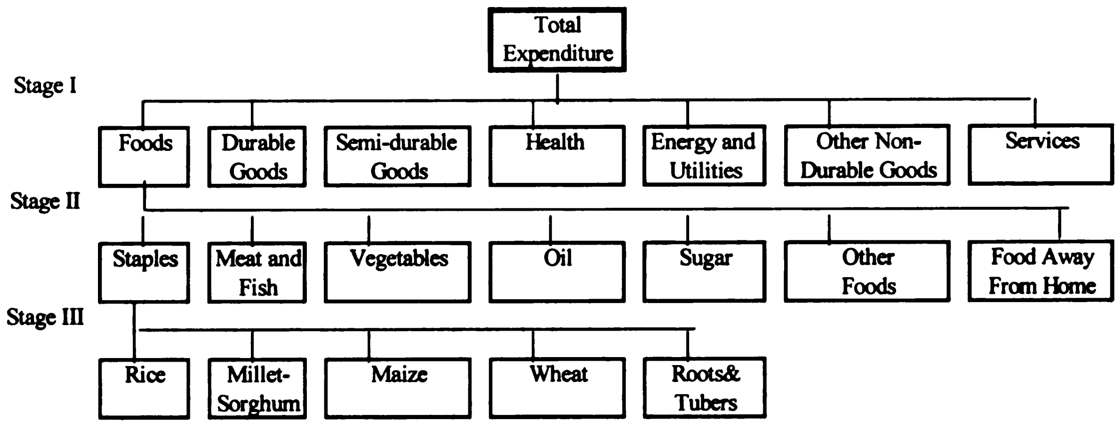


Figure 3-1: Three-Stage Budgeting Process for Urban Households in Mali

3.2.1. The Almost Ideal Demand System (AIDS)

The study will model, as shown in Figure 3-1, the allocation of (i) total expenditure (Stage I), (ii) food expenditure (Stage II) and (iii) staples expenditure (Stage III) for each season separately and for the entire data pooled (yielding 160 observations). The Almost Ideal Demand System (AIDS), developed by Deaton and Muellbauer (1980a, 1980b), is used to estimate demand equation parameters. The AIDS is a demand system that is superior to its predecessors and is recommended as a vehicle for testing, extending, and improving conventional demand analysis because it is linear in the parameters and hence

[26] Table A3-1 of Appendix 3 presents the definition of the various commodities and commodity groups.
[27] The assumption of weak intertemporal separability allows each demand equation in each season to be expressed as a function of prices and income in that season alone, so that goods in each season form a closely related group with only general relations between seasons (Deaton, 1990). Thus, once households make the consumption-saving decision, the problem left is for the household to allocate total income among goods at given prices.

simple to estimate, and most satisfactory in terms of being able to estimate and test the predictions of consumer demand theory (Green & Alston, 1990; Alston et al., 1994). The AIDS model is derived from a consumer cost/expenditure minimization problem as defined by a cost/expenditure function that expresses the minimum expenditure necessary to reach a specific utility level at a given set of prices. The AIDS, formulated in terms of the budget shares, is specified in this study as follows:

$$W_{sit} = \alpha_i + \Sigma_j \gamma_{ij} \ln P_{sjt} + \beta_i \ln (X_{st}/P_{st}) + \theta_i \ln AE_{st} + u_{sit} \qquad (1)$$

The dependent variable W_{sit} is budget share of good i of the stage s model (s=1, 2, 3) at season t (t = 1, 2, 3, 4). The independent variables of the equation include P_{sit} as the price of each good i of the stage s model at season t; X_{st} as the household real expenditures per adult equivalent (AE), AE is household size in adult equivalents and P_{st} is an overall price index.[28] Following Moschini (1995), the price index is approximated by a log-linear analog of the Laspeyres price index in order to maintain the linear specification. [29] In equation (1), the γ_{ij} parameters measure the change in the ith commodity's budget share in response to a 1 percent proportional change in the jth commodity price with real income held constant. The β_i parameters, or marginal budget shares, represent the change in the ith commodity's budget share with respect to a change in real income, holding prices constant. The θ_i parameters represent the change in the ith commodity's budget share due to a 1 percent change in household size, with incomes and

[28] Other independent variables could in theory be added, but in this study, degrees of freedom considerations restricted their use.

[29] The log-linear analog of the Laspeyres price index is defined as: $\ln P^{*} = \sum_{i}^{k} W_i^0 \ln P_i$

prices held constant. The restrictions, imposed on equation (1), to ensure theoretical consistency for the almost ideal demand system are:

Adding-up: $\Sigma_i \alpha_i = 1$, $\Sigma_i \gamma_{ij} = 0$ (1a)

Symmetry: $\gamma_{ij} = \gamma_{ji}$ (1b)

Homogeneity: $\Sigma_j \gamma_{ji} = 0$ (1c)

Adding-up requires that the demand functions must satisfy the linear budget constraint (marginal budget shares derived from the system must add up to one). Homogeneity of degree zero in all prices and income means that the scaling of all prices and income has no effect on the quantity demanded of each good. Symmetry entails that the cross-price derivatives of the Hicksian demands are symmetric.

The Chow Test, which is simply an F test, will be performed to test the hypothesis of the constancy of the parameters of the demand system across seasons. The study will test for the stability of the coefficients under the null hypothesis that the estimated income and price elasticities do not vary across seasons. Once the F-statistic is computed, we will compare that value against the critical F-values at a chosen significance level (e.g., 1%, 5%, and 10%). If the F-value is less than the critical F-value, then we do not reject the null hypothesis, meaning that the impact of changes in Bamako households' real incomes and relative prices on consumption patterns is constant across seasons.

The income and price elasticities, evaluated at the mean budget shares, will be derived from the parameter estimates equations using the following:

$\eta_i = 1 + [\beta_i / w_i]$: Expenditure elasticity (2)

$\xi_i = -1-\beta_i + [\gamma_{ii} / w_i]$: Marshallian (uncompensated) own-price elasticity (3)

$\xi_{ij} = [\gamma_{ij}{}^{*} / w_i] - \beta_i [w_j / w_i]$: Marshallian (uncompensated) cross-price elasticity (4)

$\eta_{ij} = \xi_{ij} + \eta_i * w_j$: Hicksian (compensated) price elasticities (5)

Where, η_i is the expenditure elasticity, ξ_i is the Marshallian (uncompensated) own-price elasticity, ξ_{ij} is the Marshallian (uncompensated) cross-price elasticity, and η_{ij} is the Hicksian (compensated) price elasticities. Following Lazaridis (2003), a system of share equations based on equation (1) and subject to the restrictions (adding-up, homogeneity, and symmetry) is estimated using iterative Seemingly Unrelated Regression (ISUR) method for constrained systems developed by Zellner (1962).[30] The adding-up property of demand causes the error covariance matrix of system to be singular, so one of the expenditure share equations is dropped from the system to avoid singularity problems. The estimates are invariant to which equation is deleted from the system, if no heteroskedasticity is present, because the coefficients of the omitted equation are recovered by using the adding-up restrictions.

3.2.2. The Data[31]

The panel data used in this study is from a 2000-2001 survey undertaken in Bamako by the Direction Régionale du Plan et de la Statistique (DRPS) of the Direction Nationale de la Statistique et de l'Informatique (DNSI) and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA) of Michigan State

---

[30] Demand equations are related because the error term across equations are correlated by the fact that the dependent variables need to satisfy the budget constraint (the budget shares must sum up to one). Although in this case the OLS estimates are consistent and unbiased, the SUR estimation method yields estimates that are more efficient.

[31] The definitions and summary statistics of the variables are presented in Table A3-2 of Appendix 3.

University (MSU), the Assemblée Permanente des Chambres d'Agriculture du Mali (APCAM), and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD). The four surveys covered 40 Food Consumption Units (FCU), the sample size being the same in each round. The same 40 households were tracked over time and interviewed in all four periods. There was no sample attrition.

The total expenditures in CFA Francs aggregates were computed following Deaton and Zaidi (1999).[32] The budget shares were calculated as the expenditure on a good as a fraction of total expenditure. Unit values, used as proxy for prices, were computed as a ratio of total household expenditure on a good divided by the total quantity consumed of the good. Households' real incomes are proxied by total real expenditures and are calculated by deflating their nominal income (total expenditures) by the Laspeyres price index. The data on household size was converted into adult equivalents using the following scales: male > 14 years = 1.0; female > 14 years = 0.8; children = 0.5 (Duncan, 1994).

3.3. Empirical Results

This study seeks to examine the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako, Mali. In this section, the empirical results are presented in three parts. First, the analysis begins with an evaluation of the estimated coefficients. Second, the income and price elasticities are examined. Third, sensitivity analyses are performed on households' consumption by varying estimated income and price elasticities.

[32] Detailed information on the construction of the expenditure aggregates is provided in Appendix A2-1.

3.3.1. Coefficients

The aim of this section is to examine the estimated demand parameters in order to investigate the effects of changes in real incomes and relative prices on the expenditure share of each commodity aggregate by season, holding fixed all other factors. Results of the Chow test are also presented in order to assess whether the estimated income and price parameters are stable across seasons.

3.3.1.1. Stage I Coefficients

Table 3-1, below, displays the estimates of the parameters, their associated t-values, and the Chow test results for the Stage I model. The parameters of the dropped equations, Services, were recovered using the adding up restrictions. The dependent variables are the expenditure share of each commodity aggregate. In addition to prices and real income, a household size (in adult equivalents) variable was included in the regression models. A total of 7 equations were estimated for each season.

First, the results indicate that price, income, and household size factors account for a substantial part of the observed variation in the budget share devoted to the commodities considered. For instance, the goodness-of-fit measure, R^2, ranges between 0.65 and 0.82 for food, suggesting that, as a group, the price, income, and household size variables explain about 65 to 82 percent of the observed variation in the food budget share. The R^2 for non-food expenditure categories is lower than that for food. For instance, the R^2 ranges between 0.16 and 0.48 for health and 0.13 and 0.21 for semi-durable goods.

Second, the estimated results show that coefficients of a great number of the explanatory variables in all seasons are statistically significant at the 1%, 5%, or 10%

level, indicating a large degree of price and income responsiveness of budget shares. For instance, the results reveal that the estimated income parameters for food are statistically significant at the 1 percent level in all seasons and for the pooled data.

Third, the signs of the price and income coefficients are consistent with the theory. The marginal budget share estimates, β, for food, are all negative, are -0.130, -0.224, -0.186, and –0.207 for the lean, harvest, post-harvest, and planting seasons and -0.202 for the pooled data. These results suggest that food is a necessity, as food expenditures take a smaller percentage of income as households get richer. In contrast, the coefficients for durable goods and health are all positive, suggesting that these are luxuries, since at higher income levels, households increase the proportion of the total budget allocated to these non-food items.

Finally, the Chow test results indicate a certain degree of non-constancy of price and income parameters across seasons. For instance, the Chow tests results showed that there was statistically significant structural change, at 1 % significance level, across seasons in all the estimated income and price coefficients for the food equation. This means that the impact of real income and relative prices on the food budget share is not constant across seasons. The null hypothesis of stability of the income parameters was also rejected, at the 1 % significance level, for durable goods and health. The Chow tests results also showed that there was statistically significant structural change, at least at the 10 % significance level, in one or more of the estimated price parameters for all demand equations in the Stage I model.

These findings confirm the main hypothesis of this study, as they indicate that Bamako households' consumption patterns are responsive to changes in their real incomes and relative prices and that the relationship between household income and relative prices and food and non-food consumption patterns changes from one season to another.

Table 3-1: Parameter Estimates and Chow Test Results for Stage I Model

Variables	Dependent Variable: Expenditure Share of											
	Food						Durable Goods					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
const	1.345	1.865	1.656	1.874	1.770		-0.429	-1.420	-0.158	-0.187	-0.609	
	(5.33)	**(6.36)**	**(5.44)**	**(8.75)**	**(13.35)**		(1.26)	**(2.85)**	(0.64)	(0.71)	**(3.46)**	
X/P	-0.130	-0.224	-0.186	-0.207	-0.202	**6.577**	0.073	0.234	0.032	0.045	0.108	**5.202**
	(3.67)	**(5.95)**	**(4.46)**	**(7.65)**	**(11.54)**	*(0.00)*	(1.55)	**(3.70)**	(0.98)	(1.32)	**(4.73)**	*(0.00)*
p1	0.060	0.096	0.106	0.073	0.077	**3.742**	-0.017	0.003	-0.010	0.002	0.001	**4.572**
	(2.66)	**(4.24)**	**(3.56)**	**(3.65)**	**(6.35)**	*(0.00)*	(1.49)	(0.29)	(0.92)	(0.22)	(0.23)	*(0.00)*
p2	-0.017	0.003	-0.010	0.002	0.001	**3.590**	0.057	0.019	0.023	0.008	0.026	1.720
	(1.49)	(0.29)	(0.92)	(0.22)	(0.23)	*(0.00)*	**(3.07)**	(0.82)	**(2.12)**	(0.68)	**(2.91)**	*(0.11)*
p3	-0.013	0.003	-0.002	-0.013	0.000	**3.387**	-0.007	-0.011	0.014	-0.005	-0.007	**2.062**
	(0.75)	(0.19)	(0.11)	(1.15)	(0.04)	*(0.00)*	(0.41)	(0.71)	(1.13)	(0.65)	(0.97)	*(0.05)*
p4	0.002	-0.010	-0.003	-0.024	-0.014	**4.458**	-0.028	-0.001	-0.005	-0.014	-0.011	1.610
	(0.25)	(1.17)	(0.17)	**(3.34)**	**(2.80)**	*(0.00)*	**(2.58)**	(0.06)	(0.48)	(1.47)	**(1.95)**	*(0.14)*
p5	0.003	-0.037	-0.042	-0.023	-0.026	**5.503**	0.005	-0.006	-0.007	-0.007	-0.003	**2.378**
	(0.17)	**(2.26)**	**(2.47)**	**(1.92)**	**(3.59)**	*(0.00)*	(0.46)	(0.71)	(0.84)	(1.07)	(0.70)	*(0.03)*
p6	-0.001	-0.040	-0.022	0.012	-0.007	**3.582**	0.009	0.001	-0.009	0.006	0.001	**2.630**
	(0.09)	**(2.67)**	**(2.09)**	(0.85)	(1.07)	*(0.00)*	(1.21)	(0.16)	**(2.66)**	(0.86)	(0.36)	*(0.02)*
p7	-0.034	-0.016	-0.026	-0.026	-0.032	**5.268**	-0.017	-0.006	-0.006	0.011	-0.007	**3.132**
	(1.40)	(0.91)	(0.99)	(1.56)	**(3.18)**	*(0.00)*	(0.90)	(0.44)	(0.53)	(1.22)	(1.11)	*(0.00)*
AE	0.007	0.023	0.031	0.019	0.021		-0.019	-0.025	-0.027	-0.005	-0.022	
	(0.33)	(0.82)	(1.05)	(0.84)	(1.58)		(0.54)	(0.50)	(1.04)	(0.17)	(1.13)	
R-sqd	0.71	0.76	0.65	0.82	0.73		0.39	0.32	0.20	0.08	0.20	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; X/P = total real expenditure per adult equivalent, p1 = price of food, p2 = price of durable goods, p3 = price of semi-durable goods, p4 = price of health, p5 = price of energy and utilities, p6 = price of other non-durables (Hygiene and Tobacco), and p7 = price of services, AE = adult equivalent. T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level ; P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

Table 3-1: Parameter Estimates and Chow Test Results for Stage I Model (continued)

	Dependent Variable: Expenditure Share of											
	Semi-Durable Goods						Health					
Variables	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
const	0.131	0.091	-0.876	0.411	-0.381		-0.448	-0.222	-0.298	-1.016	-0.309	
	(0.33)	(0.26)	**(2.63)**	**2.25**	**(2.28)**		(1.68)	(0.73)	(1.18)	**(2.79)**	**(2.00)**	
X/P	-0.024	0.013	0.130	-0.030	0.063	1.568	0.090	0.028	0.077	0.177	0.065	**3.333**
	(0.42)	(0.28)	**(2.91)**	(1.27)	**(2.87)**	*(0.53)*	**(2.52)**	(0.71)	**(2.25)**	**(3.69)**	**(3.25)**	*(0.00)*
p1	-0.013	0.003	-0.002	-0.013	0.000	**2.365**	0.002	-0.010	-0.003	-0.024	-0.014	1.490
	(0.75)	0.19	(0.11)	(1.15)	0.04	*(0.03)*	(0.25)	(1.17)	(0.17)	**(3.34)**	**(2.80)**	(0.18)
p2	-0.007	-0.011	0.014	-0.005	-0.007	1.210	-0.028	-0.001	-0.005	-0.014	-0.011	1.143
	(0.41)	(0.71)	1.13	(0.65)	(0.97)	*(0.30)*	**(2.58)**	(0.06)	(0.48)	(1.47)	**(1.95)**	(0.33)
p3	0.113	0.030	0.024	-0.002	0.041	**2.430**	-0.010	-0.009	-0.016	0.001	-0.011	1.017
	(3.49)	(1.37)	(0.98)	(0.16)	**(3.19)**	*(0.02)*	(0.76)	(0.82)	(1.06)	(0.10)	**(1.72)**	(0.41)
p4	-0.010	-0.009	-0.016	0.001	-0.011	**1.832**	0.037	0.023	0.002	0.037	0.034	0.913
	(0.76)	(0.82)	(1.06)	(0.10)	**(1.72)**	*(0.09)*	**(3.12)**	**(2.12)**	(0.09)	**(2.42)**	**(4.65)**	(0.48)
p5	-0.005	-0.007	0.010	0.000	-0.001	1.205	-0.014	0.000	0.020	0.002	-0.001	**3.315**
	(0.31)	(0.61)	(0.72)	(0.03)	(0.19)	*(0.30)*	**(1.87)**	(0.02)	(1.50)	(0.34)	(0.36)	(0.00)
p6	-0.010	0.002	0.018	0.007	0.001	1.388	0.004	0.004	0.003	0.000	0.003	**1.937**
	(0.96)	(0.18)	**(2.96)**	(0.78)	(0.30)	*(0.22)*	(0.78)	(0.78)	(0.45)	(0.08)	(1.33)	(0.07)
p7	-0.068	-0.008	-0.047	0.012	-0.023	**2.323**	0.009	-0.007	-0.001	-0.001	0.001	1.703
	(2.38)	(0.52)	**(2.30)**	(0.99)	**(2.54)**	*(0.03)*	(0.61)	(0.76)	(0.06)	(0.08)	(0.13)	(0.12)
AE	0.014	-0.037	0.026	-0.046	0.009		-0.035	0.036	-0.039	-0.031	-0.023	
	(0.36)	(1.09)	(0.72)	**(2.33)**	(0.48)		(1.27)	(1.17)	(1.46)	(0.80)	(1.37)	
R-squared	0.28	0.13	0.21	0.15	0.13		0.32	0.16	0.25	0.48	0.22	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; X/P = total real expenditure per adult equivalent, p1 = price of food, p2 = price of durable goods, p3 = price of semi-durable goods, p4 = price of health, p5 = price of energy and utilities, p6 = price of other non-durables (Hygiene and Tobacco), and p7 = price of services, AE = adult equivalent. T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level. P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

Table 3-1: Parameter Estimates and Chow Test Results for Stage I Model (continued)

	Dependent Variable: Expenditure Share of																
	Energy and Utilities						Other Non-Durable Goods						Services				
Variables	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled
const	-0.203	0.323	0.583	0.040	0.199		0.086	0.360	0.174	0.068	0.149		0.516	0.003	-0.081	-0.190	0.180
	(1.04)	(1.48)	**(2.85)**	(0.24)	**(2.14)**		(0.59)	**(2.18)**	**(1.88)**	(0.45)	**(2.24)**						
X/P	0.033	-0.030	-0.071	0.009	-0.016	1.587	-0.018	-0.038	-0.027	-0.017	-0.021	1.598	-0.023	0.017	0.045	0.023	0.001
	(1.17)	(1.09)	**(2.56)**	(0.43)	(1.28)	*(0.14)*	(0.89)	(1.81)	**(2.20)**	(0.90)	**(2.41)**	*(0.14)*					
p1	0.003	-0.037	-0.042	-0.023	-0.026	**1.978**	-0.001	-0.040	-0.022	0.012	-0.007	**1.780**	-0.034	-0.016	-0.026	-0.026	-0.032
	(0.17)	**(2.26)**	**(2.47)**	(1.92)	**(3.59)**	*(0.07)*	(0.09)	**(2.67)**	**(2.09)**	(0.85)	(1.07)	*(0.10)*					
p2	0.005	-0.006	-0.007	-0.007	-0.003	1.278	0.009	0.001	-0.009	0.006	0.001	1.607	-0.017	-0.006	-0.006	0.011	-0.007
	(0.46)	(0.71)	(0.84)	(1.07)	(0.70)	*(0.26)*	(1.21)	(0.16)	**(2.66)**	(0.86)	(0.36)	*(0.14)*					
p3	-0.005	-0.007	0.010	0.000	-0.001	1.298	-0.010	0.002	0.018	0.007	0.001	**2.408**	-0.068	-0.008	-0.047	0.012	-0.023
	(0.31)	(0.61)	(0.72)	(0.03)	(0.19)	*(0.25)*	(0.96)	(0.18)	**(2.96)**	(0.78)	(0.30)	*(0.03)*					
p4	-0.014	0.000	0.020	0.002	-0.001	1.767	0.004	0.004	0.003	0.000	0.003	0.907	0.009	-0.007	-0.001	-0.001	0.001
	(1.87)	(0.02)	(1.50)	(0.34)	(0.36)	*(0.10)*	(0.78)	(0.78)	(0.45)	(0.08)	(1.33)	*(0.49)*					
p5	0.038	0.048	0.059	0.067	0.055	1.552	-0.009	0.026	-0.003	-0.011	0.002	1.082	-0.019	-0.024	-0.037	-0.027	-0.025
	(2.20)	**(2.11)**	**(3.05)**	**(4.85)**	**(6.72)**	*(0.16)*	(0.72)	(1.37)	(0.34)	(1.01)	(0.29)	*(0.37)*					
p6	-0.009	0.026	-0.003	-0.011	0.002	**2.087**	-0.024	0.035	-0.002	-0.015	-0.005	**2.028**	0.031	-0.027	0.016	0.002	0.005
	(0.72)	(1.37)	(0.34)	(1.01)	(0.29)	*(0.05)*	(1.24)	(1.09)	(0.11)	(0.72)	(0.45)	*(0.06)*					
p7	-0.019	-0.024	-0.037	-0.027	-0.025	1.703	0.031	-0.027	0.016	0.002	0.005	**2.292**	0.097	0.089	0.103	0.028	0.082
	(0.95)	(1.48)	**(1.77)**	**(2.02)**	**(3.11)**	*(0.12)*	**(1.72)**	**(1.84)**	(1.36)	(0.12)	(0.62)	*(0.03)*					
AE	0.039	0.017	-0.009	0.018	0.017		0.020	-0.012	0.015	0.020	0.009		-0.026	-0.001	0.003	0.024	-0.011
	(2.12)	(0.86)	(0.41)	(0.98)	**(1.74)**		(1.54)	(0.80)	(1.56)	(1.30)	(1.40)						
R-squared	0.29	0.28	0.35	0.52	0.31		0.27	0.18	0.38	0.08	0.09						

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; X/P = total real expenditure per adult equivalent, p1 = price of food, p2 = price of durable goods, p3 = price of semi-durable goods, p4 = price of health, p5 = price of energy and utilities, p6 = price of other non-durables (Hygiene and Tobacco), and p7 = price of services; AE = adult equivalent. T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level. P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

3.3.1.2. Stage II Coefficients

Results of the Stage II model, presented below in Table 3-2, indicate that the explanatory variables account for 46 to 64 percent of the observed variation in the budget share devoted to staples and for 14 to 61 percent in that of meat and fish. Furthermore, the estimated results show that with the exception of vegetables and oil, the estimated income coefficients are statistically significant in at least one season for each of the commodity aggregates. This means that Bamako households' consumption of staples, meat and fish, oil, and other foods is responsive to changes in their real incomes. Also, a great number of the price variables in all seasons are statistically significant at the 10% level. For instance, 4 of the 7 price variables were statistically significant in the staples' equation for the pooled data.

The marginal budget shares, β, for staples are –0.172, -0.212, -0.185, and –0.252 for the lean, harvest, post-harvest, and planting seasons and –0.195 for the pooled data and are all statistically significant at the 1 percent level. These results suggest that staples are necessities; thus, Bamako households' expenditures on staples take a smaller percentage of income as households get richer. The income coefficients for meat and fish range between 0.048 during the planting season and 0.169 during the harvest season. The estimates of β for meat and fish are all positive and statistically significant at the 1 percent level in all seasons except May and for the pooled data. This means that meat and fish commodities are luxuries for Bamako households, since at higher income levels, households increase the proportion of the food budget allocated to these goods.

With the exception of the price of other foods, the null hypothesis of stability of the income and price parameters for the staple equation could not be rejected at the 10 %

significance level. These results suggest that the impact of real income and relative prices, except for the price of other foods, on the budget share for staples is stable across seasons. In contrast, the Chow tests results show that there was statistically significant structural change, at least at the 10 % significance level, in all the income and price coefficients, except for the price of meat and fish, in the meat and fish equation. The null hypothesis of stability of the price parameters was also rejected, at least at the 10 % significance level, for the following demand equations: vegetables, sugar, and other foods.

Table 3-2: Parameter Estimates and Chow Test Results for Stage II Model

Variables	Dependent Variable: Expenditure Share of											
	Staples						Meat and Fish					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
const	0.772	0.664	0.708	0.854	0.741		-0.237	-0.330	-0.344	-0.094	-0.221	
	(9.29)	**(6.85)**	**(6.88)**	**(6.04)**	**(13.86)**		**(2.92)**	**(3.24)**	**(4.33)**	(0.88)	**(4.74)**	
X/P	-0.172	-0.212	-0.185	-0.252	-0.195	1.027	0.121	0.169	0.166	0.048	0.115	**2.202**
	(5.23)	**(5.97)**	**(5.98)**	**(4.93)**	**(10.29)**	*(0.41)*	**(3.73)**	**(4.41)**	**(6.81)**	(1.25)	**(6.79)**	*(0.04)*
p1	0.100	0.095	0.071	0.000	0.109	1.080	-0.023	-0.008	-0.059	-0.013	-0.017	**1.913**
	(3.23)	**(2.58)**	(1.25)	(0.01)	**(4.85)**	*(0.37)*	(1.35)	(0.38)	**(1.96)**	(0.49)	(1.46)	*(0.07)*
p2	-0.023	-0.008	-0.059	-0.013	-0.017	1.705	0.023	0.032	0.056	0.040	0.031	1.718
	(1.35)	(0.38)	(1.96)	(0.49)	(1.46)	*(0.12)*	(1.23)	(1.43)	(2.01)	**(1.89)**	**(2.84)**	*(0.11)*
p3	-0.036	0.011	-0.023	-0.009	-0.032	0.808	0.028	-0.013	-0.004	0.008	0.009	**2.708**
	(1.93)	(0.51)	(0.88)	(0.33)	**(2.77)**	*(0.56)*	**(2.33)**	(0.81)	(0.24)	(0.61)	(1.20)	*(0.01)*
p4	0.004	-0.020	0.003	0.003	-0.020	0.767	0.003	0.000	-0.001	-0.002	-0.001	**2.285**
	(0.24)	**(2.37)**	(0.17)	(0.20)	**(3.22)**	*(0.60)*	(0.34)	(0.06)	(0.13)	(0.30)	(0.36)	*(0.03)*
p5	-0.019	-0.018	0.014	0.056	-0.002	0.730	0.001	-0.013	0.021	-0.023	-0.009	**2.922**
	(0.98)	(0.85)	(0.46)	**(1.83)**	(0.15)	*(0.62)*	(0.11)	(0.85)	(1.13)	**(1.68)**	(1.27)	*(0.01)*
p6	-0.014	-0.007	0.023	0.006	-0.003	**2.383**	-0.024	-0.001	-0.028	0.000	-0.012	**3.080**
	(1.07)	(0.53)	(1.28)	(0.37)	(0.47)	*(0.03)*	**(2.32)**	(0.07)	**(2.25)**	(0.04)	**(2.18)**	*(0.01)*
p7	-0.013	-0.052	-0.029	-0.042	-0.035	1.032	-0.008	0.003	0.016	-0.009	0.000	**2.202**
	(1.13)	**(3.64)**	(1.50)	**(2.31)**	**(4.26)**	*(0.40)*	(0.76)	(0.20)	(1.05)	(0.65)	(0.02)	*(0.04)*
AE	-0.038	0.016	0.000	-0.037	-0.010		0.059	0.069	0.065	0.035	0.055	
	(2.12)	(0.91)	0.00	(1.66)	(0.94)		**(3.33)**	**(3.63)**	**(4.34)**	**(2.09)**	**(6.06)**	
R-sqd	0.52	0.64	0.52	0.49	0.46		0.40	0.45	0.61	0.14	0.35	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting;; X/P = total real food expenditure per adult equivalent, p1 = Price of staples, p2 = price of meat and fish, p3 = price of vegetables, p4 = price of oil, p5 = price of sugar, p6 = price of other foods, and p7 = food away from home, AE = adult equivalent; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

Table 3-2: Parameter Estimates and Chow Test Results for Stage II Model (continued)

Variables	Dependent Variable: Expenditure Share of											
	Vegetables						Oil					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
const	0.130	0.134	0.201	0.059	0.124		0.042	-0.040	0.002	0.038	-0.007	
	(2.28)	**(2.21)**	**(3.46)**	(0.86)	**(4.02)**		(1.05)	(1.31)	(0.06)	(1.02)	(0.39)	
X/P	-0.004	0.018	-0.010	0.023	0.001	1.275	0.009	0.024	0.010	-0.010	0.012	0.902
	(0.19)	(0.79)	(0.58)	(0.94)	(0.07)	*(0.27)*	(0.59)	**(2.15)**	(0.92)	(0.72)	**(2.04)**	*(0.49)*
p1	-0.036	0.011	-0.023	-0.009	-0.032	1.090	0.004	-0.020	0.003	0.003	-0.020	0.778
	(1.93)	(0.51)	(0.88)	(0.33)	**(2.77)**	*(0.37)*	(0.24)	**(2.37)**	(0.17)	(0.20)	**(3.22)**	*(0.59)*
p2	0.028	-0.013	-0.004	0.008	0.009	0.820	0.003	0.000	-0.001	-0.002	-0.001	1.052
	(2.33)	(0.81)	(0.24)	(0.61)	(1.20)	*(0.55)*	(0.34)	(0.06)	(0.13)	(0.30)	(0.36)	*(0.39)*
p3	0.017	-0.036	0.050	-0.026	0.007	**3.113**	-0.001	0.006	0.005	0.007	0.006	1.192
	(0.91)	(1.54)	**(2.31)**	(1.22)	(0.67)	*(0.00)*	(0.10)	(0.89)	(0.48)	(0.81)	(1.53)	*(0.31)*
p4	-0.001	0.006	0.005	0.007	0.006	1.408	-0.012	0.010	0.010	-0.004	0.007	1.665
	(0.10)	(0.89)	(0.48)	(0.81)	(1.53)	*(0.21)*	(0.89)	**(2.71)**	(1.19)	(0.56)	**(2.25)**	*(0.12)*
p5	0.005	0.036	-0.028	0.023	0.010	1.005	-0.014	0.009	-0.010	-0.001	0.005	0.663
	(0.39)	**(2.07)**	**(1.68)**	(1.39)	(1.21)	*(0.42)*	(1.24)	(1.48)	(0.95)	(0.11)	(1.21)	*(0.68)*
p6	-0.011	-0.004	-0.008	-0.005	-0.002	1.287	0.014	-0.003	0.000	-0.001	0.002	0.783
	(0.98)	(0.45)	(0.72)	(0.50)	(0.31)	*(0.26)*	**(1.78)**	(0.59)	0.00	(0.11)	(0.92)	*(0.58)*
p7	-0.003	0.001	0.009	0.001	0.002	0.687	0.006	-0.002	-0.006	-0.002	0.000	0.963
	(0.42)	(0.07)	(0.81)	(0.14)	(0.35)	*(0.66)*	(1.14)	(0.40)	(0.84)	(0.49)	(0.11)	*(0.45)*
AE	-0.012	-0.011	-0.021	-0.002	-0.011		-0.004	0.005	0.003	0.003	0.003	
	(0.99)	(0.97)	**(1.87)**	(0.22)	**(1.87)**		(0.53)	(0.99)	(0.52)	(0.59)	(0.85)	
R-sqd	0.16	0.13	0.16	0.15	0.05		0.07	0.20	0.08	0.13	0.06	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting;; X/P = total real food expenditure per adult equivalent, p1 = Price of staples, p2 = price of meat and fish, p3 = price of vegetables, p4 = price of oil, p5 = price of sugar, p6 = price of other foods, and p7 = food away from home, AE = adult equivalent; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

Table 3-2: Parameter Estimates and Chow Test Results for Stage II Model (continued)

Variables	Dependent Variable: Expenditure Share of																
	Sugar						Other Foods						Food Away From Home				
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled
const	0.088	0.144	0.044	0.243	0.104		0.107	0.223	0.126	0.155	0.137		0.805	0.633	0.830	0.603	0.758
	(1.96)	**(2.70)**	(0.72)	**(3.73)**	**(3.72)**		**(1.96)**	**(4.09)**	**(2.85)**	**(2.78)**	**(5.53)**						
X/P	-0.015	-0.024	-0.002	-0.042	-0.008	0.712	-0.016	-0.071	-0.016	-0.045	-0.034	1.182	0.032	0.095	0.018	0.087	0.042
	(0.87)	(1.23)	(0.13)	(1.81)	(0.85)	*(0.64)*	(0.74)	**(3.48)**	(1.15)	**(2.23)**	**(3.74)**	*(0.31)*					
p1	-0.019	-0.018	0.014	0.056	-0.002	1.452	-0.014	-0.007	0.023	0.006	-0.003	1.112	0.032	0.025	-0.037	-0.062	0.005
	(0.98)	(0.85)	(0.46)	**(1.83)**	(0.15)	*(0.19)*	(1.07)	(0.53)	(1.28)	(0.37)	(0.47)	*(0.35)*					
p2	0.001	-0.013	0.021	-0.023	-0.009	1.600	-0.024	-0.001	-0.028	0.000	-0.012	1.120	0.023	0.014	0.008	0.024	0.021
	(0.11)	(0.85)	(1.13)	**(1.68)**	(1.27)	*(0.14)*	**(2.32)**	(0.07)	**(2.25)**	(0.04)	**(2.18)**	*(0.35)*					
p3	0.005	0.036	-0.028	0.023	0.010	1.772	-0.011	-0.004	-0.008	-0.005	-0.002	1.392	0.005	-0.032	0.036	-0.019	-0.008
	(0.39)	**(2.07)**	**(1.68)**	(1.39)	(1.21)	*(0.10)*	(0.98)	(0.45)	(0.72)	(0.50)	(0.31)	*(0.21)*					
p4	-0.014	0.009	-0.010	-0.001	0.005	**1.803**	0.014	-0.003	0.000	-0.001	0.002	1.733	0.000	-0.007	0.010	0.002	-0.008
	(1.24)	(1.48)	(0.95)	(0.11)	(1.21)	*(0.09)*	**(1.78)**	(0.59)	0.00	(0.11)	(0.92)	*(0.11)*					
p5	0.007	0.005	-0.001	-0.022	0.005	0.723	0.015	-0.015	0.015	-0.021	-0.005	**2.857**	-0.022	0.010	-0.014	0.043	0.000
	(0.33)	(0.22)	(0.05)	(0.76)	(0.38)	*(0.63)*	(1.58)	**(1.64)**	(1.32)	**(2.08)**	(1.01)	*(0.01)*					
p6	0.015	-0.015	0.015	-0.021	-0.005	**2.005**	0.035	0.036	0.014	0.035	0.034	**2.032**	-0.050	-0.021	-0.030	-0.014	-0.029
	(1.58)	**(1.64)**	(1.32)	**(2.08)**	(1.01)	*(0.06)*	**(3.23)**	**(3.45)**	(1.28)	**(3.89)**	(6.96)	*(0.06)*					
p7	0.005	-0.004	-0.010	-0.013	-0.004	1.685	-0.015	-0.006	-0.017	-0.014	-0.015	1.090	0.011	0.010	0.027	0.027	0.019
	(0.81)	(0.45)	(0.91)	(1.55)	(0.94)	*(0.12)*	**(2.06)**	(0.76)	**(1.87)**	**(1.91)**	**(3.90)**	*(0.37)*					
AE	-0.004	-0.017	0.001	-0.023	-0.009		-0.001	-0.008	0.005	-0.001	0.000		0.005	0.025	-0.006	0.024	0.010
	(0.44)	**(1.77)**	(0.11)	**(2.28)**	**(1.76)**		(0.05)	(0.84)	(0.60)	(0.06)	(0.07)						
R-sqd	0.15	0.30	0.06	0.38	0.05		0.15	0.43	0.20	0.39	0.29						

Note: X/P = total real food expenditure per adult equivalent, p1 = Price of staples, p2 = price of meat and fish, p3 = price of vegetables, p4 = price of oil, p5 = price of sugar, p6 = price of other foods, and p7 = food away from home, AE = adult equivalent; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics. There are no standard errors available for the Services equation since its parameters were recovered using the adding up restriction.

3.3.1.3. Stage III Coefficients

Table 3-3, below, presents the estimated parameters for the Stage III model. Price, income, and household size variables can explain about 10 to 20 percent of the observed variation in the share of rice, millet-sorghum, maize, and wheat. The relatively low R^2 may be due to the fact that households' demand for specific staples, such as rice, is a function of their tastes and preferences for these goods, which are usually controlled for in the estimation process through the inclusion of many socio-demographic variables.

The estimates of β for rice are –0.085, -0.028, -0.076, and –0.009 for the lean, harvest, post-harvest, and planting seasons and –0.109 for the pooled data and are statistically significant at the 10 percent level only for the pooled data. The income coefficients for millet-sorghum range between –0.009 during the harvest season and –0.055 during the planting season, and none of them are statistically significant. The marginal budget shares for maize range between –0.027 for the pooled data and –0.185 for the post-harvest season and are statistically significant, at the 10 percent significance level, only for the pooled data. The results indicate that rice, millet-sorghum, and maize are necessities for Bamako households since at higher income levels, households will reduce the proportion of the food budget allocated to these goods. The estimated income coefficients for wheat are all positive, ranging between 0.002 during the planting season and 0.110 during the lean season, and are statistically significant during the lean, post-harvest, and for the pooled data. This means that wheat is a luxury for Bamako households.

The Chow test results indicate that there was statistically significant structural change, at 1 % significance level, across seasons in all the estimated income and price coefficients for the maize equation. The Chow tests results also showed that there was statistically significant structural change, at least at the 10 % significance level, in one or more of the estimated price parameters for all demand equations in the Stage III model.

Table 3-3: Parameter Estimates and Chow Test Results for Stage III Model

Variables	Dependent Variable: Expenditure Share of											
	Rice						Millet-Sorghum					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
const	0.861	0.643	0.500	0.401	0.598		0.247	0.038	-0.041	0.317	0.152	
	(3.37)	**(2.22)**	**(2.22)**	(1.29)	**(5.57)**		(1.18)	(0.15)	(0.19)	(1.11)	(1.50)	
X/P	-0.085	-0.028	-0.076	-0.009	-0.109	1.618	-0.047	-0.009	-0.054	-0.055	-0.037	1.682
	(1.14)	(0.32)	(1.03)	(0.11)	**(2.69)**	*(0.14)*	(0.76)	(0.12)	(0.77)	(0.69)	(0.99)	*(0.12)*
p1	-0.017	0.166	0.259	0.071	0.080	1.618	-0.009	-0.111	-0.311	-0.183	-0.122	**2.977**
	(0.18)	(1.61)	**(2.04)**	(0.42)	(1.54)	*(0.14)*	(0.16)	**(1.94)**	**(3.75)**	**(1.75)**	**(3.60)**	*(0.01)*
p2	-0.009	-0.111	-0.311	-0.183	-0.122	**2.723**	-0.048	0.095	0.093	0.159	0.074	**2.807**
	(0.16)	**(1.94)**	**(3.75)**	**(1.75)**	**(3.60)**	*(0.01)*	(0.81)	**(1.86)**	(1.15)	**(1.74)**	**(2.21)**	*(0.01)*
p3	0.016	0.083	-0.001	0.149	0.067	1.357	0.096	0.009	0.132	-0.025	0.041	**1.962**
	(0.28)	(1.08)	(0.02)	**(3.30)**	**(2.42)**	*(0.23)*	**(2.34)**	(0.17)	**(3.69)**	(0.88)	**(1.95)**	*(0.07)*
p4	0.009	-0.055	0.040	-0.012	-0.005	**2.077**	-0.041	0.021	0.071	0.056	0.016	**3.097**
	(0.25)	**(1.87)**	(1.12)	(0.20)	(0.27)	*(0.05)*	(1.53)	(0.94)	**(2.62)**	(1.33)	(1.14)	*(0.00)*
p5	0.002	-0.083	0.014	-0.024	-0.020	1.292	0.003	-0.013	0.015	-0.006	-0.010	1.667
	(0.09)	**(3.10)**	(0.23)	(0.62)	(1.42)	*(0.26)*	(0.16)	(0.69)	(0.38)	(0.25)	(0.87)	*(0.12)*
AE	0.011	0.011	0.007	0.005	0.045		0.002	-0.002	0.001	0.003	0.001	
	(2.40)	**(2.13)**	**(1.81)**	(1.05)	**(1.84)**		(0.43)	(0.43)	(0.24)	(0.56)	(0.03)	
R-sqd	0.21	0.32	0.35	0.22	0.20		0.25	0.21	0.24	0.17	0.10	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; X/P = total real staple expenditure per adult equivalent, p1 = Price of rice, p2 = price of millet-sorghum, p3 = price of maize, p4 = price of wheat, p5 = price of roots and tubers, and AE = adult equivalent; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics. There are no standard errors available for the Roots&Tubers equations since its parameters were recovered using the adding up restriction.

Table 3-3: Parameter Estimates and Chow Test Results for Stage III Model (continued)

Variables	Dependent Variable: Expenditure Share of																
	Maize						Wheat						Roots&Tubers				
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled
const	0.056	-0.027	0.428	0.146	0.172		-0.230	-0.020	-0.072	0.155	-0.005		0.066	0.366	0.185	-0.018	0.082
	(0.26)	(0.08)	**(2.78)**	(1.39)	**(1.98)**		(1.47)	(0.13)	(0.77)	(0.91)	(0.08)						
X/P	-0.117	-0.063	-0.185	-0.057	-0.027	**5.223**	0.110	0.047	0.099	0.002	0.051	0.618	0.140	0.053	0.215	0.119	0.122
	(0.44)	(0.65)	(1.03)	(0.67)	**(2.41)**	*(0.00)*	**(2.41)**	(1.05)	**(3.36)**	(0.04)	**(2.34)**	*(0.72)*					
p1	0.016	0.083	-0.001	0.149	0.067	**4.087**	0.009	-0.055	0.040	-0.012	-0.005	1.267	0.002	-0.083	0.014	-0.024	-0.020
	(0.28)	(1.08)	(0.02)	**(3.30)**	**(2.42)**	*(0.00)*	(0.25)	**(1.87)**	(1.12)	(0.20)	(0.27)	*(0.27)*					
p2	0.096	0.009	0.132	-0.025	0.041	**5.418**	-0.041	0.021	0.071	0.056	0.016	0.850	0.003	-0.013	0.015	-0.006	-0.010
	(2.34)	(0.17)	**(3.69)**	(0.88)	**(1.95)**	*(0.00)*	(1.53)	(0.94)	**(2.62)**	(1.33)	(1.14)	*(0.53)*					
p3	-0.153	-0.167	-0.100	-0.083	-0.106	**4.332**	0.065	0.039	-0.017	-0.037	0.004	**2.123**	-0.023	0.036	-0.014	-0.004	-0.006
	(2.81)	**(1.88)**	**(3.14)**	**(3.77)**	**(4.11)**	*(0.00)*	**(2.49)**	(1.33)	(1.03)	**(1.99)**	(0.31)	*(0.05)*					
p4	0.065	0.039	-0.017	-0.037	0.004	**5.345**	-0.043	-0.011	-0.085	-0.027	-0.034	1.093	0.011	0.007	-0.008	0.021	0.019
	(2.49)	(1.33)	(1.03)	**(1.99)**	(0.31)	*(0.00)*	(1.73)	(0.60)	**(4.67)**	(0.78)	**(2.99)**	*(0.36)*					
p5	-0.023	0.036	-0.014	-0.004	-0.006	**4.023**	0.011	0.007	-0.008	0.021	0.019	0.570	0.008	0.054	-0.006	0.013	0.017
	(1.29)	(1.38)	(0.63)	(0.28)	(0.67)	*(0.00)*	(1.00)	(0.57)	(0.40)	(1.37)	**(3.01)**	*(0.75)*					
AE	-0.008	-0.008	-0.003	-0.005	-0.051		-0.003	-0.002	-0.004	-0.001	0.030		-0.002	0.002	-0.001	-0.002	-0.025
	(1.93)	(1.49)	(1.13)	**(2.84)**	(2.54)		(1.20)	(0.95)	**(2.48)**	(0.32)	**(2.22)**						
R-sqd	0.37	0.16	0.48	0.52	0.30		0.17	0.12	0.55	0.22	0.10						

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; X/P = total real staple expenditure per adult equivalent, p1 = Price of rice, p2 = price of millet-sorghum, p3 = price of maize, p4 = price of wheat, p5 = price of roots and tubers, and AE = adult equivalent; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics. There are no standard errors available for the Roots&Tubers equations since its parameters were recovered using the adding up restriction.

3.3.2. Income Elasticities

Table 3-4, below, reports the estimated income elasticities for the Stage I, II, and III models for each season and the pooled data and the Chow test results. The income elasticity estimates, in absolute terms, are used to classify commodities into one of three categories: inferior goods ($\eta(i) < 0$), normal goods ($0 < \eta(i) < 1$), and luxury goods ($\eta(i) > 1$). In this section, the estimated income elasticities are examined in order to determine if in any given season (1) households' consumption patterns are responsive to changes in their real incomes and (2) there are evidence of seasonal changes in income responsiveness.

Table 3-4: Estimated Income Elasticities for Stage I, II, and III Models

Commodities	L	H	PH	P	Pooled	Chow
Stage I						
Food	0.626*	0.463*	0.577*	0.574*	0.516*	6.576*
Durable Goods	1.496	2.277*	1.361	1.468	1.912*	5.202*
Semi-Durable Goods	0.865	1.125	1.980*	0.563	1.600*	1.568
Health	2.104*	1.368	1.847**	2.364*	1.721*	3.33*
Energy and Utilities	1.386	0.634	0.343*	1.094	0.829	1.587
Other Non-Durables	0.502	0.116***	0.267**	0.646	0.492*	1.598
Services	0.816	1.164	1.437	1.301	1.012	
Stage II						
Staples	0.439*	0.386*	0.467*	0.274*	0.418*	1.027
Meat and Fish	1.810*	2.064*	2.087*	1.359	1.775*	2.202**
Vegetables	0.968	1.150	0.916	1.208	1.006	1.275
Oil	1.208	1.819**	1.270	0.639	1.364**	0.902
Sugar	0.751	0.631	0.966	0.400***	0.874	0.712
Other Foods	0.863	0.329*	0.850	0.560**	0.687*	1.182
Food Away From Home	1.422	1.550	1.232	2.349	1.606	
Stage III						
Rice	0.837	0.945	0.862	0.983	0.796*	1.618
Millet-Sorghum	0.772	0.957	0.742	0.817	0.841	1.682
Maize	0.286	0.617	-0.521	0.199	0.793**	5.223*
Wheat	2.626**	2.028	3.068*	1.039	1.944**	0.618
Roots&Tubers	4.547	1.868	3.920	4.123	3.292	

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; *, **, and *** denotes estimated income parameters are significant at the 1%, 5% and 10% level, respectively. Tests of statistical significance are not available for the dropped equations because their parameters were recovered using the adding-up restrictions.

3.3.2.1. Stage I Income Elasticities: Food vs. Non-Food Commodities

For most commodities, the estimated income elasticity of demand is statistically significant at the 1, 5, or 10 percent level, suggesting that Bamako households' consumption patterns in any given season are responsive to changes in their real incomes. For instance, the pooled data estimated income elasticities are statistically significant, at the 1 percent level, for all commodities, except energy and utilities. The estimated income elasticities are also statistically significant, at least at the 10 percent level, for food and health during the lean season, for food, health, and other non-durable goods during the harvest season, for all commodities except durables goods during the post-harvest seasons, and for food and health during the planting season.

All the estimated income elasticities are positive, suggesting that the food and non-food commodities are normal goods, as their consumption will increase with income. The results indicate that food and other non-durable commodity groups are clearly necessities across all seasons ($0< \eta(i) <1$), indicating that Bamako households will tend to spend proportionally less on these commodities at higher income levels. The income elasticities of demand for durable goods (housewares and education) and health were found to be greater than 1 in all seasons, suggesting that these commodities are luxury products for Bamako households. These finding suggest that as households' income increase, they tend to spend proportionally more on these non-food commodities. Moreover, the results show that semi-durable goods (clothing and footwear) are necessities in August and May and luxuries during the other seasons.

The results also indicate that there is considerable variation in the estimated income elasticities across seasons and across commodity groups in any given season. Between the lean and harvest season, which corresponds to the period when households' real expenditures decreased by 36 percent, the income elasticity for food decreases from 0.626 to 0.463 while those of most non-food commodities increase, especially durable (from 1.496 to 2.277) and semi-durable goods (from 0.865 to 1.125). In contrast, between the harvest and post harvest seasons, which corresponds to the period when households' real expenditures increased by 4 percent, the income elasticity of demand for food increases from 0.463 to 0.577, while that for durable goods, energy and utilities, and services decreased. Between the post-harvest and planting seasons, which corresponds to the period when Bamako households' real expenditures fell by 18 percent, the income elasticity of food decreases from 0.577 to 0.574, while that for durables goods (1.361 to 1.468), health (1.847 to 2.364), energy and utilities (0.343 to 1.094), and services (0.267 to 0.646) increases.

Two main conclusions can be drawn from these findings. First, the high absolute level of these income elasticities, even for food, underscores the extreme level of poverty and unmet "basic needs" that prevail in Bamako. In consequence, the results suggest that policies that aim at increasing households' real income will cause substantial improvements not only in the quantity of food available in urban households but also in the demand for non-food commodities. Rapid growth in the demand for non-food commodities could translate into sizable rise in employment, to the extent that these commodities can be produced domestically.

Second, the results indicate that the responsiveness of food consumption to changes in real income remains fairly stable across seasons compared to that of non-food commodities. For instance the food income elasticity ranges between 0.463 and 0.626

while the elasticity for durable goods ranges between 1.361 and 2.277. This is evidence that households engage in food consumption smoothing. Specifically, the results indicate that Bamako households engage in food consumption smoothing from seasonal shocks in real incomes at the expense of non-food commodities such as health and durable goods (e.g. housewares and education).

3.3.2.2. Stage II Income Elasticities: Staples vs. Non-Staples Commodities

The estimated income elasticties for the Stage II commodity groups are statistically significant at least at the 10 percent level for the following commodities: staples, meat and fish, oil, and other foods for the pooled data and the harvest season; staples and meat and fish for the lean and post-harvest seasons; and staples, sugar, and other foods during the planting season. All the estimated income elasticties of demand in the Stage II commodity groups are positive, suggesting that these commodities are normal or luxury goods. The results show that staples, sugar, and other foods have income elasticities that are less than 1 in all seasons, indicating that a 1 percent change in income results in a less than proportionate increase in expenditures on these goods. In contrast, the income elasticity for meat and fish and food away from home exceeds 1 in all seasons, suggesting that the amounts households spend on these commodities increase more than proportionally with income. The income elasticity of demand for vegetables is close to unity in all seasons. The fact that there are no inferior goods in the commodity aggregates considered is consistent with the findings of previous consumption studies (Rogers and Lowdermilk, 1991 and Reardon et al., 1999).

The estimated income elasticity for staples derived from the pooled data estimation is slightly lower than that found by Reardon et al (1999), which was 0.47 after the CFA Franc devaluation. These findings suggest that staples have been a necessity over time and that Bamako households' consumption of staples is becoming slightly less responsive to changes in their real incomes. The income elasticities derived from the pooled data estimation also indicate that staples have the smallest income elasticity of demand (0.418) while that of vegetables (1.006), food away from home (1.606), and meat and fish (1.775) are considerably larger. Reardon et al (1999) found that the income elasticity for staples (0.47) was greater than that for vegetables (0.180) and meat and fish (0.160) after the CFA Franc devaluation. These findings suggest that Bamako households' consumption of vegetables and meat and fish is becoming increasingly responsive to changes in their real incomes.

Furthermore, the null hypothesis of stability in the income parameters could only be rejected for meat and fish, suggesting that the impact of real income on the demand for meat and fish is not constant across seasons. In contrast, the results indicate that the effect of changes in real income on the demand for staples, vegetables, oil, sugar, and other foods is not statistically significantly different across seasons.

Two main conclusions can be drawn from these findings. First, the high absolute level of the income elasticities of demand for vegetables and meat and fish, which contain essential micronutrients, suggests that improvements in households' real incomes will have a substantial impact on the quality of their diets. Hence, many nutritional deficiencies, such as vitamin A deficiency, could be addressed by policies that focus on stimulating income growth.

Second, the fact that the income elasticity of staples varies less across seasons than that of non-staple commodities suggests that households engage in food consumption smoothing by protecting their consumption of staples at the expense of non-staple foods, which contain essential micro-nutrients. The results of the previous essay indicated that Bamako households will tend to diversify their diets during periods of low grain prices (harvest and post-harvest seasons) and revert to necessities as food prices begin to increase and real income levels decline.

3.3.2.3. Stage III Income Elasticities: Rice vs. Other Staples Commodities

Only a few of the estimated income elasticties of the Stage III model are statistically significant at least at the 10 percent level: rice, maize, and wheat for the pooled data, and wheat during the lean and harvest seasons. These results indicate that, with the exception of wheat, Bamako households' consumption of rice, millet-sorghum, and maize is not responsive to changes in their real incomes in any given season. However, the pooled data results are statistically significant at the 10 percent level for all staples, except millet-sorghum, suggesting that Bamako households' consumption of staples is responsive to changes in their real incomes in the long-run. The pooled data results also show that the estimated income elasticity of rice (0.796) is greater than that found by Rogers and Lowdermilk (1991) of 0.562 and Reardon et al (1999) of 0.23. These results suggest that rice is becoming less of a necessity for urban households over time.

3.3.3. Own and Cross Price Elasticities

The own-price elasticities of demand are used to test the law of demand hypothesis, which says that normal goods must have downward sloping demand curves. The cross-price elasticities are used to classify commodities into one of three categories: substitutes ($\xi_{ij} > 0$), complements ($\xi_{ij} < 0$), and independent ($\xi_{ij} = 0$). In this section, the estimated own-price and cross price elasticities are examined in order to determine if in any given season (1) Bamako households' consumption patterns are responsive to changes in relative prices; (2) there is evidence of seasonal change in price responsiveness; and (3) households substitute among and between broad commodity groups.

3.3.3.1. Stage I Price Elasticities

3.3.3.1.1. Uncompensated and Compensated Own-Price Elasticities

Table 3-5, below, shows the compensated and uncompensated own-price elasticity of demand for commodities in the Stage I model by season and for the pooled data. The own-price elasticities, both compensated and uncompensated, are all negative, suggesting that there is an inverse relationship between price and quantity demanded for each of the commodity groups of the Stage I model.

Table 3-5: Compensated and Uncompensated Own-Price Elasticities for Stage I Commodities by Season

Commo-dities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
Food	**-0.698**	**-0.545**	**-0.574**	**-0.643**	**-0.612**	**-0.480**	**-0.353**	**-0.320**	**-0.364**	**-0.392**	**3.742**
DG	**-0.684**	-1.132	**-0.768**	-0.958	**-0.890**	**-0.465**	-0.714	**-0.647**	-0.816	**-0.654**	1.720
SDG	**-0.332**	-0.717	-0.945	-1.003	**-0.676**	**-0.180**	-0.604	-0.683	-0.964	**-0.493**	**2.430**
Health	**-0.638**	**-0.722**	-1.057	**-0.895**	**-0.692**	**-0.466**	**-0.618**	-0.889	**-0.588**	**-0.532**	0.913
EU	**-0.578**	**-0.380**	**-0.383**	**-0.311**	**-0.384**	**-0.461**	**-0.328**	**-0.346**	**-0.207**	**-0.307**	1.552
OND	**-1.643**	**-0.149**	-1.018	-1.305	-1.093	**-1.624**	**-0.144**	-1.008	-1.274	-1.073	**2.028**
Services	-0.211	-0.134	-0.049	-0.650	-0.162	-0.107	-0.017	-0.100	-0.553	-0.060	

Note: DG = Durable Goods; SDG = Semi-Durable Goods; EU = Energy and Utilities; and OND = Other Non-Durable Goods. Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance can't be performed for Services because their parameters were recovered using the adding-up restrictions.

For most commodities, the estimated own-price elasticity of demand is statistically significant at the 10 percent level, indicating that households' demand for these commodities is responsive to own-price changes in all seasons and for the pooled data. For instance, the pooled data own-price elasticities are statistically significant for all commodities, except other non-durable goods. All the estimated own-price elasticities are statistically significant during the lean season. The own-price elasticities are also statistically significant for food, health, energy and utilities, and other non-durable goods during the harvest season, food, durable goods, and energy and utilities during the post-harvest season, and food, health, and energy and utilities during the planting season.

All the statistically significant compensated own-price elasticities are less than 1 (in absolute value) in all seasons, suggesting that the demand for these commodities is inelastic. The statistically significant uncompensated own-price elasticities derived from the pooled data range between –0.384 for energy and utilities and –0.890 for durable goods, suggesting that the demand for energy and utilities is the least responsive to own-price changes.

The compensated own-price elasticities are much smaller in magnitude than the uncompensated ones, suggesting that prices occupy a smaller role when the income effects are removed. The results show that income effects from changes in the price of food are very strong, implying that the price of food has a substantial impact on the real income of Bamako households. For instance, the pooled data results show that households would react to a 1 percent increase in the price of food by reducing food consumption by 0.397 percent, when their purchasing power is held constant. However, with no compensation for the price increase, the price change decreases the quantity demanded of food by 0.615 percent. These results show that changes in food prices substantially affect households' purchasing power because of the large proportion of income that is devoted to food. Furthermore, a comparison of the uncompensated and compensated own-price elasticities across seasons reveals that changes in the price of food have the greatest impact on Bamako households' real incomes during the planting season and the smallest effect during the harvest season.

3.3.3.1.2. Uncompensated and Compensated Cross-Price Elasticities

Tables 3-6, below, presents the compensated and uncompensated cross-price elasticities for non-food commodities by season and for the pooled data. The results indicate that the demand for food is not very responsive to changes in the price of non-food commodities in any given season and for the pooled data. For instance, the results show that the price of health during the lean season and for the pooled data, energy and utilities in all periods except the lean season, other non-durable goods during the harvest and post-harvest seasons, and services for the pooled data have a statistically significant, but very small, impact on the demand for food.

In contrast, the results indicate that the price of food has strong and statistically significant uncompensated effects on the demand for non-food commodities. For instance, the uncompensated results show that a 1 percentage increase in the price of food reduces urban households' expenditures on traditional and formal health services by 0.451 percent for the pooled data and 0.848 percent during the planting season. A comparison of the uncompensated against the compensated cross-price elasticity of demand for health with respect to the price of food indicates that the income effects from changes in the price of food are stronger than the pure substitution effect, in that changes in the price of food will substantially increase or decrease households' real incomes.

The results, in Table 3-6, also show that the price of food has a negative statistically significant uncompensated effect on the demand for energy and utilities during the harvest (-0.299) and post-harvest (-0.099) seasons and for the pooled data (-

0.212). However, once households are compensated for changes in the price of food, the results show that the compensated cross-price elasticity of demand for energy and utilities with respect to the price of food is very small (-0.035 during the harvest and 0.051 during the post-harvest seasons). Bamako households' consumption of energy and utilities tends to increase during the harvest season, which also corresponds to the winter months, and post-harvest season, which coincides with hot dry-season winds (the Harmattan).

Table 3-6: Stage I Compensated and Uncompensated Price Elasticities

Commo-dities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
Food											
Price of food	**-0.698**	**-0.545**	**-0.574**	**-0.643**	**-0.612**	**-0.480**	**-0.353**	**-0.320**	**-0.364**	**-0.392**	**3.742**
Price of DG	0.006	0.106	0.015	0.045	0.067	0.098	0.191	0.066	0.101	0.132	**3.590**
Price of SDG	0.028	0.061	0.052	0.002	0.061	0.138	0.107	0.128	0.042	0.120	**3.387**
Price of health	0.037	0.016	0.032	**0.006**	**0.012**	0.088	0.051	0.084	**0.080**	**0.061**	**4.458**
Price of EU	0.039	**-0.045**	**-0.050**	**-0.007**	**-0.018**	0.092	**-0.007**	**0.013**	**0.048**	**0.030**	**5.503**
Price of OND	0.010	**-0.072**	**-0.034**	0.045	0.002	0.033	**-0.053**	**-0.013**	0.072	0.024	**3.582**
Price of S	-0.049	0.016	-0.017	-0.022	**-0.027**	0.031	0.063	0.043	0.021	**0.024**	**5.268**
DG											
Price of food	-0.289	-0.514	-0.273	-0.208	-0.383	0.232	0.434	0.325	0.506	0.433	**4.572**
Price of DG	**-0.684**	-1.132	**-0.768**	-0.958	**-0.890**	**-0.465**	-0.714	**-0.647**	-0.816	**-0.654**	1.720
Price of SDG	-0.136	-0.186	0.106	-0.084	-0.165	0.127	0.042	0.287	0.017	0.061	**2.062**
Price of health	**-0.235**	-0.100	-0.085	-0.208	**-0.185**	**-0.113**	0.072	0.039	-0.017	**0.000**	1.610
Price of EU	-0.011	-0.136	-0.115	-0.121	-0.110	0.116	0.050	0.032	0.019	0.069	**2.378**
Price of OND	0.040	-0.049	**-0.117**	0.035	-0.029	0.095	0.048	**-0.067**	0.105	0.049	**2.630**
Price of S	-0.182	-0.160	-0.109	0.076	-0.149	0.008	0.068	0.031	0.186	0.043	**3.132**
SDG											
Price of food	-0.027	-0.024	-0.446	0.022	-0.258	0.274	0.444	0.424	0.296	0.426	**2.365**
Price of DG	-0.021	-0.129	0.016	-0.030	-0.141	0.106	0.078	0.192	0.024	0.063	1.210
Price of SDG	**-0.332**	-0.717	-0.945	-1.003	**-0.676**	**-0.180**	-0.604	-0.683	-0.964	**-0.493**	**2.430**
Price of health	-0.048	-0.097	-0.211	0.067	**-0.168**	0.023	-0.011	-0.031	0.141	**-0.014**	**1.832**
Price of EU	-0.014	-0.079	-0.033	0.038	-0.066	0.059	0.013	0.181	0.092	0.081	1.205
Price of OND	-0.054	0.011	**0.096**	0.129	-0.013	-0.022	0.060	**0.169**	0.156	0.054	1.388
Price of S	**-0.370**	-0.091	**-0.457**	0.213	**-0.276**	**-0.260**	0.022	**-0.253**	0.256	**-0.118**	**2.323**
Health											
Price of food	-0.357	-0.287	-0.406	**-0.848**	**-0.451**	0.376	0.282	0.405	**0.300**	**0.270**	1.490
Price of DG	**-0.509**	-0.077	-0.126	-0.242	**-0.221**	**-0.201**	0.174	0.038	-0.013	**0.005**	1.143
Price of SDG	-0.320	-0.152	-0.290	-0.088	**-0.216**	0.049	-0.015	-0.045	0.075	**-0.007**	1.017
Price of health	**-0.638**	**-0.722**	-1.057	**-0.895**	**-0.692**	**-0.466**	**-0.618**	-0.889	**-0.588**	**-0.532**	0.913
Price of EU	**-0.259**	-0.032	0.132	-0.114	-0.081	**-0.081**	0.080	0.331	0.111	0.078	**3.315**
Price of OND	0.011	0.035	-0.001	-0.068	0.008	0.088	0.093	0.068	0.045	0.078	**1.937**
Price of S	-0.032	-0.134	-0.099	-0.107	-0.067	0.236	0.004	0.091	0.070	0.109	1.703
EU											
Price of food	-0.105	**-0.299**	**-0.099**	-0.290	**-0.212**	0.378	**-0.035**	**0.051**	0.242	**0.138**	**1.978**
Price of DG	-0.003	-0.004	-0.004	-0.087	-0.008	0.200	0.112	0.026	0.019	0.098	1.278
Price of SDG	-0.121	-0.047	0.177	-0.009	0.008	0.122	0.016	0.222	0.066	0.107	1.298
Price of health	**-0.192**	0.026	0.248	0.009	0.001	**-0.079**	0.074	0.279	0.151	0.080	1.767
Price of EU	**-0.578**	**-0.380**	**-0.383**	**-0.311**	**-0.384**	**-0.461**	**-0.328**	**-0.346**	**-0.207**	**-0.307**	1.552
Price of OND	-0.115	0.333	-0.003	-0.121	0.024	-0.065	0.360	0.009	-0.068	0.058	**2.087**
Price of S	-0.272	-0.263	**-0.277**	**-0.285**	**-0.258**	-0.096	-0.199	**-0.242**	**-0.203**	**-0.174**	1.703

Note: DG = Durable Goods; SDG = Semi-Durable Goods; EU = Energy and Utilities; and OND = Other Non-Durable Goods; S = Services. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for Services because their parameters were recovered using the adding-up restrictions.

Table 3-6: Stage I Compensated and Uncompensated Price Elasticities (continued)

Commodities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
OND											
Price of food	0.141	**-0.559**	-0.270	**0.417**	0.036	0.316	**-0.511**	-0.153	**0.731**	0.246	**1.780**
Price of DG	0.307	0.186	-0.183	**0.151**	0.089	0.381	0.207	-0.159	**0.213**	0.153	1.607
Price of SDG	-0.195	0.128	0.568	**0.180**	0.096	-0.106	0.140	0.604	**0.225**	0.152	**2.408**
Price of health	0.156	0.156	0.142	0.038	0.130	0.197	0.165	0.167	0.121	0.177	0.907
Price of EU	-0.193	0.677	-0.001	-0.198	0.085	-0.150	0.686	0.027	-0.137	0.130	1.082
Price of OND	**-1.643**	**-0.149**	-1.018	-1.305	-1.093	**-1.624**	**-0.144**	-1.008	-1.274	-1.073	**2.028**
Price of S	0.923	-0.554	0.496	0.072	0.165	0.987	-0.542	0.523	0.120	0.214	**2.292**
Services											
Price of food	-0.199	-0.224	-0.448	-0.493	-0.334	0.085	0.260	0.183	0.138	0.094	
Price of DG	-0.110	-0.089	-0.101	0.114	-0.072	0.009	0.125	0.027	0.241	0.059	
Price of SDG	-0.501	-0.095	-0.516	0.145	-0.239	-0.358	0.022	-0.325	0.235	-0.118	
Price of health	0.085	-0.085	-0.050	-0.048	0.006	0.152	0.003	0.081	0.121	0.102	
Price of EU	-0.133	-0.256	-0.408	-0.383	-0.258	-0.064	-0.162	-0.253	-0.259	-0.164	
Price of OND	0.253	-0.281	0.135	0.014	0.046	0.283	-0.231	0.189	0.077	0.088	
Price of s	-0.211	-0.134	-0.049	-0.650	-0.162	-0.107	-0.017	-0.100	-0.553	-0.060	

Note: DG = Durable Goods; SDG = Semi-Durable Goods; EU = Energy and Utilities; and OND = Other Non-Durable Goods; S = Services. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for Services because their parameters were recovered using the adding-up restrictions.

3.3.3.2. Stage II Price Elasticities

3.3.3.2.1. Uncompensated and Compensated Own-Price Elasticities

Table 3-7, below, presents the compensated and uncompensated own-price elasticity of demand for the Stage II model commodities by season and for the pooled data. First, the results indicate that the estimated own-price elasticities, both compensated and uncompensated, are negative and most of them are statistically significant at the 10 percent level. For instance, the pooled data own-price elasticities are statistically significant for all staples, meat and fish, oil, and other foods. The estimated own-price elasticities of demand for staples and other foods are statistically significant during the lean season; for staples, oil and other foods during the harvest season; for vegetables during the post-harvest season; and for meat and fish and other foods during the planting season.

Table 3-7: Compensated and Uncompensated Own-Price Elasticities for Stage II Commodities by Season

Commodities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
Staples	**-0.500**	**-0.513**	-0.611	-0.749	**-0.506**	**-0.366**	**-0.380**	-0.449	-0.654	**-0.364**	1.080
MF	-0.968	-0.967	-0.799	**-0.754**	**-0.905**	-0.697	-0.640	-0.479	**-0.571**	**-0.641**	1.718
Veg	-0.870	-1.321	**-0.591**	-1.254	-0.958	-0.739	-1.186	**-0.477**	-1.119	-0.835	**3.113**
Oil	-1.273	**-0.695**	-0.743	-1.128	**-0.770**	-1.220	**-0.641**	-0.698	-1.111	**-0.724**	1.665
Sugar	-0.868	-0.898	-1.017	-1.267	-0.955	-0.822	-0.856	-0.950	-1.239	-0.897	0.723
OF	**-0.687**	**-0.585**	-0.851	**-0.619**	**-0.632**	**-0.584**	**-0.550**	-0.761	**-0.561**	**-0.558**	**2.032**
FAFH	-0.919	-0.756	-0.813	-0.895	-0.825	-0.658	-0.484	-0.612	-0.411	-0.533	

Note: MF = Meat and Fish; Veg = Vegetables; OF = Other Foods; and FAFH = Food Away From Home. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for FAFH because their parameters were recovered using the adding-up restrictions.

Second, the results show that all the estimated uncompensated and compensated own-price elasticities are less than 1 (in absolute value), suggesting that the demand for these commodities is inelastic. For each of these food commodities, a 1 percent change in the commodity's own price has a less than proportionate effect on the quantity demanded of that commodity. The statistically significant uncompensated own-price elasticities derived from the pooled data indicate that staples have the smallest own-price elasticity (-0.506) while meat and fish have the largest (-0.905).

3.3.3.2.2. Uncompensated and Compensated Cross-Price Elasticities

Table 3-8, below, presents the compensated and uncompensated cross-price elasticities for the Stage II model by season and for the pooled data. First, the results show that changes in the price of staples have strong and statistically significant uncompensated effects on the demand for meat and fish, vegetables, oil, and sugar. For instance, the uncompensated results show that a 1 percentage increase in the price of staples reduces urban households' expenditures on meat and fish by 0.760 during the post-harvest season and on vegetables by 0.254 percent during the lean season.

Moreover, a comparison of the uncompensated against the compensated cross-price elasticity of demand for non-staple commodities with respect to the price of staples indicates that changes in the price of staples will substantially increase or decrease Bamako households' real incomes. For instance, the results derived from the pooled estimation indicate that households would react to an increase in the price of staples by reducing the consumption of oil (-0.237) and increasing that of vegetables (0.085), when their purchasing power is held constant (i.e. no income effects). However, when households are not compensated for the price increase, an increase in the price of staples substantially reduces households' purchasing power because staples occupy a sizeable proportion of households' food budget. Hence, the total effect of a one percent increase in the price of staples is to reduce the consumption of vegetables (-0.254 percent) and oil (-0.946 percent).

Table 3-8: Uncompensated and Compensated Price Elasticities for Stage II Model

	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow
Commodities	L	H	PH	P	Pooled	L	H	PH	P	Pooled	Test
Staples											
Price of St	**-0.500**	**-0.513**	-0.611	-0.749	**-0.506**	**-0.366**	**-0.380**	-0.449	-0.654	**-0.364**	1.080
Price of MF	0.009	0.074	-0.087	**0.059**	0.035	0.075	0.135	**-0.015**	0.096	0.097	1.705
Price of Veg	**-0.041**	0.103	0.000	0.054	**-0.017**	**0.019**	0.148	0.059	0.085	**0.034**	0.808
Price of oil	0.036	**-0.039**	0.027	0.028	**-0.037**	0.056	**-0.027**	0.043	0.036	**-0.023**	0.767
Price of S	-0.026	-0.011	0.076	**0.213**	0.044	0.001	0.014	0.109	**0.232**	0.072	0.730
Price of OF	0.021	0.044	0.124	0.093	0.056	0.074	0.084	0.173	0.121	0.101	**2.383**
Price of FAFH	0.061	**-0.043**	0.004	**0.028**	**0.001**	0.142	**0.025**	0.080	**0.084**	**0.078**	1.032
Meat and Fish											
Price of St	-0.402	-0.419	**-0.760**	-0.224	-0.384	0.153	0.294	**-0.034**	0.248	0.215	**1.913**
Price of MF	-0.968	-0.967	-0.799	**-0.754**	**-0.905**	-0.697	-0.640	-0.479	**-0.571**	**-0.641**	1.718
Price of Veg	**0.079**	-0.204	-0.162	0.023	-0.039	**0.324**	0.039	0.097	0.175	0.178	**2.708**
Price of oil	-0.014	-0.034	-0.049	-0.026	-0.033	0.065	0.027	0.026	0.010	0.027	**2.285**
Price of S	-0.042	-0.153	0.058	**-0.198**	-0.115	0.069	-0.016	0.204	**-0.103**	0.003	**2.922**
Price of OF	**-0.258**	-0.117	**-0.300**	-0.040	**-0.173**	**-0.042**	0.101	**-0.079**	0.100	**0.020**	**3.080**
Price of FAFH	-0.205	-0.169	-0.075	-0.139	-0.146	0.128	0.195	0.266	0.141	0.178	**2.202**
Vegetables											
Price of St	**-0.254**	0.037	-0.155	-0.156	**-0.253**	**0.043**	0.435	0.164	0.264	**0.085**	1.090
Price of MF	**0.213**	-0.130	-0.021	0.048	0.066	**0.358**	0.052	0.120	0.211	0.216	0.820
Price of Veg	-0.870	-1.321	**-0.591**	-1.254	-0.958	-0.739	-1.186	**-0.477**	-1.119	-0.835	**3.113**
Price of oil	-0.006	0.043	0.039	0.056	0.044	0.036	0.077	0.072	0.088	0.078	1.408
Price of S	0.040	**0.294**	**-0.222**	0.195	0.076	0.099	**0.371**	**-0.158**	0.279	0.143	1.005
Price of OF	-0.074	-0.052	-0.054	-0.065	-0.018	0.041	0.069	0.042	0.060	0.091	1.287
Price of FAFH	-0.017	-0.021	0.087	-0.032	0.008	0.161	0.181	0.237	0.217	0.192	0.687
Oil											
Price of St	0.017	**-0.946**	-0.020	0.239	**-0.698**	0.387	**-0.317**	0.421	0.461	**-0.237**	0.778
Price of MF	0.042	-0.143	-0.083	-0.034	-0.079	0.223	0.146	0.111	0.052	0.124	1.052
Price of Veg	-0.052	0.091	0.093	0.296	0.125	0.112	0.306	0.251	0.367	0.292	1.192
Price of oil	-1.273	**-0.695**	-0.743	-1.128	**-0.770**	-1.220	**-0.641**	-0.698	-1.111	**-0.724**	1.665
Price of S	-0.333	0.250	-0.286	-0.012	0.142	-0.259	0.371	-0.197	0.032	0.233	0.663
Price of OF	**0.295**	-0.172	-0.029	0.014	-0.014	**0.439**	0.020	0.106	0.080	0.134	0.783
Price of FAFH	0.097	-0.206	-0.202	-0.012	-0.054	0.319	0.115	0.006	0.119	0.196	0.963
Sugar											
Price of St	-0.226	-0.144	0.206	**1.013**	0.063	0.004	0.075	0.543	**1.152**	0.358	1.452
Price of MF	0.056	-0.139	0.300	**-0.253**	-0.123	0.168	-0.039	0.448	**-0.199**	0.007	1.600
Price of Veg	0.117	**0.585**	**-0.402**	0.402	0.155	0.218	**0.660**	**-0.282**	0.446	0.262	1.772
Price of oil	-0.218	0.148	-0.136	0.002	0.085	-0.185	0.167	-0.101	0.012	0.115	**1.803**
Price of S	-0.868	-0.898	-1.017	-1.267	-0.955	-0.822	-0.856	-0.950	-1.239	-0.897	0.723
Price of OF	0.267	**-0.195**	0.225	**-0.238**	-0.081	0.357	**-0.129**	0.327	**-0.197**	0.014	**2.005**
Price of FAFH	0.122	0.012	-0.143	-0.058	-0.040	0.260	0.123	0.015	0.025	0.119	1.685

Note: St = Staples; MF = Meat and Fish; Veg = Vegetables; S = Sugar; OF = Other Foods; FAFH = Food Away From Home. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for FAFH because their parameters were recovered using the adding-up restrictions.

Table 3-8: Uncompensated and Compensated Price Elasticities for Stage II Model (continued)

Commodities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
Other Foods											
Price of St	-0.075	0.162	0.274	0.213	0.062	0.190	0.276	0.569	0.408	0.294	1.112
Price of MF	**-0.182**	0.099	**-0.245**	0.055	**-0.082**	**-0.053**	0.152	**-0.115**	0.131	**0.020**	1.120
Price of Veg	-0.070	0.039	-0.056	0.002	0.014	0.047	0.078	0.050	0.065	0.098	1.392
Price of oil	**0.124**	-0.004	0.005	0.006	0.015	**0.162**	0.006	0.036	0.021	0.039	1.733
Price of S	0.130	**-0.102**	0.157	**-0.173**	-0.040	0.183	**-0.081**	0.216	**-0.133**	0.005	**2.857**
Price of OF	**-0.687**	**-0.585**	-0.851	**-0.619**	**-0.632**	**-0.584**	**-0.550**	-0.761	**-0.561**	**-0.558**	**2.032**
Price of FAFH	**-0.103**	0.061	**-0.134**	**-0.045**	**-0.092**	**0.055**	0.119	**0.005**	**0.070**	**0.033**	1.090
FAFH											
Price of St	-0.200	-0.486	-0.258	-0.674	-0.397	0.236	0.050	0.171	0.142	0.144	
Price of MF	-0.109	-0.071	0.061	-0.224	-0.091	0.104	0.176	0.250	0.092	0.149	
Price of Veg	-0.074	-0.061	0.027	-0.145	-0.064	0.119	0.121	0.180	0.117	0.132	
Price of oil	0.014	-0.027	-0.043	-0.048	-0.019	0.076	0.019	0.001	0.016	0.036	
Price of S	0.000	-0.056	-0.079	-0.156	-0.062	0.087	0.046	0.006	0.008	0.045	
Price of OF	-0.134	-0.092	-0.127	-0.207	-0.147	0.036	0.071	0.003	0.035	0.027	
Price of FAFH	-0.919	-0.756	-0.813	-0.895	-0.825	-0.658	-0.484	-0.612	-0.411	-0.533	

Note: St = Staples; MF = Meat and Fish; Veg = Vegetables; S = Sugar; OF = Other Foods; FAFH = Food Away From Home. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for FAFH because their parameters were recovered using the adding-up restrictions.

Second, the results show that, with the exception of sugar, changes in the price of non-staples commodities have very small uncompensated and compensated effects on Bamako households' consumption of staples in any given season and for the pooled data. For instance, the results show that a 1 percent increase in the price of vegetables during the lean season will reduce the quantity demanded of staples by 0.041 percent. A comparison of the uncompensated and compensated cross-price elasticities shows that changes in the price of these non-staples commodities have very small income effects because they occupy a relatively small proportion of households' budget. On the other hand, the results indicate that changes in the price of sugar have a positive and statistically significant impact (0.213) on staples' consumption during the planting season. A possible explanation for this finding is that households react to the high grain prices that prevail during the planting season due to low food availability by increasing their consumption of millet-sorghum as an attempt to maintain their calorie levels by preparing meals such as porridge, usually made with millet and sorghum flour and sugar, that are consumed in the morning and evening. Moreover, households may also increase their consumption of tea as a substitute for eating.

Third, the results show that most of the uncompensated cross-price elasticities indicate net complementarity between staples and food away from home, meat and fish and other foods, vegetables and staples, oil and staples, and other foods and food away from home during the lean season and for the pooled data. However, if households were compensated for the price changes, the compensated cross-price elasticities indicate that they would tend to substitute between these commodities.

3.3.3.3. Stage III Price Elasticities

3.3.3.3.1. Uncompensated and Compensated Own-Price Elasticities

Table 3-9, below, presents the compensated and uncompensated own-price elasticities for the Stage III model by season and for the pooled data. The sign of the estimates of own price elasticities of the Stage III model are all negative, indicating that there is an inverse relationship between price and quantity demanded. All the statistically significant compensated own-price elasticities were smaller than the uncompensated own-price elasticties, as expected for normal goods.

Table 3-9: Compensated and Uncompensated Own-Price Elasticities for Stage III Commodities by Season

Commo-dities	Marshallian (Uncompensated)					Hicksian (Compensated)					Chow Test
	L	H	PH	P	Pooled	L	H	PH	P	Pooled	
Rice	-1.027	-0.607	**-0.644**	-0.821	-0.767	-0.593	-0.217	**-0.193**	-0.340	-0.338	1.618
MS	-1.380	**-0.588**	-0.659	**-0.598**	**-0.691**	-1.211	**-0.389**	-0.368	**-0.307**	**-0.487**	**2.807**
Maize	**-1.903**	**-1.840**	**-1.788**	**-1.977**	**-1.968**	**-1.694**	**-1.492**	**-1.691**	**-1.861**	**-1.759**	**4.332**
Wheat	**-1.605**	-1.453	**-2.786**	-1.490	**-1.759**	**-1.449**	-1.390	**-2.667**	-1.445	**-1.660**	1.093
RT	-0.678	-0.154	-1.405	-0.777	-0.651	-0.648	-0.155	-1.364	-0.711	-0.591	

Note: MS = Millet-Sorghum and RT = Roots and Tubers. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for Roots&Tubers because their parameters were recovered using the adding-up restrictions.

The own-price elasticities, both compensated and uncompensated, are negative and for the most part, statistically significant. The compensated own-price elasticities derived from pooled data are smallest for rice (-0.338) and largest for maize (-1.759), implying that the quantity demanded of rice is far less responsive to own-price changes than that of maize. The estimated compensated own-price elasticities of maize in all seasons and for the pooled data and wheat during the lean and post-harvest seasons and for the pooled data are greater than 1 (in absolute terms), suggesting that the demand for these commodities is elastic. This means that for each of these commodities, a 1 percent change in the commodity's own price has a more than proportionate effect on the quantity demanded of that commodity. However, one should note that the estimated high price elasticities of demand for staples, especially maize, are only valid within the price range observed during the survey year. Without this caveat, it is hard to reconcile the very high price estimated elasticity of demand for maize with the high year-to-year price volatility of maize, which implies an inelastic demand.

3.3.3.3.2. Uncompensated and Compensated Cross-Price Elasticities

Tables 3-10, below, presents the uncompensated and compensated cross-price elasticity of demand for staples by season and for the pooled data. With the exception of the lean season, the results indicate that the price of rice has a positive and statistically significant effect on the consumption of millet-sorghum once the income effects are removed in all seasons. These results suggest that rice and millet-sorghum are net substitutes, in that households would turn towards purchasing more millet-sorghum in the face of higher rice prices. However, once the income effects are accounted for, the uncompensated cross-price elasticity of rice with respect to millet-sorghum is statistically significantly negative, meaning that rice and millet-sorghum tended become complements. Thus, an increase in the price of rice would result in reduced consumption of millet-sorghum as the income effects from rice price changes are stronger than the pure substitution effect. Rogers and Lowdermilk (1999) found that the effects of changing rice prices did not have a statistically significant impact on millet-sorghum purchases. They attributed this result to the fact that rice and millet-sorghum occupied different functions in urban households' diets. Household tended to consume rice at mid-day while millet-sorghum were consumed in the morning and evening.

Table 3-10: Uncompensated and Compensated Price Elasticities for Stage III Model

Commodities	Marshallian (Uncompensated) L	H	PH	P	Pooled	Hicksian (Compensated) L	H	PH	P	Pooled	Chow Test
Rice											
Price of Rice	-1.027	-0.607	**-0.644**	-0.821	-0.767	-0.593	-0.217	**-0.193**	-0.340	-0.338	1.618
Price of MS	0.118	**-0.103**	**-0.456**	**-0.238**	**-0.168**	0.288	**0.054**	**-0.284**	**0.031**	**0.018**	**2.723**
Price of M	0.069	0.155	0.043	**0.260**	**0.158**	0.205	0.278	0.143	**0.323**	**0.263**	1.357
Price of W	0.028	**-0.111**	0.099	-0.063	-0.007	0.084	**-0.077**	0.138	-0.015	0.037	**2.077**
Price of RT	-0.017	**-0.083**	0.134	-0.033	-0.022	0.015	**-0.038**	0.195	0.001	0.021	1.292
MS											
Price of Rice	0.304	**-0.363**	**-1.504**	**-0.467**	**-0.440**	0.737	**0.133**	**-0.743**	**0.055**	**0.029**	**2.977**
Price of MS	-1.380	**-0.588**	-0.659	**-0.598**	**-0.691**	-1.211	**-0.389**	-0.368	**-0.307**	**-0.487**	**2.807**
Price of M	**0.404**	-0.031	**0.589**	-0.122	**0.186**	**0.539**	0.125	**0.757**	-0.053	**0.300**	**1.962**
Price of W	-0.207	0.135	**0.265**	0.236	0.108	-0.152	0.179	**0.331**	0.288	0.155	**3.097**
Price of RT	0.053	-0.107	-0.080	-0.020	-0.044	0.086	-0.049	0.022	0.017	0.003	1.667
Maize											
Price of Rice	**-0.013**	-0.222	0.208	**1.569**	**0.244**	**0.654**	0.883	0.645	**2.451**	**1.141**	**4.087**
Price of MS	**0.411**	-0.284	**1.139**	-0.716	**0.162**	**0.672**	0.160	**1.306**	-0.223	**0.561**	**5.418**
Price of M	**-1.903**	**-1.840**	**-1.788**	**-1.977**	**-1.968**	**-1.694**	**-1.492**	**-1.691**	**-1.861**	**-1.759**	**4.332**
Price of W	0.355	0.210	-0.196	**-0.426**	-0.005	0.441	0.308	-0.158	**-0.337**	0.085	**5.345**
Price of RT	-0.124	0.012	-0.162	-0.092	-0.116	-0.074	0.141	-0.103	-0.030	-0.028	**4.023**
Wheat											
Price of Rice	-0.563	**-1.580**	0.222	-0.601	-0.623	0.656	**-0.867**	1.586	-0.152	0.359	1.267
Price of MS	-0.938	0.525	**0.928**	1.354	0.239	-0.461	0.812	**1.449**	1.605	0.665	0.850
Price of M	**0.693**	0.870	-0.703	**-0.504**	**-0.040**	**1.075**	1.095	-0.400	**-0.445**	**0.200**	**2.123**
Price of W	**-1.605**	-1.453	**-2.786**	-1.490	**-1.759**	**-1.449**	-1.390	**-2.667**	-1.445	**-1.660**	1.093
Price of RT	0.087	0.266	-0.151	0.405	0.338	0.179	0.350	0.032	0.437	0.437	0.570
RT											
Price of Rice	-0.202	-0.316	1.141	-0.922	-0.422	0.204	-0.323	1.449	0.013	0.186	
Price of MS	0.287	-0.164	-0.054	-0.384	-0.263	0.446	-0.167	0.063	0.138	0.001	
Price of M	-0.435	0.383	-0.238	-0.178	-0.210	-0.308	0.381	-0.170	-0.055	-0.062	
Price of W	0.254	0.266	-0.006	0.522	0.404	0.306	0.265	0.021	0.616	0.466	
Price of RT	-0.678	-0.154	-1.405	-0.777	-0.651	-0.648	-0.155	-1.364	-0.711	-0.591	

Note: MS = Millet-Sorghum; M = Maize; W = Wheat; and RT = Roots and Tubers. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; Bold values denote that the estimated price elasticities are statistically significant at the 10% level. Tests of statistical significance cannot be performed for Roots&Tubers because their parameters were recovered using the adding-up restrictions.

Furthermore, both the pooled data and seasonal results indicate that the price of rice has a positive effect, both compensated and uncompensated (except during the lean season), on the consumption of maize, meaning that rice and maize are net substitutes. Hence, households are more likely to move towards maize during the planting season when the price of rice tends to be very high. Concerning wheat, the results indicate that the price of rice has a statistically significant large uncompensated effect on the consumption of this commodity only during the harvest season. During that period, a 1 percentage increase in the price of rice results in a 1.580 percent decrease in the consumption of wheat.

Moreover, the results provide practically no evidence to support the hypothesis that cereals and roots and tubers are substitutes (e.g., Timmer and Alderman, 1979; Pakpahan, 1988), implying that Bamako households, in the face of higher prices of cereals, would not consume more roots and tubers. The results show that the price of roots and tubers has a negative, both compensated and uncompensated, statistically significant, but very small, impact on the demand for rice during the lean season.

3.3.4. Sensitivity Analysis

Much research in food policy has focused on the effects of changes in households' income levels on the food income and price elasticity at a given point in time (Alderman (1990), Rogers and Lowdermilk (1991), and Dorosh et al. (1994)). These previous studies have shown that low-income households are much more sensitive to changes in incomes and prices than high-income households (Timmer, 1983). The robustness of the estimated price and income parameters are tested in this section using sensitivity analyses in which different scenarios are simulated by manipulating real income levels and tracing their effects.

More specifically, in this section, sensitivity analyses are performed in order to determine the effect of changes in Bamako households' real incomes on (1) the income elasticity of food and (2) the own-price elasticity of food in any given season.

3.3.4.1. Effects of Changes in Households' Real Incomes on the Income Elasticity of Food

This first scenario examines the impact of changes in households' real incomes on the income elasticity for food (as an aggregate commodity).[33] The expected change in the food income elasticity is derived using the following equation:

$$\Delta\eta_{food} = 1 + [\beta_{food} / \Delta w_{food}], \text{ where } \Delta w_{food} = FE / \Delta TE \quad (3)$$

In this equation, FE represents food expenditure per adult equivalent and TE is total real expenditure per adult equivalent. Food expenditures are held constant while several simulations are performed on households' average weekly real total expenditures per adult equivalent, used as a proxy for real income. The effects of changes in households' total expenditures on the income elasticity for the food are traced, holding everything else constant. The baseline parameters and variables are presented below in Table 3-11.

Table 3-11: First Scenario Base Parameters and Variables

Variables	Baseline			
	Lean	Harvest	Post-Harvest	Planting
Share of food	0.348	0.416	0.439	0.486
Food expenditures/AE	2368	2223	2131	2149
Total real expenditure/AE	8123	5242	5458	4461
Food income elasticity	0.626	0.463	0.577	0.574

The impacts of changes in households' total expenditures on the income elasticity for the food are presented, below, in Figure 3-2. One should note that the model, by construction (see equation (3)), will show a uniform decline in the income elasticity of demand for food as households reach higher income levels. Thus, all the sensitivity analysis is testing for is the rate of change of the estimated income elasticity of demand

---

[33] The income elasticity was derived using the following formula: $\eta_i = 1 + [\beta_i / w_i]$

for food as households' expenditures increase. First, the results indicate that households' demand for food becomes highly inelastic as their real income increases. For instance, the results indicate that as households' real incomes increase from 2000 to 10,000 FCFA/AE/week (or by 400%), the income responsiveness of their demand for food decreases from 3.5 to 0.4 (or by 775 %) during the lean season. Second, the results show that there is a uniform shift in the entire income-food consumption relationship across seasons, suggesting that the impact of real income on the demand for food is not constant across seasons. The results reveal that there is a substantial difference in the income responsiveness of demand for food between the lean and the other seasons. Bamako households' demand for food is most responsive to changes in real income in August, during the lean season, when their real incomes are high and the demand for non-food commodities is high. There is no sizable difference in the impact of real income on households' demand for food between the harvest, post-harvest, and planting seasons.

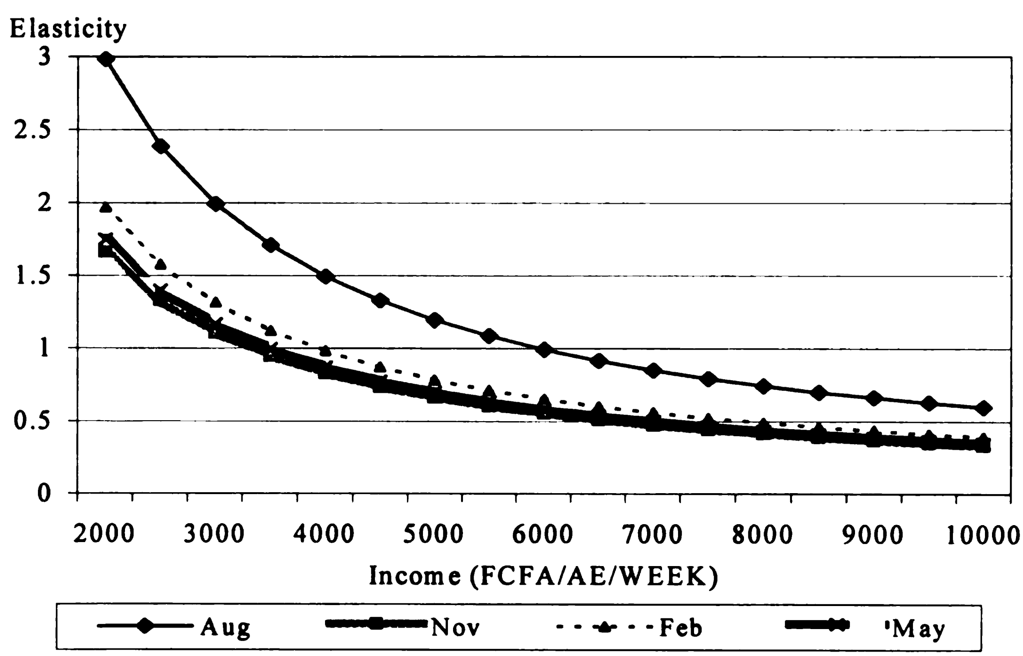


Figure 3-2: Effect of Changes in Real Incomes on the Income Elasticity of Food by Season

3.3.4.2. Effects of Changes in Households' Real Incomes on the Food Price Elasticity

The second scenario investigates the effects of changes in households' real expenditures on the compensated own-price elasticity of food (i.e., no income effects).[34] The expected change in the compensated own-price income elasticity of food is calculated using the following equation:

$$\Delta\eta_{ii} = \xi_{ii} + \eta_i \bullet \Delta w_i, \; i = \text{Food and } \Delta w_{food} = FE/\, \Delta TE \quad (4)$$

In this equation, FE represents food expenditure per adult equivalent and TE is total real expenditure per adult equivalent. Food expenditures are held constant while several simulations are performed on households' average weekly real total expenditures per adult equivalent. The effects of changes in households' total expenditure levels on the own-price elasticity of demand for food are traced. The baseline parameters and variables are presented, below, in Table 3-12.

Table 3-12: Second Scenario Base Parameters and Variables

Variables	Baseline			
	Lean	Harvest	Post-Harvest	Planting
Share of food	0.348	0.416	0.439	0.486
Food expenditures/AE	2368	2223	2131	2149
Total real expenditure/AE	8123	5242	5458	4461
Food own-price elasticity	-0.480	-0.353	-0.320	-0.364

Figure 3-3, below, shows the impacts of changes in households' real incomes on the compensated own-price elasticity of demand for food. One should note that the model, by construction (see equation (4)), will show a uniform increase in the own-price elasticity of demand for food as households expenditure levels increase. However, the model allows a discussion on the magnitude of the decline as real income increases. The

[34] The compensated price elasticity was derived using the following formula: $\eta_{ij} = \xi_{ij} + \eta_i \bullet w_j$

results indicate that the responsiveness of households' food consumption to changes in the price of food decreases from well above 2 percent to near zero as their real income increases from 1000 to 10000 FCFA/AE/week. Moreover, there is a uniform shift in the entire compensated own-price elasticity-income relationship across seasons, indicating that the effect of own-price changes on the demand for food is not constant across seasons. Figure 3-3 clearly indicates that households' demand for food is far more responsive to own-price changes during the lean season than during the harvest, post-harvest, and planting seasons.

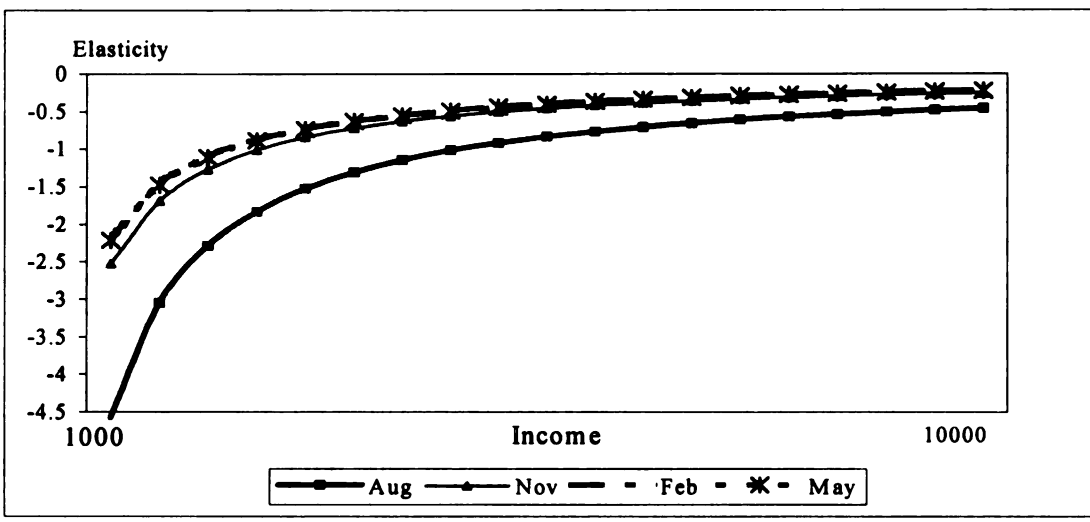


Figure 3-3: Effect of Changes in Income Levels on the Own-Price Elasticity of Food by Season

3.4. Conclusions

In this essay, the Almost Ideal Demand System was applied to a three-stage demand model for different seasons in order to estimate the impact of seasonal changes in Bamako households' real incomes and relative prices on their consumption patterns. First, the results indicate that price, income, and household size factors account for a substantial part of the observed variation in the budget share devoted to the commodities considered in the Stage I, II, and III models.

Second, the study finds that Bamako households' consumption is responsive to changes in real incomes and relative prices in any given season and that that there are seasonal changes in income and price responsiveness for all the commodities in the three demand models. This implies that the impact of a uniform food policy on the quantity and quality of food available in Bamako households will vary by season.

Third, the results indicate that Bamako households engage in food consumption smoothing from seasonal shocks in real incomes. Food consumption smoothing was achieved at the expense of non-food commodities such as health and durable goods (housewares and education), of non-staple foods, and through significant substitutions among and between broad commodity groups.

Fourth, the estimated price elasticities indicate that (1) the price of food has strong and statistically significant uncompensated effects on the demand for non-food commodities, such as health and education; (2) the price of staples has striking impacts on the demand for non-staple foods, which are sources of high-quality protein and micronutrients and; (3) the price of rice has a positive effect on the consumption of maize, meaning that rice and maize are net substitutes.

The findings of this essay have several implications for development planning in Mali. First, the high absolute level of the income elasticities, even for food, underscores the extreme level of poverty and unmet "basic needs" that prevail in Bamako. As a consequence, the results suggest that policies that aim at increasing households' real income will cause substantial improvements not only in the quantity of food available in urban households but also in the demand for non-food commodities. Rapid growth in the demand for non-food commodities could translate into sizable rise in employment, to the extent that these commodities can be produced domestically.

Second, the empirical results for food commodity groups showed that as Bamako households' real income increases, they will increase their expenditure on non-staple commodities (e.g., meat and fish and vegetables) more rapidly than on staple foods. As a consequence, households will diversify their diets, through greater consumption of non-staple commodities, as their income grows. This finding suggests that the pattern of production within the agricultural sector in Mali will have to change with economic growth, as increased specialization in livestock and horticultural production will be required. Hence, greater allocation of resources and investment in the production and marketing of horticultural commodities offer the potential to substantially reduce malnutrition, especially vitamin A deficiency, increase employment, and reduce poverty in urban areas.

REFERENCES

Alston, J. M., K.A. Foster, and R.D. Green, (1994). Estimating Elasticities with the Linear Approximate Almost Ideal Demand System: Some Monte Carlo Results. *Review Economics And Statistics*, Vol.76, 351-356.

Alston J M ,& Chalfant J. 1993. The silence of Lambdas: A test of the almost ideal and Rotterdam models. *American Journal of Agricultural Economics* 75 300–313.

Deaton, A and Muellbauer J. *Economics and consumer behavior*. Cambridge, Cambridge University Press: 1980a.

Deaton, A. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy.* World Bank. The John Hopkins University Press. Baltimore, London: 1997.

Deaton, A. & Zaidi, S., 1999. *Guidelines for Constructing Consumption Aggregates for Welfare Analysis*. Papers 192, Princeton, Woodrow Wilson School - Development Studies.

Deaton, A and J. Muellbauer. 1980. An almost ideal demand system. *The American Economic Review* 70: 312-326.

Dembélé, N. N. and J.M. Staatz, June 1999. The Impact of Market Reform on Agricultural Transformation in Mali. *MSU Agricultural Economics Staff Paper* No. 99-29.

Duncan, H. Boughton. 1994. *A Commodity Subsector Approach to the Design of Agricultural Research: the Case of Maize in Mali*. Ph.D. dissertation, Michigan State University.

Green R, and Alston J M. 1990. Elasticities in AIDS models. *American Journal of Agricultural Economics* May 442–445.

Moschini, G. 1995. Units of measurement and the stone index in demand system estimation. *American Journal of Agricultural Economics* 77: 63-68.

Pakpahan, Agus 1988. *Food Demand Analysis in Urban West Java, Indonesia*. Ph.D. dissertation, Michigan State University.

Paxon, Christina H., 1993. Consumption and Income Seasonality in Thailand. *Journal of Political Economy*, 101(1): 39-72.

Pollak, Robert A. and T.J. Wales. *Demand System Specification and Estimation*. New York: Oxford University Press, 1992.

Raunikar, Robert and Huan, Chung-Liang. *Demand Analysis: Problems, Issues, and Empirical Evidence*. Ames: Iowa State University Press, 1987.

Reardon et al., 1999. Household Consumption Responses to the Franc CFA Devaluation: Evidence from Urban Mali. *Food Policy* 24 (1999), 517-534.

Rogers, B.L. and Lowdermilk, M. (1991). Price Policy and Food Consumption in Urban Mali. *Food Policy* 16, 461-473.

Sadoulet, Elisabeth, and de Janvry, Alain. *Quantitative Development Policy Analysis*. Chapter 6. Baltimore, MD: The Johns Hopkins University Press, 1995.

Sahn, E. 1989. *Seasonal Variability in Third World Agriculture: The Consequences for Food Security.* Baltimore and London: John Hopkins University Press.

Teklu, Tesfaye, 1996. Food Demand Studies in Sub-Saharan Africa: A Survey of Empirical Evidence. *Food Policy*, Vol. 21, No. 6, pp. 479-496, 1996.

Timmer et al. 1983. *Food Policy Analysis*. Published for the World Bank. John Hopkins University Press.

USAID. 2000. http://www.usaid.org/Mali urban profile

APPENDIX 3

Table A3-1: Definition of Commodities

Major Component	Commodity		Item	
1 Food	1	Staples	1	Rice
			2	Millet-Sorghum
			3	Maize
			4	Wheat
			5	Atieke
			6	Cassava
			7	Potato
			8	Sweet Potato
	2	Meat and Fish	9	Beef
			10	Mutton and Poultry
			11	Dry Fish
			12	Fresh Fish
	3	Vegetables	13	Leaves
			14	Okra
			15	Onions
			16	Tomatoes (fresh and concentrate)
			17	Other Vegetables
			18	Beans (fresh and dried)
	4	Oil	19	Peanut Oil
			20	Palm Oil
			21	Sheanut Oil
	5	Sugar	22	Sugar
	6	Others	23	Butter and Buttermilk
			24	Fresh Milk
			25	Condensed Sweetned Milk
			26	Powdered milk
			27	Eggs
			28	Peanuts
			29	Seeds
			30	Coffee
			31	Tea Lipton
			32	Green Tea
			33	Quinqueliba and Other Beverages
			34	Bananas
			35	Lemons
			36	Tamarinds
			37	Other Fruits (Dates, Orange, Raisin)
			38	Seasonings and Spices
	7	Food Away From Home	39	Food Away From Home
2 Non Food	8	Durable Goods	40	Education
			41	Housewares
	9	Semi-Durable Goods	42	Personal Care
	10	Health	43	Health
	11	Energy and Utilities	44	Energy and Utilities
	12	Other Non-Durable Goods	45	Hygiene
			46	Tobacco
	13	Services	47	Transportation
			48	Recreation
			49	Other Services

Table A3-2: Definitions of Variables and Summary Statistics

Variable	Description	August		November		February		May		Pooled	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Stage I											
w1	Share of food	0.348	0.127	0.416	0.149	0.439	0.170	0.486	0.152	0.422	0.157
w2	Share of DG	0.146	0.156	0.183	0.195	0.089	0.103	0.097	0.099	0.129	0.148
w3	Share of SDG	0.175	0.161	0.100	0.111	0.133	0.142	0.069	0.065	0.119	0.130
w4	Share of health	0.082	0.118	0.076	0.104	0.091	0.106	0.130	0.181	0.095	0.132
w5	Share of EU	0.085	0.069	0.081	0.062	0.108	0.086	0.096	0.075	0.092	0.074
w6	Share of OND	0.037	0.046	0.043	0.043	0.037	0.032	0.048	0.046	0.041	0.042
w7	Share of Services	0.127	0.124	0.100	0.090	0.103	0.118	0.075	0.072	0.101	0.104
p1	Price of food	204	100	234	110	218	94	264	101	230	103
p2	Price of DG	6242	5329	5292	3325	5269	5080	6421	5744	5806	4938
p3	Price of SDG	1678	991	1576	955	1922	1070	1365	724	1635	956
p4	Price of health	1854	1371	2159	1733	1871	868	2610	2094	2124	1598
p5	Price of EU	123	62	121	44	171	87	136	79	138	72
p6	Price of OND	126	27	108	18	113	30	126	37	118	30
p7	Price of Services	225	61	214	87	170	54	158	40	192	68
AE	Household size	13	7	13	7	13	8	13	8	13	8
X/P	TEAE	9521	6086	7155	3172	6818	3898	6076	4287	7392	4633
Stage II											
w1	Share of staples	0.307	0.084	0.346	0.094	0.348	0.088	0.348	0.098	0.337	0.092
w2	Share of MF	0.150	0.075	0.159	0.087	0.153	0.079	0.135	0.060	0.149	0.076
w3	Share of Veg	0.135	0.039	0.118	0.036	0.124	0.039	0.112	0.041	0.122	0.039
w4	Share of oil	0.044	0.024	0.030	0.019	0.036	0.021	0.027	0.014	0.034	0.021
w5	Share of sugar	0.061	0.026	0.066	0.032	0.070	0.036	0.070	0.039	0.067	0.034
w6	Share of OF	0.119	0.041	0.106	0.042	0.106	0.031	0.103	0.047	0.108	0.041
w7	Share of FAFH	0.184	0.114	0.176	0.130	0.164	0.095	0.206	0.147	0.182	0.123
p1	Price of staples	251	41	268	44	251	46	257	44	257	44
p2	Price of MF	960	304	1040	334	999	277	996	233	999	288
p3	Price of Veg	554	193	523	126	442	136	420	125	485	156
p4	Price of oil	678	229	614	294	671	336	577	198	635	270
p5	Price of sugar	460	96	439	74	464	98	438	42	450	81
p6	Price of OF	1037	648	734	381	622	267	680	377	769	465
p7	Price of FAFH	128	82	109	60	105	56	94	56	109	65
AE	Household size	13	7	13	7	13	8	13	8	13	8
X/P	FEAE	2368	669	2223	676	2131	829	2149	510	2218	681
Stage III											
w1	Share of rice	0.524	0.138	0.520	0.142	0.548	0.137	0.537	0.155	0.532	0.142
w2	Share of MS	0.205	0.120	0.209	0.117	0.209	0.117	0.300	0.148	0.231	0.131
w3	Share of maize	0.164	0.130	0.164	0.153	0.121	0.105	0.071	0.062	0.130	0.123
w4	Share of wheat	0.067	0.080	0.046	0.069	0.048	0.063	0.054	0.090	0.054	0.076
w5	Share of RT	0.039	0.035	0.061	0.074	0.074	0.055	0.038	0.037	0.053	0.054
p1	Price of rice	267	18	275	27	261	18	263	15	267	21
p2	Price of MS	147	40	151	41	133	33	174	49	151	44
p3	Price of maize	187	76	182	51	194	95	229	97	198	83
p4	Price of wheat	734	395	954	615	880	310	831	253	850	421
p5	Price of RT	238	97	157	107	199	36	304	151	224	118
AE	Household size	13	7	13	7	13	8	13	8	13	8
X/P	SEAE	913	437	981	346	889	303	851	340	909	359

Note: All prices and expenditures are in CFA Francs. DG = Durable Goods; SDG = Semi-Durable Goods; EU = Energy and Utilities; and OND = Other Non-Durable Goods; TEAE = Total Expenditure per Adult Equivalent; S = Staples; MF = Meat and Fish; Veg = Vegetables; S = Sugar; OF = Other Foods; FAFH = Food Away From Home; FEAE = Food Expenditures per Adult Equivalent; MS = Millet-Sorghum; M = Maize; W = Wheat; and RT = Roots and Tubers; and SEAE = Staples Expenditures per Adult Equivalent.

CHAPTER 4

ESTIMATING THE EFFECTS OF SEASONAL CHANGES IN REAL INCOMES AND RELATIVE PRICES ON HOUSEHOLDS' DEMAND FOR NUTRIENTS IN BAMAKO, MALI

4.1. Introduction

The state of poor nutrition, caused by households' inability to meet minimum energy, protein, and other essential nutrients' requirements, is particularly severe in Mali. In 2001, the Mali demographic and health survey (DHS) reported that 22 percent of women between the ages of 15 and 19 years and 11 percent of those between 20 and 24 years suffered from chronic energy deficiency. More than 10 percent of the population has blinding disorders, such as trachoma, due to a vitamin A deficiency (DHS, 2001). An estimated four out of five children (82 percent) under 5 years old have anemia, which is caused by a deficiency in iron, and about 63 percent of women present a form of anemia (DHS, 2001). Iron deficiency contributes significantly to reduced resistance to infection, impairment of some cognitive functions, and maternal deaths (FAO, 1997).

Furthermore, as shown in essay 1 (chapter 2), in 2000-2001, Bamako households' mean real expenditures varied considerably across seasons. Households' real expenditures decreased by 36 percent between the lean and post-harvest season, increased by 4 percent between the harvest and post-harvest season, and dropped by 18 percent between the post-harvest and planting season. The seasonal variation in households' real expenditures could be partly explained by seasonal changes in the relative prices of goods and services, the size and timing of remittances, and the fact that households' expenditures on many non-food commodities tend to be highly seasonal.

Empirical evidence (Sahn, 1989 and Dostie, 2000) suggests that seasonal changes in real income affect the quantity and quality of foods available in households and, thereby constitute an important determinant of household food security. Therefore, understanding how the demand for nutrients responds to changes in real incomes and relative prices is crucial for the formulation and implementation of policies to help improve nutrition in developing countries such as Mali. In the last few years, the empirical literature (e.g., World Bank (1981), Behrman and Deolalikar (1987), Strauss and Duncan (1990), and Bouis and Haddad (1992)) has largely focused on the role of income on nutrient consumption despite the widespread implementation of food subsidy programs in developing countries. Moreover, the development literature has two divergent views on the issue of whether nutrient intake responds to income. The traditional view postulates that increases in income will lead to nutrient improvement in households, hence that economic growth would eradicate hunger and malnutrition (World Bank, 1981). In contrast, recent studies (e.g. Behrman and Deolalikar (1987)) and Bouis (1994)) argue that income growth will not result in substantial improvements in nutrient intake. The current literature claims that low-income households will increase food expenditures with rising income, but that the marginal increase in income is spent on food attributes other than nutrients.[35] A potential explanation for the diverging views is that the relationship between income and nutrient intake depends on the country, use of cross-section, panel, or time series data, model specification, and estimation technique (Dawson and Tiffin, 1998).

---

[35] Examples of food attributes include degree of processing and taste (Behrman and Deolalikar (1987)). For instance, Bamako households' preference for rice has largely been attributed to taste factors and to the fact that rice takes less time, fuel, and labor to prepare (Rogers and Lowdermilk, 1991).

This study tests the hypothesis that households' demand for nutrients is responsive to changes in their real incomes *and* relative prices and that the magnitude of the nutrient income and price elasticities will change from one season to another. Most of the empirical evidence on the determinants of nutrient demand (Behrman and Deolalikar (1987), Bhargava (1991), and Subramanian and Deaton (1996)) has focused on the effects of income on the demand for nutrients. However, the empirical evidence on the effects of food price changes on the demand for nutrients is relatively scarce. Therefore, this study, through the estimation of nutrient-price elasticities by season and for the entire year, attempts to make a significant contribution to food policy formulation in Mali. The findings of this study would be important for policy design, as it would mean that (1) the policies that aim at increasing households' real incomes will also improve their nutrition, (2) food prices can be used as instruments to reduce malnutrition in households, and (3) the effectiveness of such policies will be contingent upon whether or not they are systematically synchronized with the short-run response of households' consumption patterns to income and price changes.[36] The effects of seasonal changes in real incomes and relative prices on households' demand for nutrients have not been assessed in Bamako, Mali.

The general objective of this study is to estimate the impact of seasonal changes in real incomes and relative prices on the households' demand for nutrients in Bamako, Mali. The specific objectives of this study are threefold. First, the study estimates nutrient-income elasticities in order to determine if (1) household demand for nutrients is responsive to changes in real incomes and (2) the nutrient-income elasticities are stable

[36] Temporal targeting mechanisms, such as seasonal income transfers to low-income households and seasonal imports of rice, are examples of programs or policies that are season-specific.

across seasons. Second, the study seeks to compute nutrient price elasticities in order to identify whether (1) the demand for nutrients is responsive to changes in relative food prices and (2) the sign and magnitude of the nutrient price elasticities depend on the season considered. The final task of the study is to perform sensitivity analyses on the estimated nutrient income and price elasticities using several simulation scenarios.

4.2. Methods

4.2.1. Nutrient Demand Model

This study is primarily concerned with the relationship between households' real incomes, relative prices, and nutrient availability, which is investigated for four seasons (planting, lean (pre-harvest), harvest, and post-harvest) and for the entire year. The demand for total calories, calories from staples, calories from other foods, protein, calcium, iron, and vitamin A is estimated separately for each season and the entire year using Engel functions.[37] Following Skoufias (2002), the nutrient demand functions are specified as a log-linear function of the form below:

$$\ln N_{kht} = \alpha + \beta \ln Y_{ht} + \gamma \ln P_{ht} + \delta \ln AE_{ht} + u_{kht} \quad (1)$$

where, k indexes a nutrient (calories, protein, calcium, iron, and vitamin A)

h indexes an household (h = 1,…,40)

t indexes seasons (t = 1, 2, 3, 4)

N is nutrient demand (i.e., amounts of nutrients available in household per adult equivalent (AE)

Y is total real household expenditure per adult equivalent (AE)

[37] These particular nutrients were chosen because of the main types of nutrient deficiencies that persist in Mali.

P is a vector of food prices (P1 = price of rice, P2 = price of millet-sorghum, P3 = price of beef, P4 = price of dry fish, and P5 = price of green leaves)

AE is household size in adult equivalents[38]

u is an error term

Household demand for nutrients is expressed as a function of food prices, real incomes, and household size. Real expenditures per adult equivalent (Y) are used as a proxy for income and are calculated by deflating nominal expenditures by the Laspeyres price index. Unit values, used as proxies for prices, were computed as the ratio of total household expenditure on a good divided by the total quantity consumed of the good. The prices of rice and millet-sorghum (P1 and P2) are included in the analysis in order to measure the effect of staple prices on nutrient demand. The prices of beef (P3) and dry fish (P4) are chosen to assess the impact of meat and fish prices on the demand for nutrients as these foods are important sources of protein. The price of green leaves (i.e. potato leaves, spinach) (P5) is included in the analysis to account for the effect of vegetable prices on nutrient demand estimates since green leaves are the main sources of vitamin A and calcium in urban households' diets.

This study assumes that all the explanatory variables (prices, income, and household size) are exogenous (i.e., uncorrelated with the error term). The Ordinary Least Squares (OLS) method is chosen to estimate the parameters of the nutrient demand functions because it yields estimates that are unbiased and consistent under the exogeneity assumption. OLS has been widely applied in many empirical studies to estimate nutrient demand functions (Rogers and Lowdermilk (1991), Subramanian and Deaton (1996), and

[38] The data on household size was converted into adult equivalents using the following scales: male > 14 years = 1.0; female > 14 years = 0.8; children = 0.5 (Duncan, 1994).

Skoufias (2002)). The demand for total calories, calories obtained from staples, calories derived from other foods, and protein, calcium, iron, and vitamin A is estimated, as specified in Equation (1), by Ordinary Least Squares (OLS) separately for each season and for the pooled data. [39] The stability of the estimated nutrient income and price elasticities across seasons is assessed using the Chow test.

4.2.2. Data

The panel data used in this study is from a 2000-2001 survey undertaken in Bamako by the Direction Régionale du Plan et de la Statistique (DRPS) of the Direction Nationale de la Statistique et de l'Informatique (DNSI) and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA) of Michigan State University (MSU), the Assemblée Permanente des Chambres d'Agriculture du Mali (APCAM), and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD).The survey was conducted in four rounds and covered the same 40 Food Consumption Units (FCU) in each round.

The nutrient estimates were derived from the at-home food consumption data on the quantities of food consumed and data on the nutrient composition of foods.[40] Nutrient values exclude nutrients from the inedible or non-servable components of foods (i.e., bones). Losses from trimming, cooking, plate wastage, and spoilage are not accounted for in these values.[41] The nutrient estimates computed this way represent

---

[39] It is legitimate to estimate each of these demand functions separately, using OLS, rather than as a system of equations because all the independent variables are assumed to be exogenous (Deaton, 1997). In this case, there is no simultaneity bias, which is the bias that results from using OLS to estimate an equation in a simultaneous equation model (Wooldridge, 1999).

[40] The food composition data come from the food composition table for Mali prepared by Sundberg and Adams (1998) and from the USDA's Nutrient Data Bank System (2003).

[41] The Food and Agricultural Organization (FAO) assumes that losses from trimming, cooking, plate wastage, and spoilage represent about 10 percent.

nutrients in foods that are available for household consumption and not actual nutrient intakes by individuals.

Summary statistics of the variables along with detailed information on the nutrients contributed by major food groups and specific food items are presented in Tables A4-1 through A4-3 of the Appendix.

4.3. Empirical Results

The demand functions, as specified in equation (1), were estimated by ordinary least squares for calories, total calories, calories obtained from staples, calories derived from other foods, protein, calcium, vitamin A and iron for the pooled data and for each season separately. The estimated coefficients can be interpreted directly as price and income elasticities since both the dependent and independent variables are expressed in logarithms. Estimates of the nutrient demand functions, their associated t-values and F statistics for each season and for the pooled data, and the Chow test results are presented in Tables A4-4 of Appendix 4.

First, the results indicate that the prices of major food commodities, real income, and household size factors account for part of the observed variation in the amounts of nutrients available for household consumption at any given season. For instance, the goodness-of-fit measure, R^2, for the calorie equation ranges from 0.126 during the harvest season to 0.510 during the lean season, suggesting that, as a group, the price, income, and household size variables explain about 12 to 51 percent of the observed variation in calorie availability.

Second, the estimated results show that the demand for nutrients in Bamako households is responsive to changes in real incomes and relative prices. Out of 35 estimated nutrient-income elasticities, 22 are statistically significant at least at the 10 percent level. Out of 175 price parameters, 40 are statistically significant at least at the 10 percent level.

Third, the null hypothesis of stability in the nutrient income parameters across seasons was rejected at the 10 percent level for all the estimated coefficients, except for calcium, suggesting that there is a statistically significant shift in the estimated nutrient-income elasticities across seasons. Moreover, the Chow test results indicate a degree of non-constancy of many price parameters across seasons, as the test of stability in the price coefficients was rejected at the 10 percent level for 13 out of 35 estimated coefficients.

4.3.1. Nutrient-Income Elasticities

The nutrient-income elasticities provide information on the response of nutrient demand to a change in households' real incomes, holding other factors fixed. In this sub-section, the effects of seasonal changes in Bamako households' real incomes on the demand for nutrients are examined in order to determine if the demand for nutrients is responsive to changes in real incomes and if nutrient-income elasticities are stable across seasons.

4.3.1.1. Calories

Table 4-1, below, presents the calorie-income elasticity of demand by season and for the pooled data and the results of the Chow test. First, the results indicate that real income has a statistically significant impact, at the 1 % level, on the demand for calories in all periods except the harvest and planting seasons. Many previous studies, such as Strauss and Thomas (1990), Rogers and Lowdermilk (1991), Bouis and Haddad (1992), and Subramanian and Deaton (1996), have also found a statistically significant relationship between calories and income. The pooled data results, in Table 4-1, show that on average, a 1 percent increase in households' real annual incomes increases calorie availability by 0.162 percent. This estimate is almost five times smaller than that found by Rogers and Lowdermilk (1991) of 0.760, suggesting that Bamako households' demand for calories becoming may be increasingly less responsive to changes in income.

Table 4-1: Calorie-Income Elasticities by Season and for the Pooled Data

Nutrient	L	H	PH	P	Pooled	Chow
Total Calories	0.193*	0.102	0.171**	0.166	0.162**	4.390*

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively.
L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Second, the results, in Table 4-1, also indicate that improvements in households' real incomes will have a positive impact on calorie purchases during the lean and post-harvest seasons. Moreover, the Chow test results indicate that the relationship between households' income and amounts of calories available for consumption is not constant across seasons. A 1 percent increase in urban households' real incomes will increase calorie availability by 0.193 % and 0.170 % during the lean and post-harvest seasons, respectively.

Furthermore, the results, in Table 4-1, also allow a comparison of the estimated calorie-income elasticities against the food income elasticities previously derived in the second essay.[42] Calorie-income elasticities are expected to be lower than food-income elasticities because households will tend to substitute between and within commodity groups to maintain constant calorie consumption (Subramanian and Deaton, 1996). The

[42] The food income elasticties estimated for the Stage I regression model in the second essay of this study are 0.626 in August, 0.463 in November, 0.577 in February, 0.574 in May, and 0.516 for the pooled data.

results of this study are consistent with those findings, as the estimated food income elasticties are substantially larger than the estimated the calorie-income elasticities in each season and annually. This finding is evidence that households are upgrading the quality of their diets, substituting more expensive sources of calories for cheaper sources, as their income increases. These results are consistent with findings of the descriptive analysis (Essay 1) that shows that diet diversification occurs as households' incomes rise.

Following Skoufias (2002), the effects of specific foods on the demand for calories are examined by performing separate regressions for calories from staples and calories from other foods. Table 4-2, below, presents the income elasticity of calories by food source for each season and annually. The income elasticity of demand for calories from staples is statistically significant at the 1 percent level for the pooled data and at the 10 percent level for the lean season, whereas the income elasticity of demand for calories from other foods is statistically significant, at least at the 5 percent level, in all seasons and for the pooled data.

Table 4-2: Calorie-Income Elasticities by Food Source

Nutrient	L	H	PH	P	Pooled	Chow
Calories from staples	0.136***	-0.034	0.080	0.114	0.070*	1.800***
Calories from other foods	0.336*	0.401*	0.326**	0.310**	0.364*	5.860*

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

The pooled data results show that an increase in real incomes will have a positive and less than proportionate impact on both the amounts of calories from staples (0.070) and other foods (0.364). These results also indicate that on average, annually, calories from staples are far less responsive to changes in real incomes than calories from other foods. In addition, the income elasticity of demand for calories from other foods exceeds that for calories for staples in all seasons considered. For instance, during the lean season, a 1 percent increase in real incomes will improve calorie availability from staples and other foods by 0.136 and 0.336 percent, respectively. This finding suggests that households will increase their consumption of other foods more rapidly than that of staples as their real incomes increases, indicating that households will tend to shift to more expensive sources of calories as they get richer.

A comparison of the estimated coefficients by season reveals that focusing only on the income elasticity of demand for total calories could be misleading because it may mask opposing changes in the income elasticity of calories for specific foods (Skoufias, 2002). For instance, during the harvest season, a 1 percent increase in real income will result in a 0.102 percent increase in total calorie availability (Table 4-1). Once the income effects are decomposed by food source, the results indicate that much of the increase in calorie availability may be attributed to increases in the amounts of calories obtained from other foods (0.401). The income elasticity for calories from staples, which is negative (-0.034) and not statistically significant, indicates that increases in real income in the harvest season will have no effects of the amounts of calories derived from staples. Furthermore, the Chow test reveals that there is evidence of instability in the estimated income parameters across seasons for both calories obtained from staples, at the 10 percent significance level, and calories derived from other foods, at the 1 percent significance level. Hence, Bamako households will respond to marginal increases in their real incomes over that period by increasing their consumption of other foods only.

4.3.1.2. Protein, Calcium, Vitamin A, and Iron

Table 4-3, below, presents the estimated nutrient-income elasticities for protein, calcium, vitamin A, and iron for each season and for the pooled data. First, the results indicate that, on average annually, the demand for nutrients is responsive to changes in Bamako households' real incomes. The nutrient-income elasticities derived from the pooled data are statistically significant at the 1 percent level for protein, vitamin A, and calcium, and at the 5 percent level for iron. However, when separate regressions are run by season, the results show that during the lean season the demand for all nutrients, except calcium, is responsive to incremental changes in real incomes while, during the harvest season, none of the nutrient-income elasticities is statistically significant. This means that once prices and household size are controlled for, changes in households' real incomes have no effect on the demand for protein, vitamin A, calcium, and iron during the harvest season. This is quite surprising because, as shown in Table 4-2, changes in real incomes have a statistically significant impact on calories obtained from other foods during the harvest season.

A possible explanation for these seemingly contradictory findings is that the sizeable decline in households' total real expenditures (36 percent (Essay 1)) between the lean and post-harvest season may push households towards subsistence levels of food consumption. In this context, households will protect their food consumption levels primarily through staples. Hence, although marginal increases in households' real incomes will be devoted to acquiring non-staple foods, the increase in non-staples consumption may not be sufficiently large enough to have a substantial impact on the availability of protein and micronutrients.

Table 4-3: Nutrient Income Elasticities by Season and for the Pooled Data

Nutrient	L	H	PH	P	Pooled	Chow
Protein	0.210**	0.090	0.192**	0.213**	0.191*	4.150*
Vitamin A	0.725**	0.492	0.680**	0.597	0.721*	2.240**
Calcium	0.128	0.097	0.160	0.276**	0.198*	1.630
Iron	0.210**	0.012	0.087	0.157	0.129**	2.680*

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Behrman and Deolalikar (1987) found that income does not have a statistically significant effect on the consumption of protein, calcium, and iron for households in rural South India. Bouis and Novenario-Reese (1997) found that iron consumption, in rural Bangladesh, is responsive to changes in income but that of vitamin A is not. They attributed this finding to the fact that vitamin A is available in very specific foods such as vegetables while, iron can be found in many staple grains.

Second, the results indicate that all the nutrient-income elasticities are positive and less than 1, indicating that increments in Bamako households' real incomes will have a positive, but less than proportionate, impact on household demand for nutrients in any given season and for the pooled data. The pooled data results show that a 10 percent growth in real incomes will increase the demand for protein (+1.91%), calcium (+1.98%), vitamin A (+7.21%) and iron (+1.29%). These results are consistent with those of Pitt (1983), whose study in rural Bangladesh shows that increases in households' incomes result in less than proportionate increments in the consumption of *all* nutrients. Furthermore, the pooled data results indicate that the income elasticities of protein and micronutrients are substantially lower than those of calories from staples (in Table 4-2), suggesting that households will increase their consumption of foods that contain essential nutrients more rapidly than that of staple foods, as their real income increases. These findings remain consistent even when the analysis is broken down by season. For instance, during the lean season, a 1 percent increase in real income will improve the demand for calories from staples by 0.210 percent while that for vitamin A increases by 0.725 percent. The results clearly indicate that households are upgrading the quality of their diets, substituting less expensive sources of calories for cheaper sources, as their income increases.

Third, the results indicate that the income elasticities vary noticeably across the range of nutrients (e.g., from 0.129 for iron to 0.721 for vitamin A for the pooled data) and across seasons, especially for micronutrients (e.g., from 0.492 during the harvest season to 0.725 during the lean season for vitamin A). The higher income elasticity of demand for vitamin A during the post-harvest season (0.680) can be partly explained by the low availability (higher prices) of spinach and green leaves during the cool dry season, which corresponds to the growing season for most horticultural crops. In addition, the results reveal that the income elasticities for calories (from 0.102 to 0.193) vary less across seasons than those for vitamin A (from 0.492 to 0.725). These results suggest that the adjustments Bamako households make to their food baskets to maintain calorie consumption more or less constant across seasons will have a greater impact on the consumption of foods that contribute essential vitamins and minerals, such as calcium and vitamin A, to urban households' diets. This finding is further substantiated by the Chow test results, which shows that the null hypothesis of stability in the estimated income parameters across was rejected at least at the 5 percent level for all nutrients, except calcium.

4.3.2. Nutrient-Price Elasticities

The effects of seasonal changes in relative prices on the demand for nutrients are examined in order to determine if (1) Bamako households' demand for nutrients is responsive to changes in relative food prices, and (2) there is evidence of seasonal changes in nutrient price responsiveness. These findings can be useful in designing for food policies that aim at improving nutrient availability in Malian households.

4.3.2.1. Rice Price Effects on the Demand for Nutrients

Table 4-4, below, presents the demand for various nutrients with respect to the price of rice for each season and for the pooled data and the Chow test results. The pooled data results indicate that, on average annually, the price of rice has no statistically significant effect on the demand for any of the nutrients considered. This is quite surprising because, as shown in the first essay of this study, rice contributed on average in 2000-2001, 39 percent of the total calories available for consumption at home, 28 percent of total protein availability, 13 percent of calcium, and 19 percent of iron. The elasticity of total calories with respect to the price of rice computed by Rogers and Lowdermilk (1991) was also not statistically significant. They attributed this finding to urban households being able to find ways to preserve their calorie consumption through substitutions between rice and other foods. However, they indicated that further work was needed to identify which foods substitute for rice in the face of higher rice prices. The results of the previous essay of this study indicated that (1) rice and millet-sorghum are net substitutes, once the income effects are removed in all seasons; (2) the price of rice has a positive effect, both compensated and uncompensated (except during the lean season), on the consumption of maize and; (3) the price of rice has a statistically significant large uncompensated effect on the consumption of wheat during the harvest season.

Table 4-4: Elasticity of Demand for Nutrients With Respect to the Price of Rice

Nutrient	L	H	PH	P	Pooled	Chow Test
Total Calories	-1.260**	0.032	0.383	-0.396	-0.245	1.320
Calories from staples	-0.965***	-0.157	0.359	-0.780	-0.316	0.840
Calories from other foods	-1.989*	0.507	0.303	1.027	-0.025	1.570
Protein	-1.246**	0.483	0.266	-0.430	-0.083	1.180
Vitamin A	-1.159	-0.190	2.766	0.329	0.324	0.680
Calcium	-0.927	1.269**	0.136	-0.121	0.292	1.090
Iron	-1.830*	0.399	0.354	-1.023	-0.203	1.990***

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

When separate regressions are run by season, the results indicate that the price of rice has a statistical significant impact on the demand for all nutrients, except calcium and vitamin A during the lean season and calcium during the harvest season. For instance, during the lean season, a 1 percent increase in the price of rice reduces the daily availability of all nutrients: total calorie availability by 1.260 percent, calories from staples by 0.965 percent, calories from other foods by 1.989 percent, protein by 1.246 percent, and iron by 1.830 percent. The amounts of calories obtained from other foods are nearly twice as responsive (-1.989) to changes in the price of rice than calories obtained from staples (-0.965) during the lean season. These results suggest that increases in the price of rice will substantially reduce the demand for nutrients during the lean season, when grain availability is relatively low in urban markets.

4.3.2.2. Millet-Sorghum Price Effects on the Demand for Nutrients

Table 4-5, below, presents the elasticity of demand for nutrients with respect to the price of millet-sorghum for each season and for the pooled data. First, the pooled data results indicate that, on average annually, the price of millet-sorghum has a negative and statistically significant impact on total calorie availability (-0.174), calories from staples (-0.279), iron (-0.240), and calcium (-0.157). Rogers and Lowdermilk (1991) also found that the demand for calories is responsive to changes in the price of millet-sorghum. The calorie-price elasticity for millet-sorghum derived from the pooled data (-0.174) is slightly lower than that of Rogers and Lowdermilk (1991) of –0.236, suggesting that the effect of changes in the price of millet-sorghum on the demand for calories has decreased over-time.

Table 4-5: Elasticity of Demand for Nutrients With Respect to the Price of Millet-Sorghum

Nutrient	L	H	PH	P	Pooled	Chow Test
Total Calories	-0.359**	-0.008	-0.402**	-0.228	-0.174*	3.360*
Calories from staples	-0.524*	-0.14	-0.504*	-0.373	-0.279*	4.400*
Calories from other foods	-0.056	0.314***	-0.112	0.147	0.083	1.69
Protein	-0.378**	0.012	-0.317***	-0.242	-0.181	2.430**
Vitamin A	0.369	0.11	-0.916	0.709	-0.081	0.67
Calcium	-0.368	-0.062	-0.318	0.022	-0.157*	1.22
Iron	-0.730*	-0.015	-0.621*	0.01	-0.240**	4.460*

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively.
L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

Second, the seasonal, statistically significant, results indicate that the nutrient elasticities with respect to the price of millet-sorghum are all negative, except for calories obtained from other foods during the harvest season, and are all less than 1. These results suggest that a 1 percent change in price of millet-sorghum has a negative and less than proportionate effect on the effective demand for nutrients in any given season. Once the price effect of millet-sorghum on total calorie availability is decomposed by specific foods, the results reveal that the amounts of calories obtained from staples are far more responsive to changes in the price of millet-sorghum than calories obtained from other foods in *all* seasons.

Third, evidence of cross-price effects is present during the harvest season, suggesting that changes in millet-sorghum prices will cause changes in the mix of foods purchased. During the harvest season, when grain prices are generally low, a 1 percent increase in the price of millet-sorghum will *increase* the availability of calories from other foods by 0.314 percent. This "perverse" price effect can be explained by the fact that changes in the price of millet-sorghum have strong income effects, as expenditures on millet-sorghum occupy on average 22 percent of households' staple budget. The positive elasticity of demand for calories from other foods with respect to the price of millet-sorghum suggests that households substitute between commodities within this food group in face of higher millet-sorghum prices by switching from high cost calorie sources to low cost calorie sources. For instance, households substitute dry fish for beef during the harvest season. Hence, the reallocation of households' budget induced by higher millet-sorghum prices result in increased calorie availability from other foods through an increase in the consumption of foods that are cheap sources of calories.

4.3.2.3. Beef Price Effects on the Demand for Nutrients

Table 4-6, below, presents the nutrient price elasticity of demand for calories, protein, calcium, vitamin A, and iron with respect to the price of beef for each season and for the pooled data. The pooled data results show that the price of beef has a positive statistical significant effect on the amounts of calories obtained from other foods. A 1 percent increase in the price of beef is expected to increase the availability of calories from other foods by 0.181 percent, on average, annually. This is due to the fact that households' allocate on average 61.7 percent of their meat and fish expenditures on beef and thus, changes in beef prices have strong income effects. Households tend to substitute between dry fish and beef. The null hypothesis of stability in the estimated parameters across seasons was rejected, at the 10 percent level, for calories from other foods, suggesting that there is a statistically significant shift across seasons in the response of the amounts of calories obtained from other foods to changes in the price of beef. The seasonal results show that the price of beef has a positive statistically significant effect, at the 5 percent level, on the amounts of calories obtained from other foods during the lean season (0.287). The price of beef has no statistically significant effect on the availability of any of the nutrients considered in all other seasons.

Table 4-6: Elasticity of Demand for Nutrients With Respect to the Price of Beef

Nutrient	L	H	PH	P	Pooled	Chow Test
Total Calories	0.039	0.073	0.120	0.031	0.045	1.300
Calories from staples	-0.059	0.043	0.034	0.021	-0.015	0.550
Calories from other foods	0.287**	0.100	0.275	0.061	0.181**	2.210**
Protein	-0.039	0.026	0.097	-0.037	-0.010	1.150
Vitamin A	0.414	0.162	-0.276	-0.203	0.026	0.330
Calcium	0.070	-0.058	0.059	-0.096	0.014	0.830
Iron	-0.150	-0.052	-0.112	-0.116	-0.114	1.520

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

4.3.2.4. Dry Fish Price Effects on Nutrient Availability

Table 4-8, below, presents the elasticities of demand for protein, calcium, vitamin A, and iron with respect to the price of dried fish for each season and for the pooled data.[43] First, the pooled data results indicate that the price of dry fish has a negative and statistically

[43] As mentioned in the first essay of this study, in 2000-2001, dry fish contributed on average 1 percent of the total calories available for consumption, 7 percent of total protein availability, 21 percent of calcium, and 2 percent of iron.

significant effect on the demand for calcium. A 1 percent increase in the price of dry fish reduces the demand for calcium by 0.293 percent. Second, the results indicate that the price of dry fish has a statistically significant negative impact on the demand for calcium during the harvest season and on that of calories, protein, and calcium during the post-harvest season. A 1 percent increase in the price of dry fish will reduce household demand for calcium by 0.236 percent during the harvest season. During the post-harvest season, when households' real incomes are high as the price of most staples decrease, a 1 percent increase in the price of dry fish will reduce the demand for calories, protein, and calcium by 0.179 percent, 0.230 percent, and 0.434 percent, respectively.

Table 4-7: Elasticity of Demand for Nutrients With Respect to the Price of Dry Fish

Nutrient	L	H	PH	P	Pooled	Chow Test
Total Calories	-0.057	-0.001	-0.179**	0.017	-0.058	1.880***
Calories from staples	-0.069	-0.008	-0.137	0.100	-0.043	1.010
Calories from other foods	-0.043	-0.002	-0.274	-0.153	-0.104	1.940***
Protein	-0.067	-0.052	-0.230**	0.025	-0.110	2.100**
Vitamin A	0.195	0.060	-0.163	-0.208	0.042	0.150
Calcium	-0.170	-0.236**	-0.434**	-0.224	-0.293*	2.820*
Iron	0.131	-0.021	-0.176	0.038	-0.020	1.810***

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively.
L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

4.3.2.5. Effects of the Price of Green Leaves on the demand for nutrients

Table 4-8, below, presents the elasticities of demand for nutrients with respect to the price of green leaves for each season and for the pooled data.[44] First, the pooled data results indicate that the price of green leaves has a negative statistically significant impact on calcium and vitamin A availability as, a 1 percent increase in the price of green leaves

[44] As shown in the first essay of this study, in 2000-2001, green leaves contributed on average annually 0.50 percent of the total calories available for consumption, 1.20 percent of total protein availability, 16 percent of calcium, 17 percent of vitamin A and 4 percent of iron.

will reduce calcium and vitamin A availability by 0.144 percent and 0.262 percent, respectively.

Second, the seasonal estimates indicate that the price of green leaves has a negative, less than proportionate, statistically significant impact on the demand for at least one nutrient in any given season, except the post-harvest season. During the lean season, a 1 percent increase in the price of green leaves will reduce the demand for total calories by 0.146 percent, calories from staples by 0.146 percent, protein by 0.123 percent, and calcium by 0.223. During the harvest season, a 1 percent increase in the price of green leaves will reduce calcium availability by 0.223 percent. During the planting season, a 1 percent increase in the price of green leaves is predicted to decrease the availability of calories from other foods by 0.208 percent.

Table 4-8: Elasticity of Demand for Nutrients With Respect to the Price of Green Leaves

Nutrient	L	H	PH	P	Pooled	Chow Test
Total Calories	-0.146**	-0.093	0.028	-0.030	-0.027	1.650
Calories from staples	-0.146**	-0.112	0.008	-0.015	-0.039	1.080
Calories from other foods	-0.164	-0.054	0.041	-0.208***	-0.047	1.820*
Protein	-0.123***	-0.122	-0.051	-0.006	-0.054	1.600
Vitamin A	-0.191	-0.248	-0.183	-0.498	-0.262**	1.040
Calcium	-0.223***	-0.267**	-0.148	0.028	-0.144*	2.140**
Iron	-0.129	-0.137	-0.023	-0.032	-0.047	1.450

Note: *, **, and *** denote significance at the 1 %, 5 %, or 10 % level, respectively.
L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

4.3.3. Sensitivity Analyses

In this section, the estimated nutrient-income parameters are used to simulate the impact of changes in households' real incomes on the demand for nutrients by season and for the pooled data. The analysis is further disaggregated to take into account the effects of including estimates of nutrient availability from away-from-home foods on average daily nutrient availability per adult equivalent. Detailed information on how the estimates of nutrient availability from away-from-home foods were computed is presented in Essay 1. Table 4-9, below, presents the baseline results by season and for the pooled data and by income group.

Table 4-9: Baseline Values

	Nutrients from at-home foods					Total Amounts of Nutrients				
Nutrient	L	H	PH	P	Pooled	L	H	PH	P	Pooled
Total Calories										
Low	2101	2122	2092	2015	2083	2290	2313	2279	2196	2270
Middle	2101	2060	2134	1912	2052	2335	2289	2372	2125	2280
High	2588	2529	2530	2335	2496	2806	2742	2743	2532	2706
Mean	2263	2237	2252	2088	2210	2477	2448	2465	2285	2419
Calories From Staples										
Low	1426	1564	1571	1550	1528	1555	1704	1712	1690	1665
Middle	1500	1444	1454	1360	1440	1667	1605	1616	1512	1600
High	1674	1689	1661	1626	1663	1815	1832	1801	1763	1803
Mean	1533	1566	1562	1512	1543	1679	1714	1710	1655	1689
Calories From Others										
Low	675	558	520	465	555	735	609	567	507	604
Middle	602	616	680	552	612	669	684	756	613	680
High	914	840	869	709	833	991	911	942	769	903
Mean	730	671	690	575	667	798	734	755	630	729
Protein										
Low	56	56	56	51	55	61	61	61	55	60
Middle	55	51	51	46	51	61	57	57	52	57
High	71	69	67	59	67	77	74	73	64	72
Mean	61	59	58	52	57	66	64	64	57	63
Calcium										
Low	484	384	404	349	405	528	418	440	381	442
Middle	432	382	336	311	365	480	425	374	346	406
High	584	477	574	445	520	633	518	622	483	564
Mean	500	414	438	369	430	547	453	479	403	470
Vitamin A										
Low	324	257	276	169	257	353	280	301	184	280
Middle	453	354	260	258	331	504	394	288	286	368
High	550	484	672	487	548	597	525	728	529	595
Mean	443	365	402	305	379	485	400	439	333	414
Iron										
Low	22	23	23	21	22	24	25	25	23	24
Middle	21	21	19	19	20	24	23	21	21	22
High	27	26	24	25	25	29	28	26	27	28
Mean	23	23	22	22	23	26	25	24	24	25

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting. Total amounts of nutrients available = Nutrients from at-home foods + Nutrients from away-from-home foods. Calories from away-from-home foods can't be disaggregated into calories from staples and other foods.

The impact of changes in real incomes is simulated using the following equation to compute the expected change in the demand for nutrients:

$$\Delta N_{kt} = \Delta X_t * \eta_{kt} \qquad (2)$$

where, ΔN_{kt} is the percentage change in the availability of Nutrient k at time t,

ΔX is the percentage change in real income at time t,

η_{kt} is the income elasticity of demand for nutrient k at time t; and

Table 4-10, below, presents the effects of a 20 percent increase in real incomes on household demand for nutrients in Bamako by season and for the pooled data, holding all other factors fixed. The increased demand for food induced by the increments in income, in face of constant food prices, would imply that food availability in urban households would need to be increased (i.e., through greater production or imports, or reduced exports).

Table 4-10: Effect of a 20 Percent Increase in Real Incomes in Percentage Changes

Nutrient	L	H	PH	P	Pooled
Total Calories	3.9	2.0	3.4	3.3	3.2
Calories From Staples	2.7	-0.7	1.6	2.3	1.4
Calories From Other Foods	6.7	8.0	6.5	6.2	7.3
Protein	4.2	1.8	3.8	4.3	3.8
Calcium	2.6	1.9	3.2	5.5	4.0
Vitamin A	14.5	9.8	13.6	11.9	14.4
Iron	4.2	0.2	1.7	3.1	2.6

Note: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

The pooled data results show that the 20 percent increase in real incomes would improve average calorie availability per adult equivalent by 3.2 percent, which is rather small. However, once the effects are disaggregated by source of calories, the results

indicate that the impact of a 20 percent increase in real incomes would be larger on the amounts of calories obtained from other foods (7.3 percent) than on those obtained from staples (1.4 percent). Hence, the increase in real incomes would likely result in improved diet diversity in Bamako households, as the amount of vitamin A available for consumption, which is mainly supplied by vegetables, would increase by 14.4 percent.

Table 4-11, below, presents the effects of the 20 percent increase in real incomes on the amounts of nutrients available by season and by income group. The pooled data results show that the 20 percent increase in real income would push average *at-home* calorie availability above the recommended dietary allowance (RDA) of 2200 kcal. However, the increase in the amounts of protein, calcium, vitamin A, and iron availability induced by the change in real income would not be enough to meet the RDA of 63 grams, 1000 milligrams, 600 micrograms, and 59 milligrams, respectively. Furthermore, the seasonally pooled data results indicate that only households in the high-income group are able to meet the RDA for calories, protein, and vitamin A. However, once the amounts of nutrients available from *away-from-home* foods are taken into account, the results indicate that all income groups would be able to meet the minimum calorie requirements. However, the low and middle-income groups' consumption of protein, calcium, vitamin A, and iron would remain below the recommended levels. High-income households would be able to meet the RDA for protein and vitamin A.

Table 4-11: Effect of a 20 Percent Increase in Real Incomes on the Amounts of Nutrients Available by Season and By income Group.

	Nutrients from at-home foods					Total Amounts of Nutrients				
Nutrient	L	H	PH	P	Pooled	L	H	PH	P	Pooled
Total Calories										
Low	2182	2166	2163	2082	2150	2378	2360	2357	2269	2343
Middle	2182	2102	2207	1976	2118	2425	2336	2453	2196	2354
High	2688	2581	2616	2413	2576	2914	2798	2837	2616	2794
Mean	2351	2283	2329	2157	2281	2573	2498	2549	2360	2497
Calories From Staples										
Low	1465	1553	1596	1586	1549	1597	1693	1740	1728	1689
Middle	1540	1434	1478	1391	1460	1712	1594	1642	1546	1622
High	1720	1678	1688	1663	1686	1865	1819	1830	1804	1828
Mean	1575	1555	1587	1547	1565	1725	1702	1737	1693	1713
Calories From Others										
Low	720	603	554	494	595	785	657	604	538	648
Middle	642	665	724	586	657	714	739	805	651	730
High	975	907	926	753	893	1057	984	1004	816	969
Mean	779	725	735	611	715	852	793	804	669	782
Protein										
Low	58	57	58	53	57	64	63	64	57	62
Middle	57	52	53	48	53	63	58	59	54	59
High	74	70	70	62	69	80	76	76	67	75
Mean	63	60	60	54	60	69	65	66	59	65
Calcium										
Low	497	391	417	369	421	541	426	454	402	459
Middle	443	390	347	329	380	492	433	386	365	422
High	599	487	592	470	541	649	528	642	510	586
Mean	513	422	452	389	447	561	462	494	425	489
Vitamin A										
Low	371	283	313	189	294	405	308	342	206	320
Middle	519	389	295	289	379	577	432	328	321	421
High	630	532	763	546	627	683	577	827	592	680
Mean	507	401	457	341	433	555	439	499	373	474
Iron										
Low	23	23	24	22	23	25	25	26	24	25
Middle	22	21	19	20	20	25	23	21	22	23
High	28	26	24	26	26	30	28	27	28	28
Mean	24	23	22	22	23	27	25	24	25	25

Note: Nutrients are expressed in mean daily availability per adult equivalent; Calories are expressed in kilo-calories/AE/day; Protein in Grams/AE/day; Vitamin A in Micrograms/AE/day; and Calcium and Iron are in Milligrams/AE/day. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting.

The seasonal results show that the impact of such increments in real incomes would push average *at-home* calorie availability above the recommended dietary allowance (RDA) of 2200 kcal in all seasons except the planting season. However, these results mask the fact that only the households in the high-income group would be able to satisfy the minimum calorie requirements in *all* seasons. Average calorie availability would remain below the requirement levels for low and middle-income households in all season, except the post-harvest for the middle-income group. High-income households would be able to satisfy the RDA for protein in all seasons, except the planting, and for vitamin A during the lean and post-harvest seasons. Households in the low and middle-income groups would be unable to meet the RDA for protein, calcium, vitamin A, and iron in all seasons.

Once the amounts of nutrients available from *away-from-home* foods are taken into account, the results indicate that *all* households, on average, would be able to meet the RDA for calories in all seasons, except the planting for the middle-income group. Low and high-income households would satisfy the RDA for protein in all seasons, except the planting for the low-income group. However, the amounts of iron, calcium, and vitamin A, with the exception of the high-income group in the lean and post-harvest seasons, available for household consumption would still remain below the recommended levels in all seasons. It should be remembered, however, that these figures are upper-end estimates, as they make no allowance for nutrient wastage or loss during food preparation.

4.4. Conclusion

In this essay, the relationship between real income, relative prices, and households' demand for nutrients in Bamako, Mali, was examined by season and annually using Engel functions. First, the results indicate that the price of major food commodities, real income, and household size factors account for a substantial part of the observed variation in the amounts of nutrients available for household consumption at any given season.

Second, the study finds that Bamako households' demand for nutrients are responsive to changes in their real incomes *and* relative prices and that the magnitude of the nutrient income and price elasticities will change from one season to another. The null hypothesis of stability in the nutrient income parameters across seasons was rejected for all the estimated coefficients, except for calcium, suggesting that there is a statistically significant shift in the estimated nutrient-income elasticities across seasons. Moreover, the Chow test results indicate a certain degree of non-constancy of many price parameters across seasons, implying that the impact of a uniform food policy on the quantity and quality of food available in Bamako households will vary by season.

Third, the results indicate that improvements in Bamako households' real incomes will have a positive, but less than proportionate, impact on household demand for nutrients in any given season and for the pooled data. More specifically, the results indicate that increases in households' real incomes will have a positive impact on calorie purchases *but* that households will increase their consumption of other foods more rapidly than that of staples as their real incomes increases. The results clearly indicate that households are upgrading the quality of their diets, substituting less expensive sources of calories for cheaper sources, as their income increases. In addition, the seasonal results suggest that Bamako households try to maintain calorie consumption more or less constant across seasons at the expense of foods that contribute essential vitamins and minerals, such as calcium and vitamin A, to households' diets.

Fourth, the results on the estimated nutrient price elasticities indicate that (1) the price of rice and beef have no statistically significant effect on the availability of any of the nutrients considered in all seasons, except the lean season, and for the pooled data; (2) the price of millet sorghum has a statistically significantly negative and less than proportionate effect on the effective demand for nutrients in any given season; (3) the price of dry fish has a negative and statistical significant effect on the amounts of calcium demanded by households; and (4) the price of green leaves has a negative statistically significant impact on the demand for calcium and vitamin A.

Fifth, the sensitivity analysis revealed that increases in real incomes would improve average calorie availability but the effects of such increments would be larger on the amounts of calories obtained from other foods than on those obtained from staples. Furthermore, the sensitivity analysis suggests that, once the availability of nutrients from away-from-home foods is taken into account, households are able to meet minimum calorie requirements in all seasons. However, the results indicate that households need to achieve substantial income gains in order to be able to meet the RDAs for protein, calcium, vitamin A, and iron in all seasons and annually. The results also showed that substantial variability remains among and probably within households, suggesting that improvements in income alone may not be enough to reduce malnutrition in Bamako households.

The findings of this essay have several implications for policy design in Mali. First, the positive nutrient-income elasticities imply that increasing households' real incomes will improve the quantity (i.e., calories) and the quality (i.e., protein, minerals, and vitamins) of food available in those households and thereby will be an effective mechanism in reducing malnutrition. Hence, the policies that aim at increasing households' real incomes will also improve their nutrition. Better nutrition outcomes can, in turn, translate into improved worker productivity (Straus and Thomas, 1998).

Second, the fact that households will increase their consumption of other foods more rapidly than that of staples as their real incomes increases suggests that households will diversify their diets as their income grows. This finding suggests that greater allocation of resources and investment in the production and marketing of horticultural commodities offer the potential to substantially reduce malnutrition, especially vitamin A deficiency, increase employment, and reduce poverty in urban areas.

Third, the finding that the demand for nutrients are responsive to changes in the price of millet-sorghum, dry fish, and green leaves suggests that food prices can be used as policy instruments to reduce malnutrition in households. Increased investments (public and private) in the production and marketing of horticultural commodities can yield the productivity gains necessary to substantially reduce the price of horticultural goods so that low-income households can readily access these foods.

Finally, the finding that many of the estimated nutrient income and price parameters are not stable across seasons imply that the effectiveness of food policies will be contingent upon whether or not they are systematically synchronized with the short-run response of households' consumption patterns to income and price changes. The results suggest that the impacts of a uniform food policy on the quantity and quality of food available in Bamako households will vary by season.

REFERENCES

Behrman J.R. and A.B. Deolalikar, (1987). Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India. *Journal of Political Economy*, 95, pp.492-507.

Behrman, J., A. Deolalikar, and B.L. Wolfe, (1988). Nutrients: Impacts and Determinants. *The World Bank Economic Review*, 2.

Behrman, J. R. (1995). *Household Behavior and Micronutrients: What We Know and What We Don't Know?* International Food Policy Research Institute, Working Papers on Agricultural Strategies for Micronutrients, No. 2.

Behrman, J.R. and Deolalikar, A.B. (1987). Will Developing Country Nutrition Improve with Income? A Case Study of Rural South India *Journal of Political Economy*, 95, 108-38.

Bouis, H.E. (1994). The Effect of Income on Demand for Food in Poor Countries: Are Our Databases Giving Us Reliable Estimates? *Journal of Development Economics*, 44(1), pp.199-226.

Bouis, H.E. and Novenaio-Reese, M.J.G. (1997). *The Determinants of Demand for Micronutrients: An Analysis of Rural Households in Bangladesh.* International Food Policy Research Institute, Food Consumption and Nutrition Division Discussion Paper No. 32.

Dawson J.P., and R. Tiffin, (1998). Estimating the Demand for Calories in India, *Amer. J. Agr. Econ.* 80 (August 1998): 474-481.

World Bank. 1981. *World development report 198*1. Oxford: Oxford University Press for the World Bank.

Deaton, A. *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy.* World Bank. The John Hopkins University Press. Baltimore, London: 1997.

Bhargava, A., (1991). Estimating Short and Long Run Income Elasticity of Foods and Nutrients for Rural South India. *Journal of the Royal Statistical Society*, A, 154, 157-74.

Bouis, H. and Haddad, L.J. (1992). Are Estimates of Calorie-Income Elasticities too High? A Recalibration of the Plausible Range. *Journal of Development Economics*, 39, 333-364.

Deaton, Angus (1997). *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy*, World Bank, The Johns Hopkins University Press, Baltimore and London.

Food and Agriculture Organization of the United Nations and International Life Sciences Institute, 1997. *Preventing micronutrient malnutrition: A guide to food-based approaches - A manual for policy makers and programme planners.* ILSI PRESS. Library of Congress Catalog Number: 97-71096.

Krishnaswamy K, K. Vijayraghavan, J . G. Sastry, H. Rao, G.N.V. Brahman, G. Radhiah, K. Kashinath, V. Rao (1997). *25 years of National Nutritional Monitoring*. Board Report of the National Institute of Nutrition, Indian Council of Medical Research, Hyderabad

Lipton, Michael (1983). *Poverty, Undernutrition, and Hunger.* World Bank Staff Working Paper Number 597, The World Bank, Washington, D.C., USA.

Ravallion, M., (1990). Economic Effects on Undernutrition. *Economic Development and Cultural Change*, 38, No. 3, 489-515.

Strauss, J. and Duncan Thomas (1990). *The Shape of the Calorie Expenditure Curve.* Economic Growth Centre Discussion Paper No. 595, Yale University.

Subramanian, S. and Angus Deaton (1996). The Demand for Food and Calories. *Journal of Political Economy*, Vol. 104, No. 1.

Ullah, A. and N. Roy (1998). *Nonparametric and Semiparametric Econometrics of Panel Data.* In A.Ullah and D.E.A. Giles (eds.), Handbook in Applied Economic Statistics, Marcel Dekker, Ch. 17, 579-604.

APPENDIX 4

Table A4-1: Summary Statistics

Variables	Lean		Harvest		Post-Harvest		Planting		Pooled	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total Calories	2259	689	2233	658	2249	713	2083	614	2206	675
Calories From Staples	1533	404	1563	402	1559	353	1509	409	1541	390
Calories From Other Foods	727	285	670	256	690	360	575	205	665	285
Protein	60	15	58	15	58	16	52	13	57	15
Calcium	498	182	414	151	435	252	367	141	429	181
Vitamin A	443	298	365	315	399	360	304	364	378	334
Iron	23	7	23	7	22	7	22	7	23	7
Rice price	269	21	275	27	260	22	264	16	267	21
Millet-Sorghum price	147	40	146	43	136	34	180	47	152	41
Beef price	980	294	1011	274	959	258	945	230	974	264
Dry fish price	1308	760	1482	571	1392	705	1427	386	1402	605
Green leaves price	299	206	307	174	518	1074	348	353	368	452
Calorie Price	111	85	108	53	116	67	103	60	109	66
Household size in AE	13	7	13	7	13	8	13	8	13	8
Total expenditure/AE	9521	6086	7155	3172	6818	3898	6076	4287	7392	4633

Note: Nutrients are expressed in mean daily availability per adult equivalent; Prices are in CFA Francs per kilogram. Calories are expressed in kilo-calories per adult equivalent (AE) per day; Protein in Grams/AE/day; Vitamin A in Micrograms/AE/day; and Calcium and Iron are in Milligrams/AE/day. Prices are expressed in CFA Francs per kilogram. Total expenditures are expressed in CFA Francs per adult equivalent per week.

Table A4-2: Nutrients Contributed by Major Food Groups (%) by Season

Seasons	Calories	Protein	Calcium	Vit A	Iron
Lean					
Rice	39.2	27.6	13.3	0.0	18.9
Other Staples	28.7	30.3	11.2	3.7	44.6
Meat and Fish	4.8	19.9	22.8	3.4	7.0
Vegetables	4.5	8.9	40.7	50.7	20.8
Oil	8.3	0.0	0.0	36.4	0.0
Sugar	7.3	0.0	0.0	0.0	0.0
All others	7.1	13.4	12.0	5.8	8.8
Harvest					
Rice	41.2	29.7	16.6	0.0	19.8
Other Staples	29.0	29.8	13.9	11.9	45.6
Meat and Fish	4.7	18.4	21.5	4.0	6.8
Vegetables	3.4	6.6	34.6	55.4	17.5
Oil	6.2	0.1	0.0	20.9	0.0
Sugar	7.2	0.0	0.0	0.0	0.0
All others	8.3	15.5	13.3	7.9	10.2
Post-Harvest					
Rice	42.2	30.9	16.9	0.0	21.7
Other Staples	27.4	28.7	12.1	2.1	43.8
Meat and Fish	4.5	18.0	22.8	2.6	7.1
Vegetables	3.8	7.3	31.5	73.4	18.0
Oil	7.1	0.1	0.0	17.2	0.0
Sugar	7.2	0.0	0.0	0.0	0.0
All others	7.8	15.0	16.7	4.7	9.4
Planting					
Rice	41.6	31.4	17.8	0.0	19.9
Other Staples	31.0	32.2	13.8	3.1	48.4
Meat and Fish	3.9	16.3	20.3	3.5	5.8
Vegetables	3.3	6.2	34.5	62.9	17.7
Oil	5.5	0.0	0.0	27.9	0.0
Sugar	7.8	0.0	0.0	0.0	0.0
All others	7.0	13.9	13.6	2.5	8.3
Average					
Rice	41.1	29.9	16.2	0.0	20.1
Other Staples	29.0	30.2	12.8	5.2	45.6
Meat and Fish	4.5	18.1	21.8	3.4	6.7
Vegetables	3.7	7.2	35.3	60.6	18.5
Oil	6.8	0.1	0.0	25.6	0.0
Sugar	7.4	0.0	0.0	0.0	0.0
All others	7.6	14.4	13.9	5.2	9.2

Table A4-3: Nutrients Contributed by Specific Food Items (%) by Season

Commodities	Calories					Protein				
	Aug	Nov	Feb	May	Avg	Aug	Nov	Feb	May	Avg
Staples										
Rice	38.96	40.97	42.13	41.49	40.89	27.33	29.38	30.67	31.23	29.66
Millet-Sorghum	23.58	24.75	22.80	26.54	24.42	24.80	25.62	24.07	27.24	25.43
Maize	3.35	2.42	2.50	2.82	2.77	3.42	2.50	2.50	3.01	2.86
Wheat	1.52	0.94	1.28	1.17	1.23	1.82	1.17	1.62	1.52	1.53
Other Cereal	0.15	0.00	0.08	0.19	0.11	0.12	0.00	0.06	0.16	0.09
Atieke	0.04	0.01	0.03	0.05	0.03	0.01	0.00	0.01	0.02	0.01
Cassava	0.06	0.25	0.07	0.02	0.10	0.04	0.16	0.05	0.01	0.07
Potato	0.07	0.02	0.43	0.11	0.16	0.06	0.02	0.38	0.10	0.14
Sweet Potato	0.10	0.64	0.02	0.04	0.20	0.06	0.36	0.01	0.02	0.11
Meat and Fish										
Beef	3.01	3.34	2.98	2.77	3.03	8.62	9.78	8.84	8.51	8.94
Mutton	0.11	0.00	0.36	0.03	0.13	0.28	0.00	0.93	0.09	0.32
Poultry	0.08	0.01	0.05	0.02	0.04	0.40	0.05	0.27	0.12	0.21
Dry Fish	1.27	1.00	1.10	0.89	1.07	8.34	6.72	7.52	6.28	7.22
Fresh Fish	0.44	0.37	0.11	0.23	0.29	2.50	2.13	0.65	1.42	1.68
Vegetables										
Leaves	0.76	0.49	0.37	0.38	0.50	1.73	1.22	0.88	0.97	1.20
Okra	0.76	0.51	0.45	0.56	0.57	1.42	0.79	0.67	0.97	0.96
Onion	0.58	0.61	0.87	0.77	0.71	0.83	0.90	1.24	1.13	1.03
Tomato	0.25	0.35	0.39	0.39	0.34	0.43	0.60	0.68	0.71	0.61
Other Vegetable: Fresh	0.41	0.46	0.61	0.34	0.45	0.56	0.71	1.09	0.53	0.72
All Other Vetegable	1.72	1.03	1.08	0.87	1.17	3.96	2.44	2.65	1.91	2.74
Oil										
Peanut Oil	6.19	4.14	5.23	3.89	4.86	0.00	0.00	0.00	0.00	0.00
Palm Oil	1.08	0.51	0.36	0.64	0.65	0.00	0.00	0.00	0.00	0.00
Sheanut Oil	1.06	1.65	1.52	0.94	1.29	0.05	0.07	0.07	0.04	0.06
Sugar	7.37	7.22	7.29	7.83	7.43	0.00	0.00	0.00	0.00	
All others										
Butter	0.04	0.04	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00
Buttermilk	0.12	0.06	0.10	0.08	0.09	0.25	0.13	0.21	0.18	0.19
Fresh Milk	0.01	0.01	0.00	0.00	0.00	0.01	0.02	0.01	0.00	0.01
Condensed Sweetened Milk	0.12	0.01	0.00	0.00	0.03	0.11	0.01	0.00	0.00	0.03
Powdered Milk	0.52	0.46	1.05	0.48	0.63	1.02	0.94	2.16	1.02	1.28
Eggs	0.15	0.02	0.01	0.00	0.05	0.48	0.06	0.04	0.00	0.15
Peanuts	5.08	6.66	5.61	5.46	5.70	8.50	11.39	9.73	9.83	9.86
Seeds	0.46	0.49	0.49	0.47	0.48	1.24	1.32	1.30	1.25	1.28
Other Legume Nut and Seed	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.01
Coffee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tea Lipton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green Tea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinqueliba	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Other Beverage	0.02	0.00	0.06	0.00	0.02	0.02	0.00	0.03	0.00	0.01
Banana	0.03	0.07	0.07	0.00	0.04	0.01	0.03	0.03	0.00	0.02
Citronella	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dates	0.01	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Lemon	0.02	0.07	0.01	0.00	0.02	0.01	0.05	0.01	0.00	0.02
Raisin	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamarind	0.06	0.00	0.08	0.09	0.06	0.07	0.00	0.09	0.11	0.07
Orange	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Seansonings and Spices	0.42	0.40	0.39	0.39	0.40	1.50	1.44	1.53	1.61	1.52
Sum	100	100	100	100	100	100	100	100	100	100

Table A4-3: Nutrients Contributed by Specific Food Items (%) by Season (continued)

Commodities	Iron					Calcium			
	Aug	Nov	Feb	May	Avg	Aug	Nov	Feb	May
Staples									
Rice	18.75	19.67	21.49	19.80	19.93	13.18	16.50	16.23	17.55
Millet-Sorghum	38.94	40.88	40.00	43.79	40.90	9.35	11.14	9.88	11.66
Maize	4.28	2.90	2.48	3.13	3.20	0.55	0.51	0.61	0.66
Wheat	0.98	0.57	0.77	0.70	0.76	0.87	0.66	0.84	0.90
Other Cereal	0.15	0.00	0.08	0.18	0.10	0.05	0.00	0.03	0.08
Atieke	0.05	0.01	0.04	0.06	0.04	0.08	0.02	0.08	0.13
Cassava	0.04	0.17	0.05	0.01	0.07	0.12	0.63	0.18	0.05
Potato	0.11	0.03	0.65	0.16	0.23	0.06	0.02	0.38	0.11
Sweet Potato	0.18	1.12	0.04	0.07	0.35	0.14	1.04	0.04	0.07
Meat and Fish									
Beef	4.47	4.95	4.68	4.08	4.54	0.64	0.85	0.72	0.74
Mutton	0.08	0.00	0.29	0.02	0.10	0.02	0.00	0.07	0.01
Poultry	0.06	0.01	0.04	0.02	0.03	0.02	0.00	0.02	0.01
Dry Fish	2.24	1.76	2.06	1.56	1.91	21.80	20.45	21.59	19.13
Fresh Fish	0.23	0.19	0.06	0.12	0.15	0.44	0.43	0.12	0.29
Vegetables									
Leaves	5.44	3.63	2.52	2.84	3.61	22.54	16.52	12.08	14.08
Okra	5.27	5.86	5.92	5.69	5.68	9.53	9.17	7.99	10.08
Onion	1.37	1.45	2.11	1.75	1.67	2.00	2.50	3.36	3.28
Tomato	0.81	1.03	1.21	1.13	1.04	0.49	0.83	0.88	0.98
Other Vegetable: Fresh	0.81	1.39	1.57	0.69	1.11	0.94	1.76	3.00	1.07
All Other Vetegable	7.14	4.16	4.66	5.85	5.45	5.29	3.65	3.76	5.37
Oil									
Peanut Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palm Oil	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.01	0.02
Sheanut Oil	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
All others									
Butter	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
Buttermilk	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fresh Milk	0.00	0.00	0.00	0.00	0.00	0.05	0.08	0.03	0.00
Condensed Sweetened Milk	0.01	0.00	0.00	0.00	0.00	0.50	0.03	0.00	0.00
Powdered Milk	0.05	0.04	0.11	0.05	0.06	4.30	4.59	9.97	5.02
Eggs	0.21	0.02	0.02	0.00	0.06	0.22	0.03	0.02	0.00
Peanuts	5.12	6.74	5.96	5.55	5.84	2.49	3.89	3.12	3.37
Seeds	2.56	2.61	2.47	2.09	2.43	1.61	1.95	1.89	1.89
Other Legume Nut and Seed	0.01	0.02	0.01	0.00	0.01	0.00	0.01	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tea Lipton	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Green Tea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quinqueliba	0.00	0.01	0.01	0.00	0.01	0.00	0.00	0.00	0.00
Other Beverage	0.01	0.00	0.02	0.00	0.01	0.07	0.00	0.10	0.00
Banana	0.02	0.03	0.03	0.00	0.02	0.01	0.01	0.01	0.00
Citronella	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dates	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
Lemon	0.04	0.14	0.02	0.00	0.05	0.05	0.21	0.03	0.01
Raisin	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tamarind	0.01	0.00	0.00	0.00	0.00	0.25	0.01	0.36	0.46
Orange	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Seansonings and Spices	0.63	0.56	0.65	0.64	0.62	2.27	2.50	2.60	3.00
Sum	100	100	100	100	100	100	100	100	100

Table A4-3: Nutrients Contributed by Specific Food Items (%) by Season (continued)

Commodities	Vitamin A				
	Aug	Nov	Feb	May	Avg
Staples					
Rice	0.00	0.00	0.00	0.00	0.00
Millet-Sorghum	1.22	1.37	1.18	1.38	1.29
Maize	0.74	0.52	0.10	0.51	0.47
Wheat	0.00	0.00	0.00	0.00	0.00
Other Cereal	0.00	0.00	0.00	0.00	0.00
Atieke	0.01	0.00	0.01	0.01	0.01
Cassava	0.01	0.06	0.02	0.00	0.02
Potato	0.03	0.01	0.20	0.07	0.08
Sweet Potato	1.41	10.68	0.36	0.72	3.29
Meat and Fish					
Beef	1.62	2.16	1.77	2.01	1.89
Mutton	0.02	0.00	0.08	0.01	0.03
Poultry	0.23	0.04	0.17	0.08	0.13
Dry Fish	0.00	0.00	0.00	0.00	0.00
Fresh Fish	1.66	1.66	0.46	1.18	1.24
Vegetables					
Leaves	21.29	18.34	11.79	16.85	17.07
Okra	2.13	0.58	0.29	1.11	1.03
Onion	0.00	0.00	0.00	0.00	0.00
Tomato	4.22	7.52	7.65	9.66	7.26
Other Vegetable: Fresh	9.98	21.55	48.68	25.80	26.50
All Other Vetegable	13.51	8.32	6.77	9.04	9.41
Oil					
Peanut Oil	0.00	0.00	0.00	0.00	0.00
Palm Oil	36.21	20.52	13.49	28.96	24.79
Sheanut Oil	0.00	0.00	0.00	0.00	0.00
Sugar	0.00	0.00	0.00	0.00	0.00

Table A4-3: Nutrients Contributed by Specific Food Items (%) by Season (continued)

Commodities	Vitamin A				
	Aug	Nov	Feb	May	Avg
All others					
Butter	0.77	0.94	0.00	0.72	0.61
Buttermilk	0.00	0.00	0.00	0.00	0.00
Fresh Milk	0.02	0.03	0.01	0.00	0.01
Condensed Sweetened Milk	0.16	0.01	0.00	0.00	0.04
Powdered Milk	1.48	1.60	3.34	1.86	2.07
Eggs	2.20	0.31	0.20	0.00	0.68
Peanuts	0.01	0.02	0.02	0.01	0.01
Seeds	0.00	0.00	0.00	0.00	0.00
Other Legume Nut and Seed	0.00	0.00	0.00	0.00	0.00
Coffee	0.00	0.00	0.00	0.00	0.00
Tea Lipton	0.00	0.00	0.00	0.00	0.00
Green Tea	0.00	0.00	0.00	0.00	0.00
Quinqueliba	0.00	0.00	0.00	0.00	0.00
Other Beverage	0.01	0.00	0.01	0.00	0.00
Banana	0.93	3.69	3.39	0.01	2.00
Citronella	0.00	0.00	0.00	0.00	0.00
Dates	0.02	0.04	0.02	0.00	0.02
Lemon	0.00	0.02	0.00	0.00	0.01
Raisin	0.00	0.00	0.00	0.00	0.00
Tamarind	0.00	0.00	0.00	0.00	0.00
Orange	0.09	0.00	0.00	0.00	0.02
Seansonings and Spices	0.01	0.02	0.00	0.00	0.01
Sum	100	100	100	100	100

Table A4-4: Nutrient Demand Estimates

Independent Variables	Dependent Variable: Log of																	
	Total Calories						Calories From Staples						Calories From Other Foods					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
RIAE	0.193	0.102	0.170	0.166	0.162	4.390	0.136	-0.034	0.080	0.114	0.070	1.800	0.336	0.401	0.325	0.310	0.364	5.860
	(3.03)	(1.05)	**(2.29)**	**(2.12)**	**(4.62)**	***(0.00)***	**(1.77)**	(0.31)	(1.08)	(1.23)	**(1.79)**	***(0.09)***	**(3.45)**	**(3.01)**	**(2.16)**	**(2.43)**	**(6.28)**	***(0.00)***
Price	-1.260	0.032	0.383	-0.396	-0.245	1.320	-0.965	-0.157	0.359	-0.780	-0.316	0.840	-1.989	0.507	0.303	1.027	-0.025	1.570
	(2.97)	(0.09)	(0.90)	(0.67)	(1.27)	*(0.24)*	**(1.88)**	(0.39)	(0.85)	(1.11)	(1.46)	*(0.55)*	**(3.06)**	(1.04)	(0.35)	(1.06)	(0.08)	*(0.15)*
P*ms*	-0.359	-0.008	-0.402	-0.228	-0.174	3.360	-0.524	-0.140	-0.504	-0.373	-0.279	4.400	-0.056	0.314	-0.112	0.147	0.083	1.690
	(3.00)	(0.07)	**(2.89)**	(1.57)	**(3.18)**	***(0.00)***	**(3.62)**	(1.07)	**(3.62)**	(2.16)	**(4.56)**	***(0.00)***	(0.31)	**(1.96)**	(0.40)	(0.62)	(0.92)	*(0.12)*
Pbeef	0.039	0.073	0.120	0.031	0.045	1.300	-0.059	0.043	0.034	0.021	-0.015	0.550	0.287	0.100	0.275	0.061	0.181	2.210
	(0.43)	(0.50)	(1.12)	(0.29)	(0.87)	*(0.26)*	(0.54)	(0.26)	(0.31)	(0.17)	(0.26)	*(0.80)*	**(2.07)**	(0.50)	(1.26)	(0.36)	**(2.10)**	***(0.04)***
Pdryfish	-0.057	-0.001	-0.179	0.017	-0.058	1.880	-0.069	-0.008	-0.137	0.100	-0.043	1.010	-0.043	-0.002	-0.274	-0.153	-0.104	1.940
	(0.81)	(0.01)	**(2.17)**	(0.13)	(1.43)	***(0.08)***	(0.80)	(0.08)	(1.66)	(0.65)	(0.94)	*(0.43)*	(0.40)	(0.02)	(1.64)	(0.72)	(1.54)	***(0.07)***
Pleaves	-0.146	-0.093	0.028	-0.030	-0.027	1.650	-0.146	-0.112	0.008	-0.015	-0.039	1.080	-0.164	-0.054	0.041	-0.208	-0.047	1.820
	(2.54)	(1.22)	(0.64)	(0.46)	(1.00)	*(0.13)*	**(2.10)**	(1.30)	(0.18)	(0.19)	(1.29)	*(0.38)*	(1.86)	(0.51)	(0.46)	**(1.96)**	(1.06)	***(0.09)***
AE	-0.106	-0.003	-0.050	-0.086	-0.036		-0.179	-0.013	-0.075	-0.087	-0.068		0.041	0.047	-0.010	-0.057	0.046	
	(1.87)	(0.03)	(0.80)	(1.28)	(1.17)		(2.63)	(0.15)	(1.19)	(1.10)	(1.96)		(0.48)	(0.44)	(0.08)	(0.52)	(0.90)	
(Constant)	16.337	6.869	6.765	9.929	9.125		16.438	9.555	8.118	12.212	10.770		14.659	-1.214	2.923	-0.291	3.281	
	(5.88)	**(3.25)**	**(3.07)**	**(3.13)**	**(8.26)**		**(4.90)**	**(4.02)**	**(3.69)**	**(3.24)**	**(8.69)**		**(3.45)**	(0.42)	(0.66)	(0.06)	**(1.80)**	
F	4.750	0.660	2.540	2.210	6.700		3.710	0.640	2.450	2.250	5.610		4.810	3.010	1.200	2.210	7.780	
R-square	0.510	0.126	0.357	0.326	0.236		0.448	0.123	0.350	0.331	0.205		0.513	0.396	0.208	0.326	0.269	

Notes: RIAE = Real Income per Adult Equivalent; ms = millet-sorghum. L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics.

Table A4-4: Nutrient Demand Estimates (continued)

Independent Variables	Dependent Variable: Log of											
	Protein						Vitamin A					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
Real income/AE	0.210	0.090	0.192	0.213	0.191	4.150	0.725	0.492	0.680	0.597	0.721	2.240
	(2.70)	(0.81)	**(2.05)**	**(2.55)**	**(4.74)**	***(0.00)***	**(2.66)**	(1.30)	**(2.04)**	(1.59)	**(4.90)**	***(0.03)***
Price	-1.246	0.483	0.266	-0.430	-0.083	1.180	-1.159	-0.190	2.766	0.329	0.324	0.680
	(2.40)	(1.19)	(0.50)	(0.68)	(0.37)	*(0.32)*	(0.64)	(0.14)	(1.45)	(0.12)	(0.40)	*(0.69)*
P*millet-sorghum*	-0.378	0.012	-0.317	-0.242	-0.181	2.430	0.369	0.110	-0.916	0.709	-0.081	0.670
	(2.58)	(0.09)	**(1.81)**	(1.56)	(2.87)	***(0.02)***	(0.72)	**(0.24)**	(1.47)	(1.02)	(0.35)	*(0.70)*
P*beef*	-0.039	0.026	0.097	-0.037	-0.010	1.150	0.414	0.162	-0.276	-0.203	0.026	0.330
	(0.35)	(0.16)	(0.72)	(0.33)	(0.16)	*(0.34)*	(1.07)	(0.29)	(0.57)	(0.41)	(0.12)	*(0.94)*
P*dryfish*	-0.067	-0.052	-0.230	0.025	-0.110	2.100	0.195	0.060	-0.163	-0.208	0.042	0.150
	(0.78)	(0.53)	**(2.22)**	(0.18)	**(2.36)**	**(0.05)**	(0.64)	(0.18)	(0.44)	(0.33)	(0.25)	*(0.99)*
P*leaves*	-0.123	-0.122	-0.051	-0.006	-0.054	1.600	-0.191	-0.248	-0.183	-0.498	-0.262	1.040
	(1.75)	(1.40)	(0.92)	(0.08)	(1.75)	*(0.14)*	(0.77)	(0.83)	(0.93)	(1.60)	**(2.34)**	*(0.41)*
AE	-0.044	0.021	-0.029	-0.017	0.002		0.258	-0.042	-0.092	0.400	0.200	
	(0.64)	(0.24)	(0.36)	(0.24)	(0.05)		(1.07)	(0.14)	(0.33)	(1.25)	(1.54)	
(Constant)	12.937	1.476	4.103	6.274	5.201		1.489	2.625	-5.714	0.443	-0.350	
	(3.81)	(0.61)	(1.48)	**(1.85)**	**(4.08)**		(0.13)	(0.32)	(0.58)	(0.03)	(0.08)	
F	3.100	0.670	1.960	1.940	6.270		1.960	0.650	1.470	1.360	5.060	
R-square	0.404	0.128	0.300	0.299	0.224		0.301	0.124	0.244	0.230	0.189	

Notes: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics.

Table A4-4: Nutrient Demand Estimates (continued)

Independent Variables	Dependent Variable: Log of											
	Calcium						Iron					
	L	H	PH	P	Pooled	Chow	L	H	PH	P	Pooled	Chow
Real income/AE	0.128	0.097	0.160	0.276	0.198	1.630	0.209	0.012	0.087	0.157	0.129	2.680
	(0.97)	(0.76)	(1.08)	**(2.11)**	**(3.28)**	*(0.13)*	**(2.36)**	(0.10)	(0.87)	(1.30)	**(2.61)**	***(0.01)***
Price	-0.927	1.269	0.136	-0.121	0.292	1.090	-1.830	0.399	0.354	-1.023	-0.203	1.990
	(1.05)	**(2.69)**	(0.16)	(0.12)	(0.87)	*(0.37)*	**(3.10)**	(0.87)	(0.63)	(1.12)	(0.74)	***(0.06)***
P*millet-sorghum*	-0.368	-0.062	-0.318	0.022	-0.157	1.220	-0.730	-0.015	-0.621	0.010	-0.240	4.460
	(1.48)	(0.40)	(1.15)	(0.09)	**(1.67)**	*(0.30)*	**(4.38)**	(0.10)	**(3.34)**	(0.04)	**(3.11)**	***(0.00)***
P*beef*	0.070	-0.058	0.059	-0.096	0.014	0.830	-0.150	-0.052	-0.112	-0.116	-0.114	1.520
	(0.37)	(0.30)	(0.28)	(0.55)	(0.16)	*(0.56)*	(1.19)	(0.28)	(0.78)	(0.72)	(1.55)	*(0.17)*
P*dryfish*	-0.170	-0.236	-0.434	-0.224	-0.293	2.820	0.131	-0.021	-0.176	0.038	-0.020	1.810
	(1.16)	**(2.08)**	**(2.65)**	(1.02)	**(4.19)**	***(0.01)***	(1.33)	(0.19)	(1.60)	(0.19)	(0.35)	***(0.09)***
P*leaves*	-0.223	-0.267	-0.148	0.028	-0.144	2.140	-0.129	-0.137	-0.023	-0.032	-0.047	1.450
	(1.87)	**(2.63)**	(1.69)	(0.26)	**(3.14)**	***(0.04)***	(1.61)	(1.38)	(0.40)	(0.32)	(1.25)	*(0.19)*
AE	-0.124	-0.154	-0.198	0.013	-0.111		-0.060	-0.010	0.014	0.027	0.030	
	(1.06)	(1.49)	(1.58)	(0.12)	(2.08)		(0.77)	(0.10)	(0.16)	(0.26)	(0.68)	
(Constant)	14.485	2.445	9.677	6.627	6.841		16.409	2.151	5.618	8.249	5.623	
	(2.52)	(0.88)	**(2.22)**	(1.25)	**(3.59)**		**(4.25)**	(0.79)	**(1.91)**	(1.68)	**(3.60)**	
F	1.220	3.050	2.340	0.900	7.100		4.470	0.410	2.360	0.700	3.250	
R-square	0.211	0.400	0.338	0.164	0.246		0.494	0.082	0.340	0.133	0.130	

Notes: L = August = lean season, H = November = harvest, PH = February = post-harvest and P = May = planting; T-values are reported in parentheses; bold t-values indicate that the estimated coefficients are statistically significant at the 10 percent level; P-values for the Chow test are in italics.

CHAPTER 5

SUMMARY, POLICY IMPLICATIONS, AND DIRECTIONS FOR FUTURE RESEARCH

5.1. Introduction

Mali's market liberalization reforms, initiated in the 1980s, have improved the availability of cereals in most markets. However, economic accessibility remains a problem for households, partly because the reforms resulted in higher and more variable food prices. The seasonal variations in food prices translate into seasonal changes in urban households' real incomes, which in turn affect the quantity (level) and quality (nutrition) of food available in these households.

This study tested the hypotheses that Bamako households' consumption patterns are responsive to changes in their real incomes and relative prices and that the income and price response of demand for commodities and nutrients will change from one season to another.

The primary objective of this study was to examine the impact of seasonal changes in Bamako households' real incomes and relative prices on their consumption patterns using the complete demand systems approach and household-level panel data. The specific objectives of the study were:

1. To describe households' seasonal changes in expenditure/consumption patterns and nutrient availability for households in Bamako;
2. To estimate income and price elasticities of demand for various commodities and commodity groups for different seasons and test whether there is evidence of seasonal changes in income and price responsiveness; and

3. To estimate price and income elasticities of demand for various nutrients across seasons and assess the stability of the estimated parameters across seasons.

The impact of seasonal changes in Bamako households' real income and relative prices on their consumption patterns has not previously been investigated in Mali. Therefore, this study, through the estimation of disaggregated consumption parameters, attempts to make a significant contribution to food policy formulation in Mali. The panel data used in this study is from a 2000-2001 survey undertaken in Bamako by the Direction Régionale du Plan et de la Statistique (DRPS) of the Direction Nationale de la Statistique et de l'Informatique (DNSI) and the Projet d'Appui au Système d'Information Décentralisé du Marché Agricole (PASIDMA) of Michigan State University (MSU), the Assemblée Permanente des Chambres d'Agriculture du Mali (APCAM), and the Centre d'Analyse et de Formulation de Politiques de Développement (CAFPD). The same 40 households were interviewed in a survey that was conducted in four rounds over a period of one year starting in August 2000 to May 2001 for the capital city, Bamako.

This chapter begins with a summary of the main findings of the study and the policy implications and ends with a discussion of its limitations and scope for future research.

5.2. Summary of Main Findings

5.2.1. Essay I (Chapter 2): Seasonal Changes in Expenditure Patterns and Nutrient Availability for Households in Bamako, Mali: A Descriptive Analysis

The descriptive analysis revealed that Bamako households' mean real expenditures vary considerably across seasons. Households' mean weekly real expenditures per adult equivalent are highest in August, the lean season, due in part to large remittances received at that time and are lowest during in May, the planting season. They decrease by 36 percent between the lean and post-harvest season (August and November), increase by

4 percent between the harvest and post-harvest season (November and February), and drop by 18 percent between the post-harvest and planting season (February and May).

Total real expenditures were disaggregated into food and non-food expenditures in order to uncover the causes of the strong seasonal changes in expenditures. The results indicated that much of the observed seasonal variation in expenditures could be attributed to changes in non-food expenditures, as food expenditures remain fairly stable across seasons. There are two possible explanations, which are not mutually exclusive, for the observed seasonal variation in non-food expenditures. The first is that households may attempt to smooth their food consumption levels across seasons by incurring large changes in their non-food budget. This can be explained by the fact that these households, especially poor households, consume near subsistence levels of food, thus are more likely to make large cutbacks in their non-food expenditures because this is the only way for them to maintain their food consumption levels. However, the observed seasonal variation in non-food expenditures could also be due to the seasonality of demand for non-food commodities. For instance, households' expenditures on clothing and footwear are generally highest in August as they prepare for the school year, which begins in September, and during periods of religious festivities, such as the Tabaski. Hence, the issue for households could either be one of smoothing consumption in the face of variable income and/or one of meeting seasonally high expenditure requirements in the face of relatively stable income. One must keep in mind that, given the extreme level of poverty that prevails in Bamako, households will have limited scope for discretion with respect to their spending.

The results on nutrient availability, showed that Bamako households' diets are overwhelmingly based on starchy staples, in this case cereals, as average annual carbohydrate availability exceeds the FAO recommended dietary allowance (RDA) by 36 percent. The results showed that the average annual calorie availability in urban households slightly exceeds the FAO's minimum daily energy requirement of 2,200 kcal per adult equivalent *but* only households in the high-income group attain this consumption level. In addition, there are some significant micronutrient (vitamin A, vitamin C, and calcium) deficiencies persisting in Bamako, even in high-income households. Bamako households can only satisfy about 60 percent of the RDA for Vitamin A, 73 percent of the RDA for vitamin C, and 42 percent of the RDA for calcium. However, these estimates of nutrient availability were solely based on the at-home food consumption data. Sensitivity analyses were performed to assess the effects of including estimates of nutrient availability from away-from-home foods on average daily nutrient availability. The results show that if away-from-home foods were taken into account, average nutrient availability in Bamako households would increase by 9.5 percent. The results also indicate that all income groups would now be able to meet minimum daily calorie requirements, but only the high-income group would be able to satisfy the recommended dietary allowance (RDA) for protein. Moreover, the increase in the amounts of vitamin A, vitamin C, calcium, and iron will not be enough for households in all income groups to meet the RDA for these nutrients.

Furthermore, the results indicate that the household availability of all nutrients varies considerably across seasons. The greatest variation in nutrient availability is observed between the post-harvest and planting seasons, and the smallest variations are registered between the harvest and post-harvest seasons. A close examination of nutrient availability in urban households revealed that food consumption smoothing was also achieved through substitutions between and within food commodity groups. These adjustments result in large variations in the quality of food available in the household, as measured by protein, carbohydrate, and micronutrients' availability. The results indicated that seasonal variations in micronutrients (vitamin A, vitamin C, and calcium) are much more pronounced than seasonal variations in calorie availability. Households maintain their calorie availability somewhat constant during the year by making substantial changes in the consumption of foods that contain essential micronutrients but few calories (i.e., meat, fish, and vegetables). The results indicate that Bamako households diversify their diets, through greater consumption of non-staple commodities, only during periods of greater food availability in urban markets, when food prices are relatively low (i.e., harvest and post-harvest seasons).

5.2.2. Essay II (Chapter 3): Estimating the Impact of Seasonal Changes in Real Incomes and Relative Prices on Households' Consumption Patterns in Bamako, Mali, Using the Almost Ideal Demand System Model

In this essay, the Almost Ideal Demand System was applied to a three-stage demand model for different seasons in order to estimate the impact of seasonal changes in Bamako households' real incomes and relative prices on their consumption patterns. First, the results indicate that price, income, and household size factors account for a substantial part of the observed variation in the budget share devoted to the commodities considered in the Stage I (total expenditure allocation), II (food expenditure allocation), and III (staple expenditure allocation) models.

Second, the study finds that Bamako households' consumption is responsive to changes in real incomes and relative prices in any given season and that that there are seasonal changes in income and price responsiveness for all the commodities in the three demand models. This implies that the impact of a uniform food policy on the quantity and quality of food available in Bamako households will vary by season.

Third, the fact that the responsiveness of food and staples' consumption to changes in real income remains fairly stable across seasons compared to that of non-food and non-staple commodities indicate that Bamako households engage in food consumption smoothing from seasonal shocks in real incomes. Food consumption smoothing was achieved at the expense of non-food commodities such as health and durable goods (housewares and education), of non-staple foods, and through significant substitutions among and between broad commodity groups.

Fourth, the estimated price elasticities indicate that (1) the price of food has strong and statistically significant uncompensated effects on the demand for non-food commodities, such as health and education; (2) the price of staples has striking impacts on the demand for non-staple foods, which are sources of high-quality protein and micronutrients and; (3) the price of rice has a positive effect on the consumption of maize, meaning that rice and maize are net substitutes.

5.2.3. Essay III (Chapter 4): Estimating the Effects of Seasonal Changes in Real Incomes and Relative Prices on Households' Demand for Nutrients in Bamako, Mali

In this essay, the effects of seasonal changes in Bamako households' real incomes and relative prices on their consumption patterns were examined using Engel functions. First, the results indicate that price, income, and household size factors account for a substantial part of the observed variation in the demand for nutrients in Bamako households. The R^2 ranges from 12 to 51 percent for calories, 13 to 40 percent for protein, 12 to 30 percent for vitamin A, 16 to 40 percent for calcium, and 8 to 49 percent for iron.

Second, the estimated results show that the demand for nutrients is responsive to changes in real incomes and relative prices. Out of 35 estimated nutrient-income elasticities, 22 are statistically significant at least at the 10 percent significance level. Out of 175 price parameters, 40 are statistically significant at least at the 10 percent significance level. Moreover, the null hypothesis of stability in the nutrient-income demand parameters across seasons was rejected at the 10 percent level for all the estimated coefficients, except for calcium, suggesting that there is a statistically significant shift in the response of nutrient demand to income changes across seasons. This means that the impact of changes in income on the demand for nutrients is not constant across seasons. The Chow test results also indicate a certain degree of non-constancy of many price parameters across seasons as the test of stability in the price coefficients was rejected at the 10 percent level for 13 out of 35 estimated coefficients. The results show that increasing households' incomes will improve the quantity (i.e. calories) and the quality (protein, minerals, and vitamins) of food available in those households in any given season. In addition, the income and price responsiveness of calories from staples remain stable across seasons while, that for calories derived from other foods, calcium, and vitamin A varied quite substantially.

5.3. Policy Implications

The findings of this dissertation have several implications for development planning in Mali. First, the fact that the empirical analysis substantiates Engel's Law (i.e., the demand for food is income inelastic), suggests that in the course of economic growth in Mali, the focus of economic activity will shift away from the agricultural sector. The high absolute level of the food and non-food income elasticities suggests that (a) this shift will be slow and (b) policies that aim at increasing households' real income will result in substantial improvements not only in the quantity of food available in urban households but also in the demand for non-food commodities. Rapid growth in the demand for non-food commodities could translate into sizable rise in employment, to the extent that these commodities can be produced domestically. In addition, the relatively high-income elasticities for food suggest that in the initial stages of growth, the demand for food will continue to grow rapidly, especially for vegetables and animal products, both of which can generate substantial employment.

Second, the results indicate that changes in the price of food, which are mainly driven by variations in the price of cereals, will substantially increase or decrease households' real incomes, as Bamako households allocate a sizeable proportion of their budget to food. The resulting real income-induced impact of volatility of the price of food has strong effects on the demand for non-food commodities, such as health and education. These findings suggest that policies that affect food prices, more specifically cereals' prices, through their impact on households' purchasing power, will have repercussions on households' access to health and education services. Thus, the country's development policies need to be based on a multisectoral approach, in that these policies need to be designed to systematically take into account the linkages between various sectors of the economy.

Third, the results revealed that rice dominates Bamako households' diets despite the fact that it constitutes a more expensive source of calories than other staples (millet, sorghum, and maize) and that there are some significant nutrient and micronutrient (vitamin A, vitamin C, iron, and calcium) deficiencies persisting in Bamako. These findings suggest that, given the importance of rice in Bamako households' diets and the presence of very significant shortages of micronutrients, successful breeding strategies to incorporate these micronutrients into rice might have a high payoff, in terms of reducing malnutrition in these households.

Fourth, the empirical results for food commodity groups showed that as Bamako households' real income increases, they will increase their expenditure on non-staple commodities (e.g., meat and fish and vegetables) more rapidly than on staple foods. As a consequence, Bamako households will diversify their diets, through greater consumption of non-staple commodities, as their income grows. The empirical analysis on nutrient demand also showed that increasing households' incomes will improve the quantity (i.e. calories) and the quality (protein, minerals, and vitamins) of food available in those households in any given season. This implies that policies that aim at increasing households' real incomes will also be an effective mechanism in reducing malnutrition. These findings suggest that the pattern of production within the agricultural sector will have to change with economic growth, as increased specialization in livestock and horticultural production will be required. Hence, greater allocation of resources and investment in the production and marketing of horticultural commodities has the potential to substantially reduce malnutrition, especially vitamin A deficiency, increase employment, and reduce poverty in urban areas. This is feasible because commercial production of horticultural goods is largely concentrated in the peri-urban zones due to the perishable nature of these commodities and underdeveloped market and road infrastructure. Also, production and marketing activities, mainly performed by women, are small in scale and are dominated by low-income households (Morant and Caldwell (1998)).

Fifth, one of the main objectives of this study was to estimate income elasticities of demand for various commodities and commodity groups for different seasons in order to investigate whether there exists, in the Malian context, any self-targeting foods (i.e., inferior goods). The results indicate that there are no inferior goods in the commodities studied. This finding, consistent with the findings of previous consumption studies (Rogers and Lowdermilk, 1991 and Reardon et al., 1999), point to the fact that as Bamako households' income increase, the immediate concern is to increase the quantity of food consumed. This underscores the fact that in Mali the consumption patterns of the poor and rich are very similar. High-income households tend to consume more of the same type of foods that poor households eat, even if some diversification of the diet is evidenced at higher income levels.

Finally, the finding that the response of households' consumption patterns to changes in real income and relative prices was not stable across seasons implies that the impact of a uniform food policy will vary by season. Moreover, " a government that decrees uniform prices for the entire year usually finds itself handling the entire marketed surplus rather than just a small margin to dampen high prices." (Timmer et al., 1983, p. 68). Therefore, the effectiveness of food and nutrition interventions (e.g., food-for-work programs, general food price policy) could be substantially improved through temporal targeting mechanisms in order to reduce transitory food insecurity in households. Examples of targeting mechanisms to increase low-income households' access to food include seasonal income transfers to low-income households and seasonal imports of rice. "With successful temporal targeting of food subsidies, the significant welfare gains from improving the seasonal distribution of food consumption have both economic and nutritional components." (Timmer et al., 1983, p. 68).

5.4. Directions for Future Research

There are three main issues that can be addressed in future research. First, further investigation of the finding that the demand for maize is highly elastic is needed. Identifying the factors that are driving the high price elasticity of demand for maize has implications pertaining to the expansion of maize consumption as a substitute for rice. Future research in this area will help determine if there is indeed scope for focusing on maize as a potential substitute for rice, since more technology exists to increase maize production in the short to medium run than for millet-sorghum.

Second, this study was solely based on data collected in the capital city of Bamako. How seasonal changes in real incomes and relative prices affect the consumption patterns of households in other urban and rural areas is still uncertain at this time. Therefore, similar studies of consumption patterns in areas of Mali with different economic characteristics could provide substantial knowledge that can be instrumental in the formulation of national development policies.

Third, the data used in this study was gathered at the household level and could not be used to assess the effect of price and income changes at the individual level. The present study was also not able to investigate the issue of food distribution within the household. Future consumption studies can be systematically designed to obtain information on the distribution of food within the household, with special emphasis on food away from home consumption. This may allow the identification of vulnerable groups (i.e. children, pregnant and lactating women, and the elderly) in low-income households. Strauss and Thomas (1995) have examined the allocation of food within the household and have found that there exists gender bias in intra-household resource allocation (e.g., males are favored over women). Gathering such information will also permit the analysis of the nutritional status of household members, which require information on nutrient intake, rather than focusing on nutrient availability. The effect of income and price on individual nutrient intake could be useful in designing food and nutrition policies.

REFERENCES

Morant, Mervalin and Caldwell, John S. (1998). Peri-urban Horticultural IPM Research in the OHVN Zone of Mali: Bio-control Methods for Green Bean Seedbed Disease Control and On-Farm Trial Monitoring. IPM CRSP University of Maryland and Virginia Tech trip report.

Timmer et al. 1983. *Food Policy Analysis*. Published for the World Bank. John Hopkins University Press.