TRENDS AND DETERMINANTS OF FOOD CONSUMPTION PATTERNS IN WEST AFRICA

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A DISSERTATION

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

Agricultural, Food and Resource Economics – Doctor of Philosophy

2014

ABSTRACT

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This dissertation examines food consumption patterns in the Economic Community of West Africa States (ECOWAS). The study provides detailed information on food demand parameters, which are critical to improving policymakers' ability to make sound food policy decisions. Chapter 2 analyzes per capita food availability data from FAO's food balance sheet (FBS) from 1980 through 2009. It identifies major contributors to diets and documents shifts in levels and composition of food supply at the country level. The analysis reveals: 1) a trend towards greater per capita calorie supplies for most countries; 2) a diversification in the composition of food supply; 3) a cassava revolution in some Coastal Non-Sahelian countries; 4) some diet upgrading in terms of protein availability; and 5) growth in daily fat supply per capita for most countries.

Chapter 3 estimates the effects of urbanization and gross domestic product per capita on starchy staples (SS) demand in Senegal, Mali and Benin using an Error-Corrected Linearized Almost Ideal Demand System. Short-run and long run-elasticities are estimated using per capita food availability data obtained from FAO's FBS and supplementary data. Support for a statistical association between urbanization and SS demand is found only in the case of millet in Mali. The results suggest mixed evidence on the effect of relative prices on SS demand and on substitution between coarse grains and rice. Evidence also supports more expenditure-elastic demand for millet and sorghum than for rice in Senegal and Mali, contrary to conventional expectations.

Aggregate-level analysis of food demand ignores the effects of the distribution of income and of differences in food supply across regions on food demand. As a result, Chapter 4 uses Mali's 2006 household budget survey data to estimate a censored Quadratic Almost Ideal Demand System model for cereals in Mali. Cereals demand parameters are estimated by rural/urban location and by income group. All expenditure elasticities were positive, as expected. Uncompensated own-price elasticities also support downward-sloping demand curves for all cereals. The results suggest high substitution between rice and coarse grains in both the rural and the urban areas and across income groups.

Chapter 5 measures the welfare effects of cereals price shocks observed from 2008 to 2011 by means of a proportional compensating variation that allows for second-order demand responses to cereal price changes. Across all income groups and place of residence, the full effect is only slightly lower than the first-order effect. This reflects the fact that during this period all cereals prices were rising sharply, limiting the scope for substitution to "cheaper" cereals. Without considering the possibility of producer supply response in the rural areas, the magnitude of the welfare loss was higher for rural households than urban households. In both the rural and the urban areas, the welfare loss from observed price changes, in terms of relative share of income affected, was greater for poorer households than richer households from 2008 to 2011. However, the absolute income loss was greater for the higher income groups. The findings present a scope to encourage ongoing diversification of staple food sources to give consumers more opportunity for substitution and choice. Price transmission across cereals suggests a need for a cereals policy rather than just, for example, a rice policy. The results suggest strong future growth in demand (pressure on prices if supply is not increased), and a need to focus on driving down unit costs throughout the food system.

To My God who makes all things possible!
Unless the Lord builds the house,
They labor in vain who build it;
Unless the Lord guards the city,
The watchman stays awake in vain. (Psalms 127:1)

ACKNOWLEDGMENTS

I am greatly indebted to my major professor and dissertation supervisor, Dr. John Staatz, for his guidance and encouragement during this dissertation process. I also wish to express my gratitude to my other committee members, Dr. Robert Myers, Dr. Songqing Jin, and Dr. Kimberly Chung for their useful feedback. I acknowledge the work of FAO for making available to researchers the FBS data upon which a part of this dissertation is based. Many thanks to Dr. Nango Dembele and Dr. Boubacar Diallo for moral and academic support. Enormous thanks to Maurice Taondyandé (IITA/RESAKSS) who provided the household budget survey used in this research, and was willing to respond to data queries. My gratitude to Steve Longabaugh for encouraging me and for generating the map used in this research. I am grateful for financial support received from the Syngenta Foundation for Sustainable Agriculture through the Strengthening Regional Agricultural Integration project with MSU, under which this research took place. I also would like to thank the following AFRE faculty who supported and encouraged me throughout my stay at MSU: Drs. Scott Swinton, Roy Black, Eric Crawford, Valerie Kelly, Colletta Moser, Cynthia Donovan and Veronique Theriault. Special thanks to Debbie Conway for moral support and for always making things easier. A special thanks to my colleagues and friends, Ramziath Adjao, Helder Zavale, Berthe Abdrahamane, Milu Muyanga, Jordan Chamberlin, Mukumbi Kudzai, and Vivek Pandey, who were always available to share their knowledge and expertise, and whose friendship was a source of strength throughout this process. Heartfelt thanks to my son, Karsten for cheering me along the way; to my mom–for all the sacrifices of love; and to my siblings, nieces and nephew. I thank my A/G church family and childhood friends for the love and prayers. Many thanks to Patricia Johannes for editing and formatting this work.

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KEY TO ABBREVIATIONS

ADF–Augmented Dickey-Fuller

AIDS–Almost Ideal Demand System

CDF–Standard Normal Cumulative Distribution Functions

CFA franc–Common Currency for West African States

CV–Proportional Compensating Variation

DEA–Daily Energy Availability

ECLAIDS–Error Corrected Linearized Almost Ideal Demand System

ECOWAS– Economic Community of West African States

ELIM–Enquête Légère Intégrée Auprès des Ménages

FAO–Food and Agricultural Organization of the United Nations

FBS–Food Balance Sheet

GDP–Gross Domestic Product

HBS–Household Budget Survey

HH–Household

HHH–Household Head

IV–Instrumental Variable

KPSS–Kwiatkowski–Phillips–Schmidt–Shin tests

MPC–Marginal Propensity to Consume

OLS–Ordinary Least Squares

OMA–Observatoire du Marché Agricole

PDF–Standard Normal Probability Density Function

PP–Phillips-Perron

QUAIDS–Quadratic Almost Ideal Demand System

R&T–Roots and Tubers

SAP–Structural Adjustment Programs

WA–West Africa

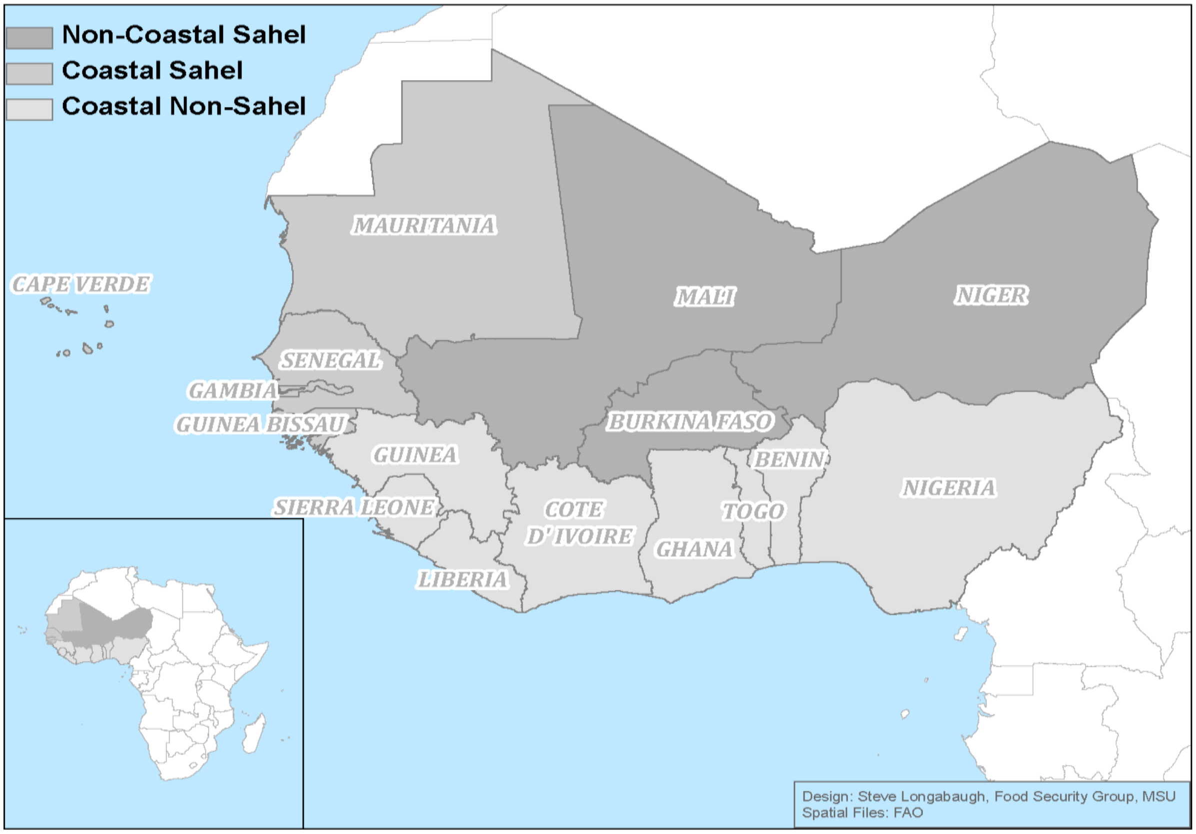
CHAPTER 1. INTRODUCTION

1.1. Issue and Background

The region of West Africa (WA) includes 16 countries: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo. A map of WA is available in Figure 1-1. With the exception of Mauritania, all of these countries are members of the Economic Community of West African States (ECOWAS). This study focuses on ECOWAS member countries since ECOWAS has a major role in defining agricultural policy for the region.

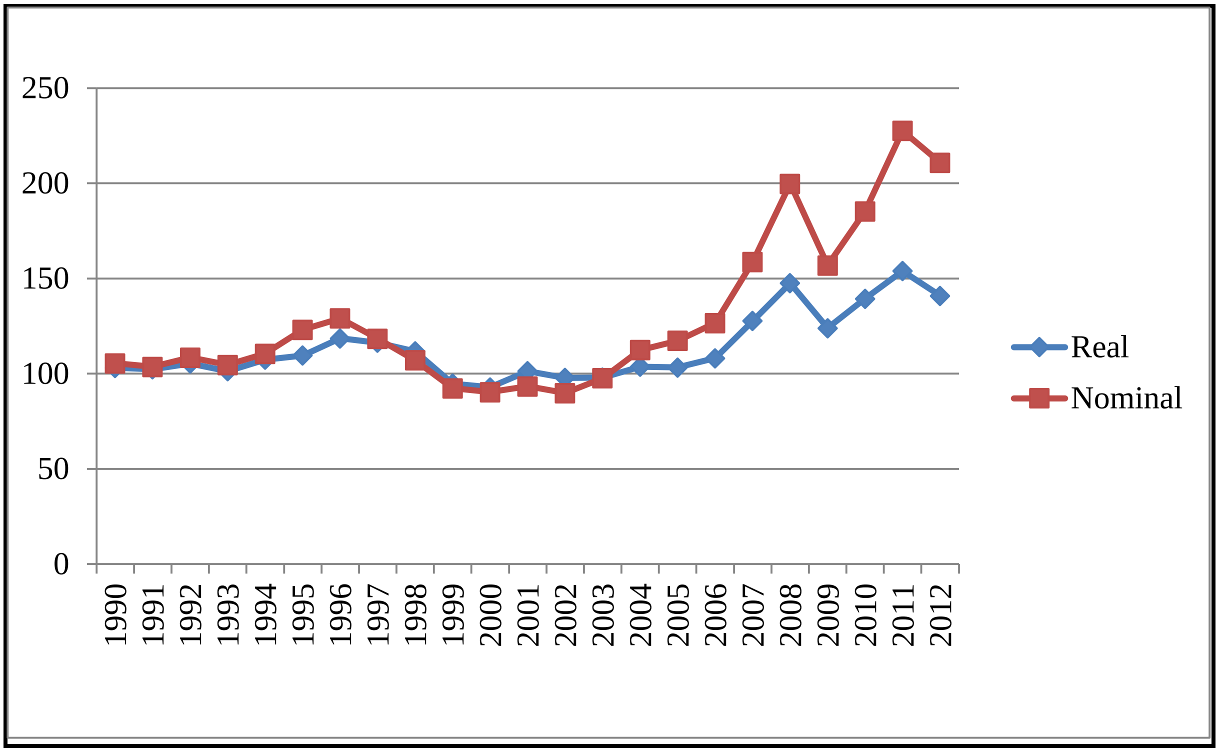
WA has undergone rapid changes in its social and economic environment during the last 25 years, resulting in shifts in food consumption patterns. Some of these changes include urbanization, growth in per capita incomes, population growth, in a few countries a demographic transition towards smaller family sizes, migration within the zone towards the coastal states, and the adoption of more western lifestyles (Lopriore and Muehlhof, 2003; Satterthwaite et. al, 2010). In addition to the aforementioned structural factors, the region has undergone policy shifts that constituted major changes in the conditions that determine demand. Examples of these include the Structural Adjustment Programs (SAP) and the 1994 CFA franc devaluation that brought about changes in relative cereal prices, thereby increasing the domestic price of rice relative to that of the local coarse grains (Camara, 2004).

Figure 1-1. Map of West Africa



The 2007-2008 global food crisis brought renewed attention to food consumption patterns worldwide and in particular in developing countries. The main symptom of the crisis was a large upsurge in international prices for the main staple foods, principally maize, wheat, rice, and soybeans, thus triggering world-wide concerns about threats to global food security (Joseph and Wodon, 2008). From a global perspective, the increase in food prices has been attributed to several factors (see Kelly, et al. 2008; Joseph and Wodon, 2008, and Staatz et al. 2008). Kelly et al. (2008) also offered an explanation for the food price crisis from a Sahelian perspective, showing how the manifestation of the food crisis has been different in this region. Since 2008, world staple food prices have remained at high levels by historical standards. An examination of the Food and Agricultural Organization (FAO)'s food price index (see Figure 1.2), a measure of the change in international prices of a basket of food commodities, shows that in 2011 the index rose above its 2008 peak. The index dropped in 2012 (nominal terms) but still remained generally higher than its 2008 level.[1]

Figure 1-2. Annual Food Price Index (2002-2004=100)



Source: Author's computation using FAO's food price index.

The circumstances of the global food crisis in WA, which previously relied on cheap food imports for a substantial part of its staple food supply, have been unique.[2] As observed by

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[1]FAO, Food Price Index: http://www.fao.org/worldfoodsituation/FoodPricesIndex/en/.
[2] The deregulation of domestic food markets and the liberalization of agriculture experienced as part of the SAP in the region forced most of West African nations into competition in the world food markets with developed country producers that produced at lower costs and sold at lower prices, sometimes due to substantial subsidies provided to their farmers and exporters.

Staatz et al. (2008), trade bans and high international food prices pushed many West African countries away from their historical reliance on regional and international trade as a key component of their food security strategies, thereby leading many governments to conclude that the risks were very high in depending on the international market for staples. Kelly et al. (2008) also observed that in the Sahel region, the impact of the food price crisis on household consumption has been differentiated according to each country's food consumption profile and food supply. However, in spite of production shortfalls in some countries, there is a strong potential for production stability at the regional level (Kelly et al. 2008).

1.2. Problem Statement

Food demand is determined by factors at the national (aggregate), the intermediate, and the household (micro) level. Aggregate-level determinants of food consumption include population, urbanization, per capita incomes and overall changes in lifestyle. Intermediate-level determinants include factors such as cultural changes that affect changes in tastes and preferences. Household-level factors include households' economic and socio-demographic characteristics such as household composition (size, age and sex), income level and geographic location. Households therefore differ among themselves in food consumption behavior and, in particular, in their response to changes in market conditions. The analysis of food consumption provides information on: 1) food demand elasticities (own-price, cross-price and income elasticities); 2) differences in demand patterns by urban/rural location, by geographical region, by socio-economic group and across households of different demographic composition. Such an analysis also provides parameters needed to understand the adjustments of consumption in the macro food economy.

Knowledge of food demand parameters and of how consumption patterns have changed over time is critical for informed policy making. However, in WA, information on food demand parameters is limited, thus restricting policymakers' ability to make sound food policy decisions. One ultimate goal of the analysis of food consumption patterns is to improve the efficiency of government interventions by providing policymakers, for example, with suggestions for the design of safety nets compatible with targeting people based on the nature and extent of food insecurity. According to Kelly et al. (2008), the greatest challenge in the design of policies and programs that will help households cope with the rising food prices is the identification of vulnerable groups so that targeting would be towards the neediest and not towards the most vocal constituencies.

A major concern has been that the price hikes for internationally traded food products are being transmitted to local cereals such as millet, maize, and sorghum due to substitutions in production and consumption. For instance, Joseph and Wodon (2008) observed that just as the prices of imported food products–rice and wheat—have been increasing, the prices of other foods that might be thought of as substitutes (millet, sorghum and maize) in Mali have also increased recently. They attributed this change to increases in cost of production and alternate demand for grains (animal feed). Diallo et al. (2010) found that 33% of price increases have been transmitted from international to local markets in WA, mainly for rice and wheat. However, the impact varies: countries with coastline (Guinea, Ivory Coast and Senegal) are more affected than landlocked ones (Mali, Niger and Burkina (Diallo et al. 2010). This difference is likely a result of differences in the cost of inland transport, since in absolute terms the transmission may be similar across countries. Food price transmission from international to African markets also differs across commodities (Minot, 2010).

Historically, cereals have represented a large share of total household consumption in the Sahel. Staatz et al. (2008) observed a growing demand for cereals in WA and attribute this to population growth, urbanization and consumers' demand for more products (including livestock products) that require cereals as intermediate inputs as income increases. Given the importance of grains in the West African food basket, a major source of concern in the context of rising food prices is the possible reduction of consumption levels whereby households may be forced to reduce both their food consumption in response to the price surge and other longer-term non-food expenditures in order to meet basic needs. Camara (2004) found 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 expenditure items such as health and education. Data limitations prevent an actual examination of food consumption behavior following the 2007-08 food crisis. However, using Mali's 2006 household budget survey (HBS) data as a base year, this study examines the possible effects of cereal price shocks on household welfare for different segments of the population.

Changing food consumption patterns also have implications for agricultural market development, currently a priority for WA's development agenda. With urbanization and the growing urban middle class in WA, understanding how these patterns have changed (in level and diversity), whether new food groups are emerging as important sources of household food energy consumption and whether the traditional cereal habits persist, will help identify opportunities and challenges for the development of agricultural value chains to meet the growing effective demand. The findings of this study will contribute to the knowledge base and policy dialogue at regional and national levels on key policy issues concerning the evolution of agri-food systems.

1.3. Research Objectives

The overall objective of this study is to investigate the trends and determinants of food availability and consumption patterns in WA. The study is based on three major hypotheses: i) over time there have been changes in the levels and the composition of consumption resulting from changes in structural factors like urbanization and increases in per capita incomes; ii) household food consumption behaviors are influenced by market conditions (food prices), household social, economic and demographic characteristics as well as the geographic region and place of residence of the household; and iii) the welfare effects of a food price change varies across households of different characteristics. The specific objectives of the study are:

- To describe aggregate-level trends in per capita food availability in WA in the period 1980-2009 (Chapter 2).
- To estimate aggregate-level determinants of starchy staples demand in selected countries in WA (Chapter 3).
- To estimate food demand parameters for urban and rural Malian households (Chapter 4).
- To examine the welfare effects of cereal price shocks on cereal demand (Chapter 5).
- To draw some implications for food security policy decisions (Chapter 6).

1.4. Literature Review and Research Gap

Numerous research efforts have been made over time to understand shifts in food consumption patterns in WA. These efforts were undertaken in 3 major eras: 1) the 1980s and early 1990s (pre-CFA franc devaluation); 2) post-1994-CFA franc devaluation through 2006; and 3) the period following the 2007-2008 food price crisis. Generally, these studies have sought to provide aggregate and micro-level evidence of shifts in food consumption.

The 1980s and early 1990s was a period characterized by heavy reliance on imports for household food grain needs. The heavy reliance was attributed to the declining competitiveness of WA food production relative to other producers in the world. A major research question during the 1980s and 1990s was whether the high consumption of imported rice and wheat was caused by relatively low rice and wheat prices. A key finding during this period was that the consumption of imported grains (especially rice) was not driven by relative cereal prices (Reardon et al. 1988[3] ; Delgado, 1989[4]; and Rogers and Lowdermilk, 1991[5]). According to Delgado and Reardon (1992), the switch to rice consumption in the West African Semi-Arid Tropics appeared to be driven more by structural factors than by shorter-run factors such as harvest shortfalls or price dips. They concluded that rice and wheat prices would have to increase very substantially over those of millet and sorghum before encouraging shifts in consumption back to coarse grains.

The 1994 devaluation of the common currency of many West African countries represented a major policy shift that changed the conditions that determine demand. An intended consequence of the devaluation was to raise the costs of all tradable goods relative to non-tradable goods and reverse the trend in cereal demand from imported to locally produced grains. Evidence based on post-devaluation studies suggests relatively low rates of substitution of coarse grains for rice in urban centers of the Sahel. Diagana et al. (1999) studied urban WA consumption patterns (Mali, Burkina Faso, Senegal and Cote d'Ivoire), and they found that the general pattern was a reduction in cereal intake (actual quantity consumed in kilograms), but the

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[3] Using data household-level data from urban Burkina Faso.
[4] Using country level data for Burkina Faso, Cote d'Ivoire, Mali, Niger and Senegal.
[5] Using household-level data from urban Mali.

expected shift from imported rice to local coarse grains as a result of price hikes for imported cereals did not occur in these countries, with the exception of Burkina Faso. The lack of such a shift was attributed to the lackluster supply response of the coarse grain sectors and the resilience of rice demand based on its convenience of processing and preparation for the urban consumer. Camara (2004) investigated the impact of seasonal changes in real incomes and relative prices on households' consumption patterns in Bamako, Mali. She found 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 commodities in the three demand models she estimated.

Evidence on food consumption patterns in WA following the 2007-2008 food price crisis is relatively thin. Joseph and Wodon (2008) examined patterns of food consumption in Mali to understand differences across households groups as defined by their level of consumption and, in particular, the differential impact on poverty of higher food prices. They assumed that the cost of an increase in the price of a food commodity for a household translates into an equivalent reduction of its consumption in real terms (unit-own price elasticity). They neither estimated nor took into account the own-price or cross-price elasticities of demand, which may lead to substitution effects and thereby help offset part of the negative effect of higher prices for certain food items. They assumed constant relative prices and argued that the substitution of millet, sorghum, and maize for rice and wheat is likely to be low in any case, due to the fact that all these products are important in the diet of the population and that the prices of the various food items seem to increase in parallel at least in the medium term (so that it is not clear that households can offset the loss in purchasing power associated with the price increase by shifting to other foods). They admitted the roughness of their approach and the possibility of slightly overestimating the impact on poverty of changes in prices.

Taondyandé and Yade (2012) examined, using descriptive and econometric approaches, how food consumption patterns had changed over time with increased per capita incomes and the growth in urban population. They also examined how food demand prospects would likely change as a result of changes in per capita income and by place of residence. Specifically, they estimated the additional demand for food (marginal propensity to consume, MPC) from an increase in per capita income as well as income elasticities. However, they do not control for price variation across the sample.

1.5. Research Contributions

The aim of the current study is to build on the Taondyandé and Yade (2012) study in four important ways. Firstly, this study examines aggregate (national) level trends in food availability patterns from national official statistics (as reported through FAO's FBS). In particular, this analysis will help us identify major contributors to food availability as well as identify any new food groups emerging as important contributors to food availability in the region.

Secondly, the study examines aggregate-level determinants of starchy staples demand in selected countries using a theoretically appropriate framework of analysis. In particular, aggregate-level demand parameters are obtained by estimating, separately for each of the countries considered, the impact of the structural variables and prices on startchy staples expenditures. Aggregate-level food demand analysis provides an understanding of the linkages between macroeconomic performance and food consumption and, through the food marketing sector, incentives for agricultural production. Overall, such an analysis provides a context in which to discuss more narrowly defined changes in food consumption patterns from micro-level analysis.

Thirdly, the current study seeks to provide estimates of price and income elasticities of demand for key food items using household-level data from Mali. Taondyandé and Yade (2012), in their estimates of the MPCs disaggregated by place of residence, ignore the effect of factors other than income that could influence household consumption. Effective design of targeted actions requires knowledge of the distribution of the effects of changes in income as well as factors other than income that determine food demand—food prices being an important one. The current study thus seeks, by means of a multivariate econometric analysis, to investigate the combined effects of the factors influencing food demand, especially for cereals, in Mali.

The parameters of the multivariate food demand analysis (i.e., own-price, cross price and income elasticities) are useful in: 1) characterizing the nature of the different food items (inferior vs. normal) and 2) in computing welfare measures of the effects of cereal price shocks. Both of these serve as vital inputs into characterizing households according to their level of vulnerability to cereal price shocks (and hence vulnerability to food insecurity, given the important role that cereals play in satisfying minimum household food security needs), and in making enlightened suggestions for food security policy. The last contribution of this study is that it examines the welfare effects of cereal price shocks on cereal demand and draws some implications for food security policy decisions.

The remainder of this study is structured as follows: Chapter 2 examines aggregate-level trends in food availability in the ECOWAS member states of West Africa; Chapter 3 examines aggregate-level food demand determinants in Mali, Senegal and Benin; Chapter 4 examines household-level food demand in urban and rural Mali; Chapter 5 examines the welfare implications of cereals price shocks for urban and rural Malian households; and Chapter 6 provides a summary of findings and policy implications.

Table 1-1 summarizes the different measures of food availability, expenditure and consumption used in this study. It is important to note that each of these indicators measures a different aspect of per capita access to food, and care must be taken not to equate the different measures (e.g., assuming that per capita food availability, as measured by food balance sheets, indicates actual food intake).

Table 1-1. Measures of Food Availability and Consumption Used in this Study

Measure	Description	Data Source	Chapter
Food Availability per capita	Measures the annual quantity (kg/capita) of food supply by commodity and also major food groups. This measure is computed by dividing total food supply available for human consumption (thousands of metric tons) for each year by the population for that year. The result is a proxy for foods actually consumed and is particularly useful for examining trends over time. Total food supply for human consumption for each year is in turn computed by deducting from the total domestic supply for each commodity the quantities channeled to other uses–feed, seeds, processing, and other modes of utilization. Domestic supply reflects total annual food production, imports, stocks of commodities, subtracting exports. Food availability data do not, however, typically account for losses through spoilage, plate waste, food preparation practices, or other factors. As a result, they may overestimate consumption.	FAO's–Food Balance Sheet	Chapters 2 and 3
Macronutrient Availability per capita	Measures the quantity of major macronutrient groups–essentially proteins and fats, available for human consumption (grams/capita/day)	FAO's–Food Balance Sheet	Chapter 2 and 3
Food Consumption Expenditures	Measures actual consumption expenditures for different food commodity groups at the household-level. It includes the total value, in local currency, of food purchased by commodity group, the value of food consumed from own-production, as well as the value of food from other modes of acquisition (e.g., gifts and celebrations).	Mali's 2006 Household Budget Survey (ELIM-2006)	Chapters 4 and 5

CHAPTER 2. TRENDS IN PER CAPITA FOOD AVAILABILITY IN WEST AFRICA

2.1. Introduction

Understanding how patterns of per capita food availabilty have changed with changes in urbanization, per capita incomes, population growth, migration within the zone towards the coastal states, and the adoption of more western lifestyles is necessary in identifying opportunities and challenges for the development of agricultural value chains to meet the growing effective demand in the region.

Lopriore and Muehlhoff (2003) documented the most recent evidence (prior to this study) on aggregate per capita food availability patterns in WA from food balance sheets (FBS). They analyzed trends in dietary energy supply and also in the quality and diversity of per capita food supplies. However, their analysis covers only up to the year 2001. This chapter expands and updates the Lopriore and Muehlhoff analysis by providing a more comprehensive and up-to-date picture of the trends in per capita food availability in WA, discussing what is happening in the "big drivers" of change in the region (e.g., Nigeria and Ghana) as well as analyzing shifts in per capita food availability in the context of the social, economic and political changes that have occurred in the region.

2.2. Objectives and Hypotheses

This chapter investigates from national official statistics (as reported through FAO's FBS) aggregate (national) trends in per capita food availability in WA in the period 1980-2009[6]. The analysis is carried out on the 15 ECOWAS member states, and it will help identify major

[6] Most recent FAO food balance sheet data are of 2009.

contributors to the national food supply (in terms of the major food commodities) as well as new food groups emerging as important contributors to the diet. The analysis is intended to test the following hypotheses:

Hypothesis 2.1: As a result of rising per capita incomes, there has been an increase in the level of per capita calorie availability in the past 30 years.

Hypothesis 2.2: In the past 30 years, there has been a diversification in the composition of food supply, whereby new food groups (e.g., roots and tubers in the non-coastal Sahelian West African countries and maize in the landlocked countries) are emerging as important contributors to the daily caloric supply.

Hypothesis 2.3: The contribution of animal protein to total daily protein supply has increased over time as per capita incomes have increased.

Hypothesis 2.4: Based on FAO's recommended daily allowances of various nutrients for a balanced diet, the per capita food supply has become more balanced in terms of macronutrient composition.

2.3. Data and Reliability of Food Balance Sheet Consumption Estimates

Data for the period 1980-2009 per country obtained from FAO's FBS are used for the analysis of aggregate-level trends in per capita food availability. The FBS calculate domestic food supply as production plus imports, plus stocks, and less exports. Not all domestic supply is available as food for human consumption due to other uses – feed, seeds, processing and other modes of utilization. These are deducted from the total, and the remaining supply for food use is converted into estimated per capita availability by dividing the total by an estimate of the country's population. The physical amounts of food available per person are then converted into per capita availability of calories, protein and fat using a food composition table.

The reliability of the FBS as a source of national average per capita food availability estimates has been questioned. For instance, Farnsworth (1961) examined the statistical shortcomings in the construction of food balances and argued that the FBS figures on per capita availability depend on the accuracy of the production, stocks, and population figures, all of which are subject to varying degrees of error across countries. She noted that the cassava production figures deserve special attention, because they illustrate a peculiarly difficult balance sheet construction problem encountered in many African countries. Unlike practically all other staple foods, mature cassava can be harvested at any time over a period of years. Moreover, since cassava usua1ly ranks as a non-preferred food, and since it is often planted for price specu1ation and as a "hungry season" reserve, large quantities are never harvested but remain on land abandoned to bush fallow. Hence, if cassava production is estimated by applying data on sampled yields per acre to the total acreage under cassava, the result is inevitably an inflated "potential production" figure, rather than an indication of the crop harvested in a single year. Farnsworth acknowledged that some allowances were made for this peculiar "cassava estimation problem", as well as for other balance sheet uncertainties, and she presents some other caveats on the using FBS data to estimate actual per capita food consumption. These include:

- The FBS estimates measure "net availability" or "net supplies" of food at the so-called "retail level," and this includes not only food delivered to retail outlets and restaurants, but also food bartered, given away, or immediately eaten after harvesting.

- The estimates represent the broad pattern of total food supplies, and while the estimates indicate important calorie contributors, the data afford no firm basis for determining which of the most important food groups furnishes the largest (or smallest) number of food calories.
- The estimates show whether the hypothetical "average person" of a given country customarily consumes much or very little meat or milk as compared with “average persons" in other countries; whether the specified country depends very heavily or very little on the typical "cheap foods"–cereals and major starchy roots and tubers; whether wheat, rice or some specified cheaper grain is the dominant cereal; and what kind of starchy roots and tubers are most common.
- For many low-income countries, the national average pattern of consumption represents a composite of several distinctly different types of diets consumed by different subgroups of the population (e.g., regional subgroups in Nigeria) and as a result may not yield the best information on subgroup diets (available from good dietary surveys that are representative samples of the population, with complete food coverage and taking adequate account of varying seasonal patterns of consumption).
- The estimates often reflect the underestimation or overestimation of agricultural production –a characteristic of the agricultural statistics of practically all countries. The underestimation could be from incomplete coverage (of crop areas or crops) or tax-related purposes (particularly in low-income countries where taxes are often tied directly or indirectly to farm output). Such crop reporting deficiencies are much greater for subsistence crops than for commercial crops, and greater for minor than major crops, and greater for secondary successive and mixed crops than for single primary crops.

Overestimation occurs in some countries, when (1) pre-harvest sampling methods are employed without appropriate adjustment for later losses, and (2) government officials fabricate or "adjust" yield and production figures primarily for the purpose of impressing either the voting public or their own superiors.

- The estimates are at their worst when constructed for individual years and accepted as evidence of year-to-year changes in consumption. Only the largest indicated annual changes, say 20 per cent or more, can be relied on as reflections of actual variations in food consumption in most countries, and even these only as indicators of the direction, not the magnitude of change.
- The estimates at the “retail level" are not the same as the estimated nutrient intake due to losses and waste. Furthermore, nutrient losses and waste beyond the “retail level" vary markedly from country to country, from commodity to commodity[7], from year to year (depending mainly on weather conditions and crop quality), and from times of food shortage to times of plenty. Farnsworth acknowledged that the FAO estimators employ a uniform 15 per cent allowance for such losses.

Farnsworth wrote her piece of work more than half a century ago. While some of the concerns about the manner in which FBS are constructed may still be valid, it is also most likely true that national agricultural statistics have improved substantially over time in the estimation of food availability. Nonetheless, her caveats about FBS data still need to be borne in mind. For

[7] For example in tropical countries heavily dependent on root crops, plantains, and maize, not only do such foods deteriorate rapidly after harvest in hot, moist climates, but some of the less-desired staples, like cassava, may be so amply available that they are wastefully prepared for consumption in producing areas.

example, a question can be raised about the extent to which any apparent diversification of the food supply over time shown by the FBS reflects real diversification versus just an improvement in the ability of national agricultural statistics to capture production of secondary crops (particularly non-cereal production). Notwithstanding the criticisms of food balance sheets, Timmer et al., (1983) argued that the analysis of FBS is the starting point for most food policy analysis at the country level. Lopriore and Muehlhoff (2003) also observed that although the analysis of food supply data derived from FAO's FBS do not provide information on consumption patterns and tend to overestimate intakes, it can be used to describe the trends in the structure of a national diet in terms of the major food commodities. Smith and Haddad (2000) also argued that per capita daily energy availability (DEA) from the FAO's FBS is one of the main indicators of national food availability. The authors provide empirical evidence suggesting that there is a strong correlation between this per capita DEA and more individual-based indicators of food security (e.g., anthropometric indicators of children's nutritional status). In particular, Smith and Haddad (2000) show that national caloric availability was responsible for more than a quarter of reductions in child malnutrition in developing countries over the period 1970-95.

2.4. Methodological Approach

Food supply data from the FAO's FBS is used to describe aggregate trends in the structure of per capita food availability, by country, in terms of the major food commodities. The FAO's FBS shows national and per capita quantities of food available for human consumption for almost all food commodities and all countries. The FBS also shows data on per capita food energy availability as well as the availability of individual macronutrient groups (proteins and fats). The analysis of protein availability by source and fat supply helps to better understand changes in the quality of the food available in terms of major macronutrients. With data on per capita availability of individual macronutrients and information on the nutrient conversions for each macronutrient[8], the caloric (or energy) contribution of proteins and fats are calculated. According to FAO (2000), the healthy range of macronutrient intake (what FAO calls "a balanced diet"), expressed as a percent of total energy, can be broad: 55-75% from carbohydrates, 15-35% from fats and 10-15% from proteins.

For these key variables, three-year averages are computed to facilitate comparison. In most cases, the results are presented by specific sub-regions in ECOWAS-WA. These include the Non-Coastal Sahel (Mali, Burkina Faso and Niger); the Coastal Sahel (Cape Verde, Gambia, Guinea Bissau, Senegal); and the Coastal Non-Sahel (Benin, Cote d'Ivoire, Ghana, Guinea, Liberia, Nigeria, Sierra Leone and Togo). The analyses are structured as follows: (i) trends in energy availability (supply)[9]; (ii) trends in the composition of food availability; (iii) trends in macronutrient availability; iv) trends in the contribution of plant and animal sources to protein

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[8] The general rule is that protein and carbohydrates contain 4 kcal/gm and fat contains 9 kcal/gm.
[9] Availability and supply mean the same thing in this context and are used interchangeably.

availability, and v) trends in the share of macronutrients in food supply. The discussion of findings includes a presentation of the major trends in per capita availability, paying attention to what is happening in the "big movers" in the region, and providing details, as necessary on the three countries (Benin, Mali and Senegal) for which aggregate demand determinants are later estimated in chapter 3 of this study. For detailed country-specific trends, the reader should look at Me-Nsope and Staatz (2013).

2.5. Findings

First, the trends in the major structural factors hypothesized to influence trends in food consumption–population growth, urbanization, prices and economic growth—are examined. Second, the trends in per capita food availability from FAO's FBS are discussed.

2.5.1. Determinants of Food Consumption Patterns

2.5.1.1. Population

According to the United Nations (2011)[10], the 15 West African States that constitute ECOWAS have a population of approximately 250 million people, covering an area of roughly 5 million km². The average annual population growth rate is reported at 3%, and it is forecasted that the sub-region's population will reach 430 million by 2020. Five-year cumulative population growth rates in the period 1980-2010 reveal positive continual growth for almost all countries in the region (Table 2-1). The 2010 population figures reveal the overwhelming importance of the coastal countries (especially Cote d'Ivoire, Ghana and Nigeria) in the region's total population.

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[10] http://www.ohchr.org/EN/Countries/AfricaRegion/Pages/WestAfricaSummary1011.aspx

Nigeria alone accounts for over half of the region's total population, thus making her a major influence in the sub region as far as food demand is concerned. The size of the consumer population obviously has an effect on aggregate food demand since food is a basic necessity. It is also anticipated that, increasingly in the future, the population of WA will be along the coast due to substantial out-migration from the inland countries of the Sudano-Sahelian belt (e.g., Burkina Faso and Mali) to the coastal countries in WA [11] . The occurrence of such a shift is hypothesized to have important consequences on how consumption patterns for the region as a whole evolve.

Table 2-1. Five - Year Cumulative Population Growth Rate (%) in 1980-2010

Country	1980 to 1985	1985 to 1990	1990 to 1995	1995 to 2000	2000 to 2005	2005 to 2010*	Total Population 2010(000)	Share in Regional Total in 2010
Benin	2.7	2.9	3.4	2.9	3.2	3.0	8,850	2.9%
Burkina Faso	2.5	2.6	2.7	2.8	2.9	2.9	16,469	5.5%
Cape Verde	1.8	1.2	2.5	2.0	1.6	2.2	496	0.2%
Côte d'Ivoire	4.2	3.5	3.2	2.4	1.7	1.8	19,738	6.6%
Gambia	4.0	4.6	3.1	2.8	3.0	2.6	1,728	0.6%
Ghana	3.3	2.8	2.8	2.4	2.4	2.0	24,392	8.1%
Guinea	2.2	3.1	5.5	2.0	1.6	2.2	9,982	3.3%
Guinea-Bissau	2.0	2.0	2.0	2.0	2.0	3.0	1,515	0.5%
Liberia	2.8	-0.8	-0.3	6.1	2.2	4.5	3,994	1.3%
Mali	2.0	1.6	2.5	2.8	3.1	3.0	15,370	5.1%
Niger	2.8	2.9	3.3	3.5	3.5	3.5	15,512	5.2%
Nigeria	2.6	2.6	2.4	2.3	2.5	2.3	158,423	52.7%
Senegal	2.8	3.0	2.9	2.6	2.7	2.5	12,434	4.1%
Sierra Leone	2.3	2.4	-0.4	1.2	4.4	2.0	5,868	2.0%
Togo	3.4	3.0	2.2	3.2	2.4	2.7	6,028	2.0%

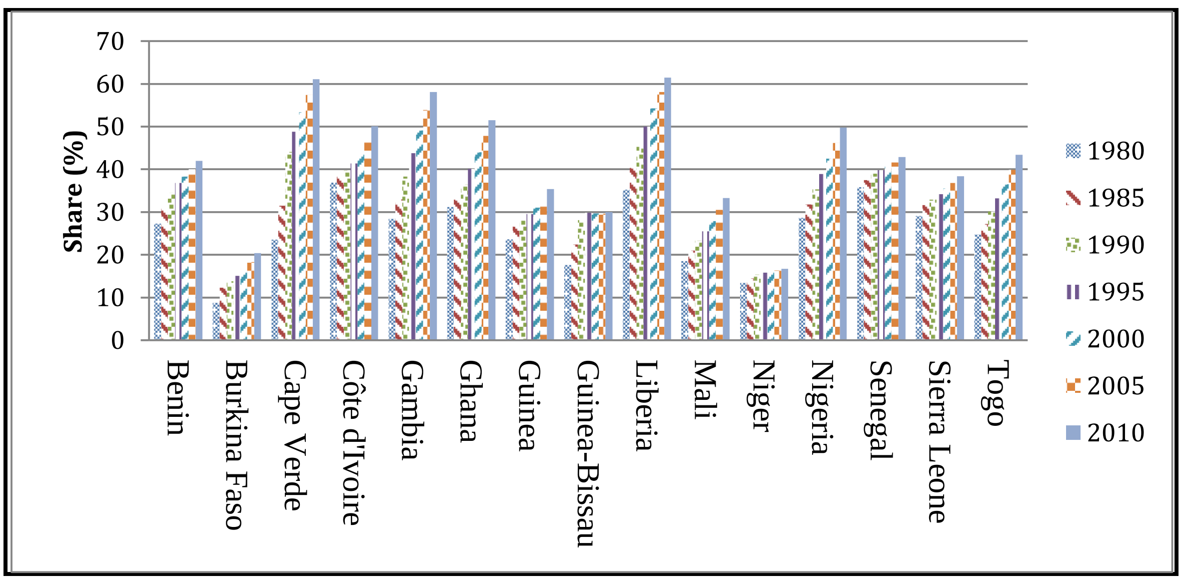
*Growth rates up to 2005 were calculated from FAO's Population Statistics, while the growth rates for 2005-2010 were taken from the United Nation's population statistics.

[11] http://www.unep.org/dewa/africa/publications/aeo-1/120.htm

2.5.1.2. Urbanization

The population of WA is not only growing; it is becoming increasingly more urban. In WA, 85% of the population lived in rural areas in 1960 but by 2020, the urban-rural ratio is expected to be around 60:40 %[12]. In 2010, roughly 137 million people lived in urban areas, as against 170 million rural dwellers. Figures for 2010 reveal urban population shares of over 40% for 10 out of the 1615 ECOWAS countries, and a share above 50% for 5 of the 15 (Figure 2-1). The urban population share grew by more than 100% in the period 1980-2010 in 3 of the 15 ECOWAS countries (Burkina Faso, Cape Verde and Gambia); and by greater than 50% in an additional 7 of the 15 ECOWAS countries (Benin, Ghana, Guinea Bissau, Liberia, Mali, Nigeria and Togo).

Figure 2-1. Urban Population Shares (%) - West Africa (1980-2010)



Source: Author's compilation using data from World Bank, 2013.

[12] http://westafricainsight.org/articles/PDF/92

The descriptive results presented later in this chapter provide some insight on how food availability in levels and composition is evolving with the growth in the urban population. The econometric results presented later in Chapter 3 also serve to provide evidence of any statistical association between the growth in urban population share and starchy staples availability per capita.

2.5.1.3. Economic Growth

Changes in consumption patterns have also been associated with changes in a nation's per capita gross national product. In economic theory, the relationship between food consumption and income levels is characterized by Engel's law–the proportion of income spent on food falls as income rises. The evolution in real per capita gross domestic product (GDP)–an indicator of purchasing power, in the region reveals an overall positive trend over the period 1980-2010. Increases in average annual real per capita GDP growth rates are particularly large in the 2000s (Table 2-2).

With the exception of a few countries (Cote d'Ivoire, Guinea Bissau, Liberia, Guinea and Togo), per capita GDP has been growing for most countries since 2000, and the growth rates have been largest for Cape Verde, Ghana, Nigeria, Burkina Faso, Mali and Sierra Leone. Regmi and Dyck (2001) observe that urbanization is closely related to economic development and that both interact to bring about important changes in the composition of consumption—the specific effects of urbanization on consumption differ depending on the economic conditions. Urbanization may result in an overall increase in per capita consumption, could result in improvement in diet quality (such as an increase in animal protein consumption), and could also increase the demand for processed or easy-to-prepare food (Regmi, 2001).

Table 2-2. Average Annual Real Per Capita GDP Growth Rates

Country	1980-85	1985-90	1990-95	1995-00	2000-05	2005-10
Benin	-2.0	-1.1	1.2	1.9	0.8	1.9
Burkina Faso	0.5	0.5	1.5	4.1	3.0	2.8
Cape Verde	3.2	1.3	2.4	5.8	3.4	5.8
Côte d'Ivoire	-3.0	-1.9	-0.7	-0.3	-1.7	1.4
Gambia, The	-0.9	-0.7	-1.5	2.2	1.5	3.7
Ghana	-5.0	2.2	2.1	1.7	2.4	4.2
Guinea	-0.3	1.3	-0.7	1.9	-0.2	0.7
Guinea-Bissau	-0.1	0.7	1.1	-5.9	-3.4	-0.1
Liberia	n/a	n/a	n/a	n/a	-7.0	4.9
Mali	-3.4	3.5	0.0	1.5	3.9	2.2
Niger	-6.0	-0.6	-4.5	-0.1	2.2	1.3
Nigeria	1.0	-1.9	-2.2	0.5	7.7	4.4
Senegal	-0.1	-0.7	-0.6	1.5	2.1	2.4
Sierra Leone	-2.5	0.0	-7.5	-11.9	10.3	3.9
Togo	-4.3	0.7	-2.9	-1.4	-1.5	0.9

Source: Author's computation using per capita GDP (constant prices), national currency from the International Monetary Fund, World Economic Outlook Database, April 2008

2.5.2. Trends in Per Capita Food Availability

This section examines explores the trends in per capita daily energy availability; the supply of food by major food groups; the supply of major starchy staples; the supply of macronutrients (protein and fat) per capita; and the share of individual macronutrient groups in daily food energy supply.

2.5.2.1. Trends in Daily Food Energy Availability (kcal/capita)

Per capita daily energy availability (DEA) has been widely used in the literature as one of the main indicators of national food availability (Smith and Haddad, 2000). As a national average, DEA is an imperfect indicator of the state of individual food security. However, empirical evidence, such as that provided by Smith and Haddad (2000), suggest that there is a strong correlation between this per capita DEA and more individual-based indicators of food security (e.g., anthropometric indicators of children's nutritional status). In particular, Smith and Haddad (2000) show that national caloric availability was responsible for more than a quarter of reductions in child malnutrition in developing countries over the period 1970-95. The positive growth in per capita incomes in the region over time (Table 2-2) is expected to have had a positive influence on DEA per capita.

The empirical data reveal an overall positive trend in reported total per capita DEA, particularly in the last two decades (Figures 2-2, 2-3, and 2-4). Burkina Faso, Mali, Ghana, and Nigeria experienced the largest growth (in relative terms) in reported per capita DEA (50% or more) between 1980-85 and 2004-09. Cote d'Ivoire and Liberia in the same period experienced a decline in per capita DEA.

The analysis of the trend in per capita DEA reveals that although the overall pattern for all countries in the region shows a shift towards greater calorie availability, the magnitude of growth has greatly varied and has been influenced by factors specific to each country. The analysis highlights the possible effect of growth in income on per capita DEA. In the Non-Coastal Sahel (Figure 2-2) for instance, Mali and Burkina Faso, with modest economic growth, have also shown modest increases (in absolute terms) in per capita DEA over time. Reported per capita DEA for Mali had the biggest growth in the early and mid-1980s. Compared to the period 1983-85 (characterized by drought and economic crisis in Mali), the period 1986-1988 was characterized by good harvests and improved economic performance (growth in real per capita incomes of about 3.5%), which corresponded with growth in per capita DEA of about 18%. Mali also experienced declines in reported per capita DEA in the early and mid-1990s; this was the period characterized by the initially disruptive coup d'état that took place in 1991. The 1994 CFA franc devaluation may also initially have reduced per capita purchasing power. Real per capita income data (Table 2- 2) in this period also shows very little positive growth. These factors together could explain the very modest change in per capita DEA observed during the same period.

In the Coastal Non-Sahel (Figure 2-4), Ghana has shown a strong economic performance in the past 15 years, and this has been accompanied by a remarkable performance in terms of increasing per capita DEA. Similar to Ghana, Nigeria experienced strong economic growth accompanied by remarkable positive changes in per capita DEA. Cote d'Ivoire was first in terms of per capita DEA in the Coastal Non-Sahel until the early 1990s. The high reported per capita DEA during this period in Cote d'Ivoire is explainable by the economic growth enjoyed by the country in the 1970s and 1980s from a vibrant agricultural export market. Per capita DEA, however, stagnated between the periods 1992-1994 and 2001-2003, which was also a period of economic stagnation and increasing civil strife in the country.

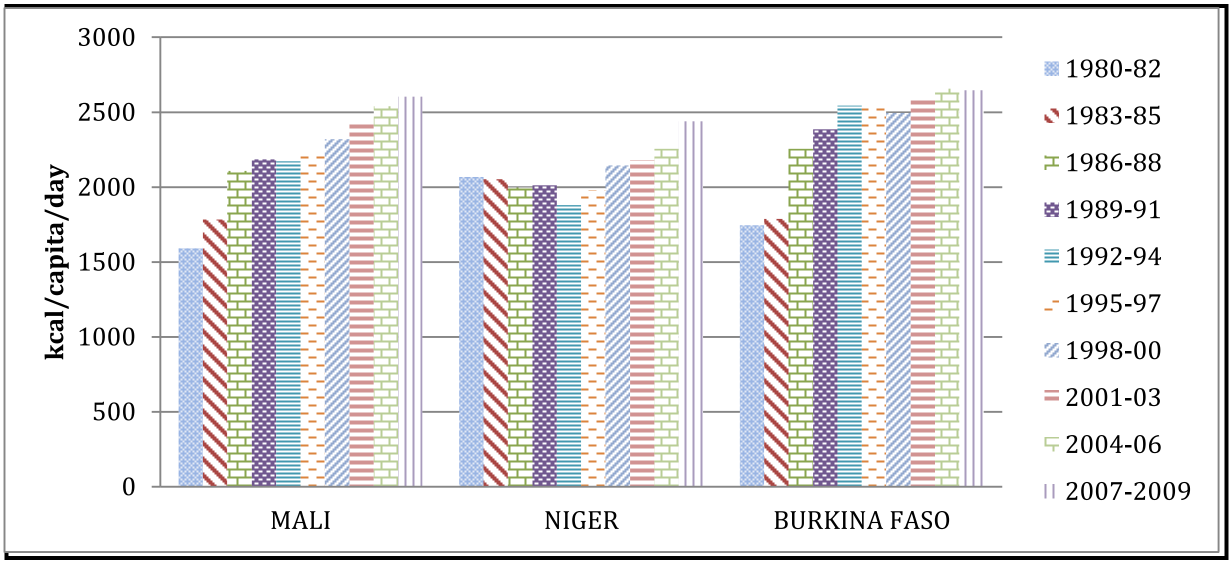
In the Coastal Sahel (Figure 2-3), Senegal experienced a declining trend in reported per capita DEA in early and mid-1980s. The drop in per capita DEA in the 1980s is likely explainable by the overall drop in GDP in Senegal during this same period, attributable in part to declining proceeds from groundnuts export sector, which fueled the economy of Senegal in the 1960s and 1970s, but has been undergoing crisis since 1987. However, since the early 2000s, reported per capita DEA has been on the rise in Senegal, as per capita incomes show some positive changes.

The analysis also highlights the differences in the trend in per capita DEA in countries that have experienced civil disruption, like Liberia, Sierra Leone, and Cote d'Ivoire. In Liberia for instance, between 1986-88 and 2001-2003, reported per capita DEA fell. This declining pattern in per capita DEA in Liberia reflects the debilitating effect of multiple civil wars that the country experienced in the 1990s and in the early 2000s. The positive trend in per capita DEA post 2003 reflects the end of the war in 2003 and a transition of Liberia into post-conflict reconstruction, and into medium-term growth and poverty reduction strategies[13]. In Sierra Leone also, the decline in per capita DEA in 1989-1991 coincided with the beginning of civil war that lasted from 1991-2002. However, since the period 2001-2003, reported per capita DEA has been rising in Sierra Leone, and this could be attributed to the positive trend in per capita GDP and the end of the civil war in the same period.

Overall, based on the observed trend in per capita DEA in this study, one can say that there have likely been some improvements in the state of food security, measured in terms of food availability, over the last three decades. Additionally, the rate of growth in per capita DEA has been influenced by growth in overall economic performance and the political stability of the countries.

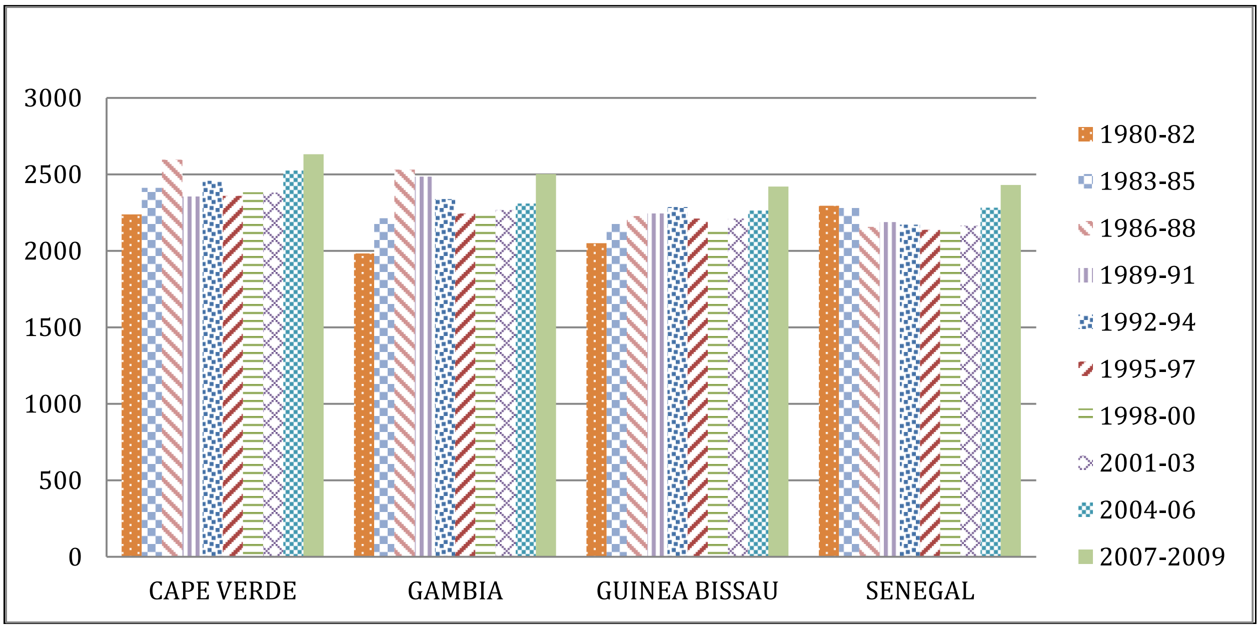
[13] http://www.africaneconomicoutlook.org/en/countries/west-africa/liberia/

Figure 2-2. Daily Energy Availability (kcal/capita/day) - Non-Coastal Sahel



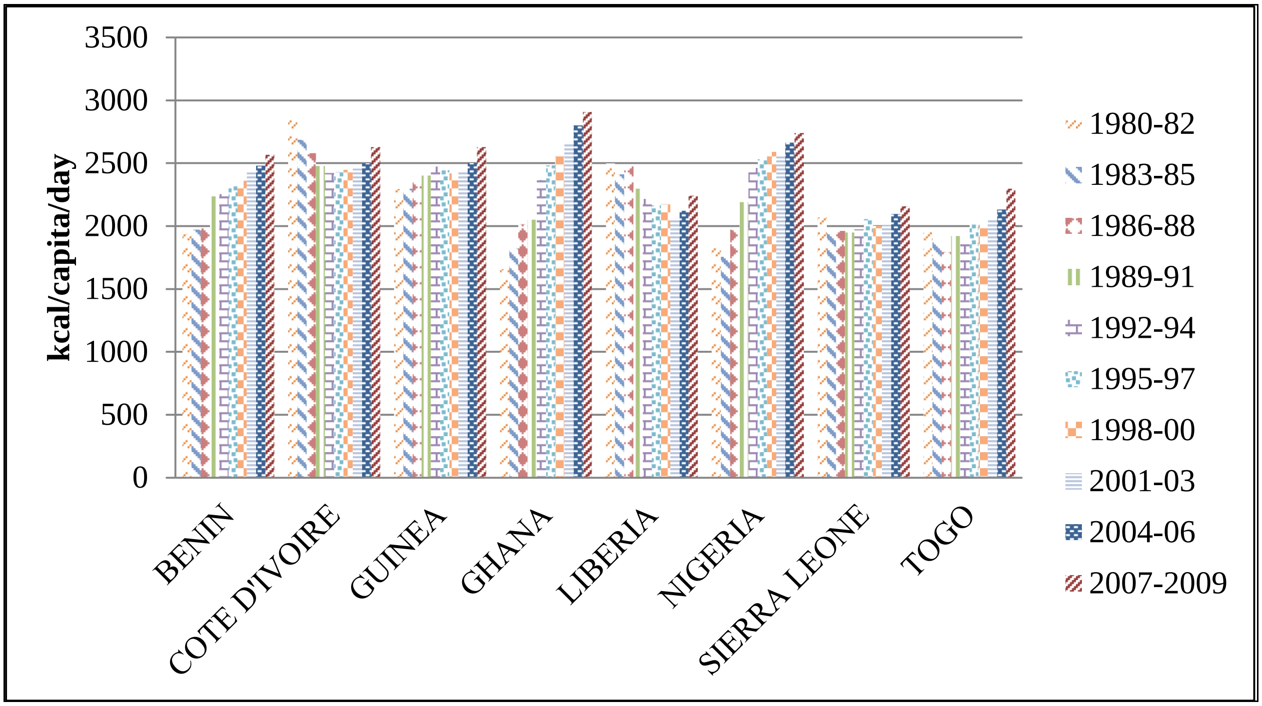
Source: Author's computation using data from FAO's Food Balance Sheets.

Figure 2-3. Daily Energy Availability (kcal/capita/day) - Coastal Sahel



Source: Author's computation using data from FAO's Food Balance Sheets.

Figure 2-4. Daily Energy Availability (kcal/capita/day) - Coastal Non-Sahel



Source: Author's computation using data from FAO's Food Balance Sheets.

2.5.2.2 Trends in the Composition of Per Capita Food Availability by Major Food Group

This sub-section examines aggregate shifts in per capita food supply by major food group. Specifically, it examines whether there has been a diversification in the composition of food supply, whereby new food groups (e.g., starchy roots and tubers (R&T) in the non-Coastal Sahel) are emerging as important contributors to the reported per capita DEA. There are some differences in major food groups across sub-regions. However, the most common food groups in this analysis are cereals (excluding beer), starchy R&T, fruits (excluding wine), vegetables, vegetable oils, meats and offal, alcoholic beverages, oilcrops, sugars and sweeteners, pulses, milk (excluding butter), and fish and seafood. The trend in a major food group, say "starchy R&T," may not reflect what changes are taking place with respect to the supply of a specific starchy R&T type (e.g., cassava or potatoes). The next sub-section examines trends in specific commodities within major staple food categories.

2.5.2.2.1. Non-Coastal Sahel

Cereals are the dominant food group in the Non-Coastal Sahel. Per capita cereals availability (in terms of kg/person) increased by 44% for Mali (Table A2-2 in Appendix), 55% for Burkina Faso (Table A2-1 in Appendix), and by only 3% in Niger (Table A2-3 in Appendix) during the study period. Mali alone experienced an increase in per capita availability of starchy R&T in this sub-region. Per capita starchy R&T supply declined in Burkina Faso (56%) and Niger (57%), albeit from small initial levels. Niger experienced the largest positive change in per capita availability of vegetables—from an average of 16 kg/capita/year in the period 1983-1985 to 51 kg/capita/year in 2007-2009 – an increase of 170% in the study period. In Mali, vegetable supply increased by 4%, while Burkina Faso experienced a decline of 27 %, in the study period. Reported availability of fruits rose in Niger (93%) and Mali (71%), while Burkina Faso experienced a decline of 38%. Reported per capita supply of meats and offal increased by 45% for Mali, 85% for Burkina Faso and 12% for Niger in the period from 1980-85 through to 2004-2009.

A possible explanation for the higher supplies and higher rate of growth in the per capita supply of meats and offal in Mali and Burkina compared to Niger is the higher per capita incomes in Mali and Burkina Faso and economic stagnation in Niger. In contrast, in Niger, consumers appear to have relied more on pulses (particularly cowpeas) as a major, and lower-cost, source of protein in the diet. Per capita supply of pulses increased in Niger by 44% in the period 1980-85 to 2004-09. In this sub-region, per capita supply of alcoholic beverages is highest for Burkina Faso–and has generally remained above an average of 50 kg/capita/year in that country.

2.5.2.2.2. Coastal Non-Sahel

Starchy R&T compete with cereals as major calorie sources in this sub-region. Cereals supply per capita has been on the rise for all countries in this sub-region. For all Coastal Non-Sahelian countries except Sierra Leone, starchy R&T supply has been greater than 100 kg/capita/year since the 1980s. Ghana (Table A2-6 in Appendix) and Nigeria (Table A2-9 in Appendix) experienced the most noticeable growth in per capita supply of starchy R&T (72% and 117% respectively), and in both countries starchy R&T supply was about double that of cereals. The sharp increase in the supply of starchy R&T per capita in Nigeria from an average of 111 kg/year in 1986-1988 to 231 kg/year in 1992-1994 reflected the "cassava revolution" in Nigeria (Nweke et al., 2002).

Ghana experienced an increase in per capita supply of almost all major food groups in the study period. Fruit supply per capita increased dramatically from an average of 86 kg/year in the period 1980-85 to 147 kg/year in 2004-09, an increase of 72%; meats and offal supply increased by about 22% (absolute supply stayed below 15 kg/capita/year); milk supply per capita rose by about 129%; vegetable oil supply increased by 55%; fish and seafood by 36%; and the supply of alcoholic beverages rose by about 26%. Nigeria, on the other hand, experienced a decline in per capita supply of meats and offal of 12%. However, the per capita supply of pulses (a source of high-quality protein) increased dramatically in Nigeria by 138%. Vegetable oil supply per capita also increased by 50% in Nigeria.

2.5.2.2.3. Coastal Sahel

In the Coastal Sahel, cereals are still a major food group. Based on per capita availability, other major food groups in this region are fruits and vegetables, meats and offal, milk, sugars and sweeteners, fish and seafood. Although cereals are a major component of food availability in this sub-region, over time, per capita cereals supply did not change very much. Compared to the Coastal non-Sahel sub-region, the per capita supply of starchy R&T is much lower in this sub-region. In Cape Verde, the starchy R&T supply per capita increased by 69% in the study period (Table A2-12 in Appendix). Senegal also experienced dramatic changes (especially in the 2000s) in the starchy R&T supply per capita—from an average of 8 kg/year in 1980-1982 to 29 kg/year in 2007-2009, an increase of 247% (Table A2-15 in Appendix). Cape Verde, which experienced rapid economic growth and has the highest per-capita income in the sub-region, experienced an increase in the supply of almost all major food groups in the study period: per capita supply of fruit by 106%; that of vegetables by 777%; that of meats and offal by 332%; that of milk supply by 69%; that of eggs by 300%; that of sugars and sweeteners by 69% and that of alcoholic beverages by 200%. In contrast, the per capita availability of pulses decreased by 27% and that of fish and seafood declined by 59%.

Senegal has also shown a positive trend in the supply of all major food groups (Table A2-15 in Appendix). In the period of study in Senegal, vegetable supply per capita increased from an average of 17 kg/year in 1980-1982 to 64 kg/year in 2007-2009–an overall increase of 269%; fruit supply remained at less than 20 kg/capita/year, and increased by 29%; the supply of meats and offal per capita increased by 23% per capita; and fish and seafood supply (highest per capita for Senegal in this sub-region) increased by 16%. With the exception of cereals, starchy R&T, alcoholic beverages and fruits, the supply of all other major food groups remained below 20 kg/capita/year in Guinea Bissau (Table A2-14 in Appendix). Food supply per capita in the Gambia also did not show any striking changes over time (Table A2-13 in Appendix).

Overall, in the Coastal Sahel region, the most noticeable change in the supply of food by major food group has been in the case of starchy R&T in Cape Verde and Senegal. The specific composition of these changes in major starchy staples food groups (cereals and roots and tubers) are investigated in the next sub section.

Overall, the analysis of trends in per capita food availability in the ECOWAS states shows the following trends in food supply by major food groups. In the Sahel region, we observe an increase in the supply of starchy R&T (e.g., in Mali, Senegal and Cape Verde). In most countries across all sub regions, we observe an increase in the per capita supply of fruits and vegetables, and also of meats and offal. However, while cereals have been for a long time basic staples in the Sahel and as such most fully reported in official production statistics, agricultural production statistics in underdeveloped low-income countries have been criticized for being deficient in the reporting of figures for crops like cassava, fruits and vegetables as well as livestock (Farnsworth, 1961). Hence, this raises a question of the extent to which the apparent diversification (more starchy staples, more fruits and vegetables) of the diet (in terms of major commodities) over time shown by the FBS reflects real diversification versus just an improvement in the ability of national agricultural statistics to capture non-cereal production (e.g., roots, tubers and horticultural products).

2.5.2.3. Trends in the Availability of Major Starchy Staple Types (kg/capita/year)

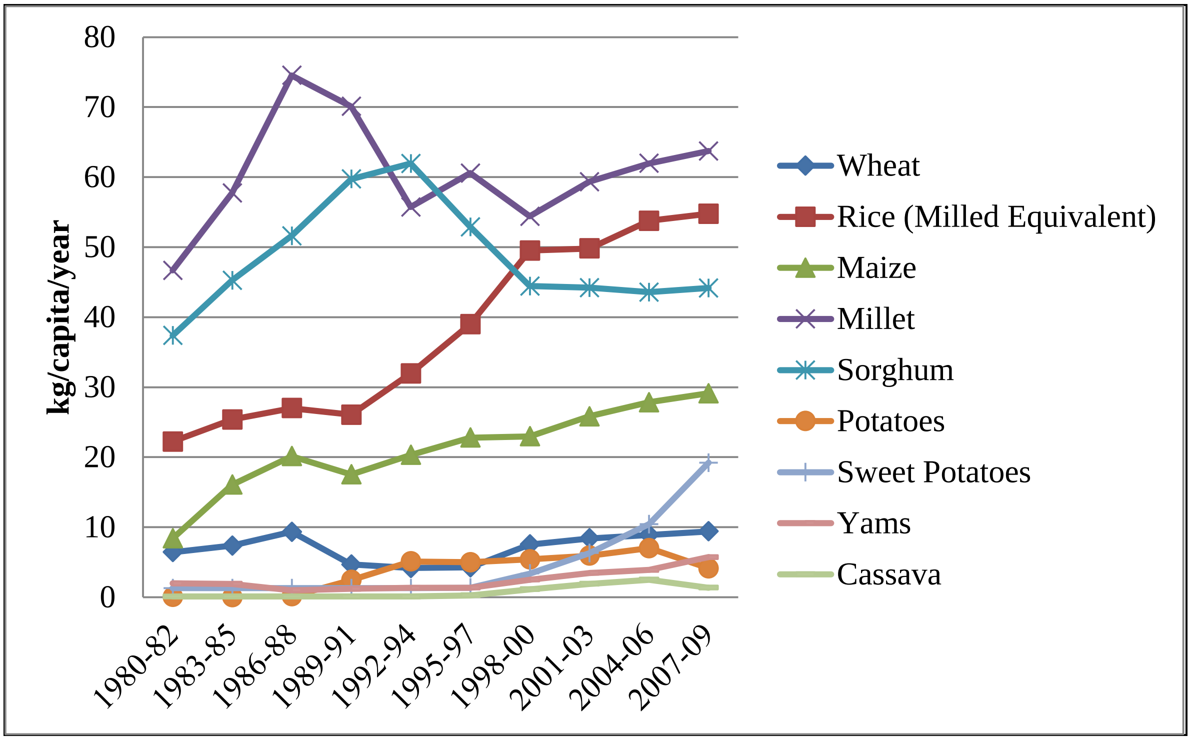
This sub-section examines the trends in the availability of specific starchy staples for a better understanding of the dynamics of food supply in the region. Disaggregating major starchy staple food groups into specific starchy staples is useful for hypothesizing about possible reasons for any shifts in food supply. For instance, increased per capita supply of starchy R&T could reflect two very different phenomena: (a) the poor shifting towards cheaper sources of calories, such as cassava and sweet potatoes, and (b) the middle class diversifying to a more "European" diet (potatoes—especially French fries). Such analysis is also useful in describing the nature of the diversification and the trend in the relative importance of each starchy staple type in the diet (in terms of specific commodities). For instance, with rising urbanization and growth in per capita incomes, it is worth investigating whether the expected shift to rice (due to urbanization) from coarse grains (e.g., millet and sorghum) is reflected in aggregate per capita cereals supply trends. The analysis of food balance sheet data reveals complex and diverse patterns of substitution amongst different starchy staple types in the different sub-regions. Empirical data reveals that the substitution is not just between rice and wheat and traditional starchy staples (millet and sorghum) as was argued in the 1980s and the 1990s, but also involves other starchy staples types like cassava, yams, sweet potatoes, Irish potatoes and maize. However, the specific pattern of substitution varies across countries and sub-regions.

2.5.2.3.1. Major Starchy Staples Availability in the Non-Coastal Sahel

Empirical data on the per capita supply of major starchy staple types shows a growth in per capita supply of rice in Burkina Faso (8 kg/capita), Mali (31 kg/capita) and Niger (6 kg/capita) for the period 1980-85 to 2004-09 (Table A2-16 in Appendix). Specifically in Mali, while in the 1980s and 1990s millet and sorghum were the most important cereals (in terms of per capita quantities supplied), in the 2000s in Mali rice replaced sorghum as the second most important cereal. This switch from sorghum to rice in Mali is not surprising given Mali's efforts towards self-sufficiency in rice supply; rice production in Mali in the 2000s has more than doubled its level in the 1990s, and the supply of rice per capita has shown dramatic increases in the 2000s.

Maize supply per capita in the Non-Coastal Sahel also showed large absolute increases in the period 1980-85 to 2004-09 inBurkina Faso (32 kg/year) and Mali (17 kg/year). Still in Mali, sweet potatoes availability increased in absolute terms by 14 kg/year, while that of Irish potatoes increased by 6 kg/year, in the study period. The growth in sweet potato availability in Mali may reflect the poor shifting to cheaper sources of calories. Thus, from this breakdown in the supply of major starchy staple types in Mali, it is clear that the recent growth in the supply of starchy R&T seen in the previous sub-section is mostly driven by increases in the supply of sweet potatoes and to a lesser extent yams and Irish potatoes. Per capita availability of wheat, sorghum, cassava and yams were generally below 5 kg/year (Figure 2.5). In Niger, with the exception of millet, rice, and maize, there was an absolute decrease in per capita availability of all major starchy staple types in Niger. This stagnating trend in per capita food supply most likely reflects the impact of economic stagnation in Niger.

Figure 2-5. Major Starchy Staples Availability - Mali (kg/capita/year)

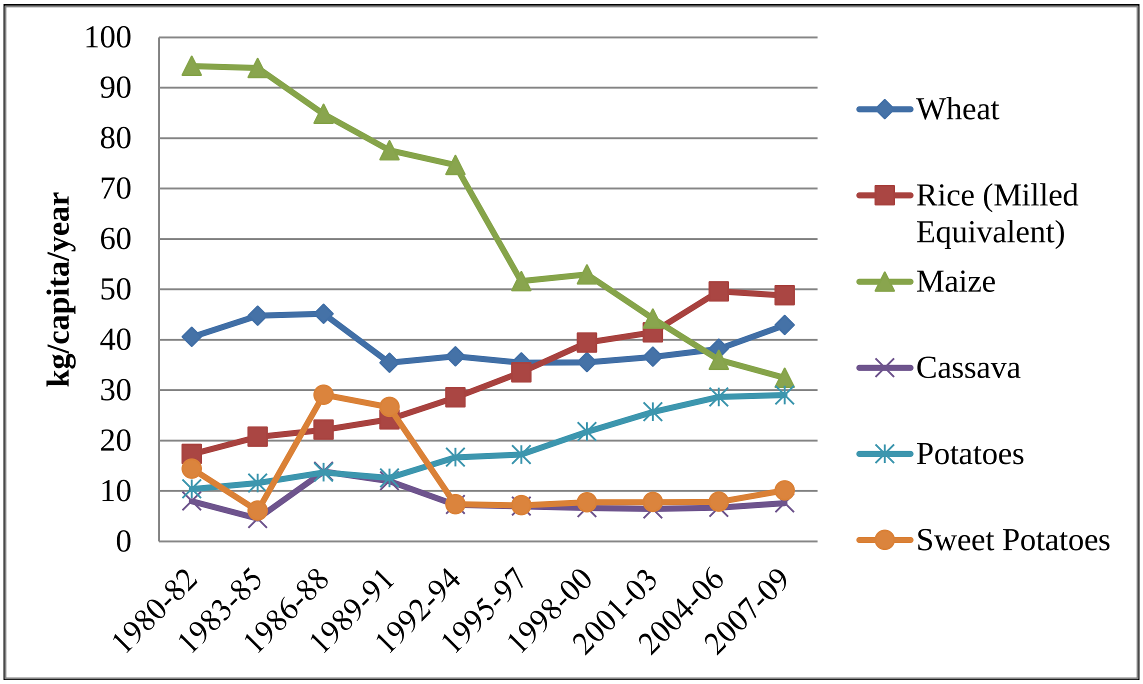


Source: Author's computation using FAO's Food Balance Sheet data.

2.5.2.3.2. Major Starchy Staples Availability in the Coastal Sahel

Data for the Coastal Sahel (Table A2-17 Appendix) also reveals diverse patterns of substitution amongst different starchy staple types. In Cape Verde, in spite of the dominant position of maize in starchy staples availability in the 1980s and the 1990s, maize supply per capita decreased drastically over time, while rice supply has grown to replace maize as the dominant starchy staple type since the mid-2000s. In the period 1980-85 through to 2004-2009, there was an absolute increase in per capita rice supply of 60 kg/year, while that of maize declined by 31 kg/year (Figure 2.6). An increase in rice supply implies increases in imports because most of it is imported[14] . Alongside the big increase in per capita rice availability in Cape Verde has been a rapid growth in the supply of Irish potatoes, whereby the per capita supply of Irish potatoes rose from an average of 11 kg/year in the period 1980-1985 to an average of 29 kg/year in 2004-2009.

Figure 2-6. Major Starchy Staples Availability - Cape Verde (kg/capita/year)



Source: Author's computation using FAO's Food Balance Sheet data.

In Senegal, rice was the dominant starchy staple type (greater than 55 kg/capita/year) throughout the study period. However, per capita maize availability increased (by 13kg/year) more than that of rice (5 kg/year) over the 30-year period (Figure 2-7). Senegal also experienced a very sharp decline in millet and sorghum availability per capita. This reflects a major shift in the composition of the average diet, linked possibly to urbanization. Furthermore, wheat availability per capita also increased in Senegal by 12 kg/year during the study period. Increases

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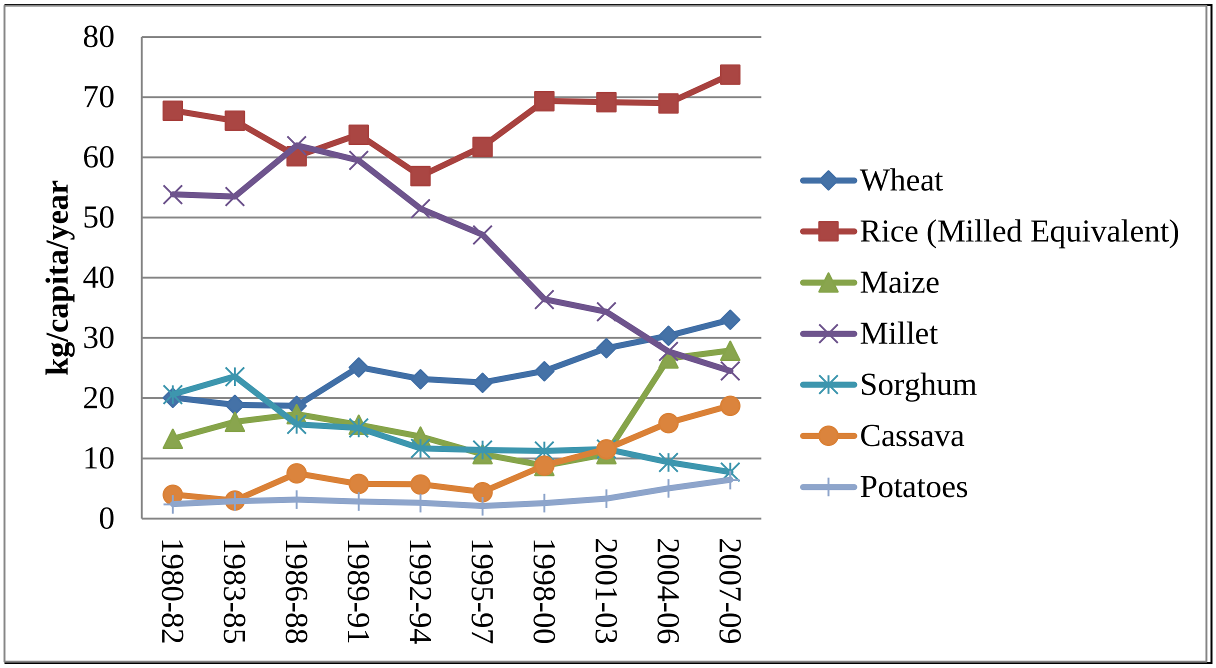
[14] FAO's FBS reveal rice production data for Cape Verde of less than 1000 tons throughout the period 1980-2009, while rice imports increased from an average of 10,000 tons in the period 1980-84 to 46,000 tons in 2005-09.

in wheat supply, like that of rice, imply an increase in imports since most of it is imported[15]. Still in Senegal, cassava availability per capita experienced the largest absolute increase (14 kg/year) amongst all other starchy staples in the study period. Guinea Bissau also showed the most absolute increase in the availability of cassava per capita (24 kg/year) in the study period.

Figure 2-7. Major Starchy Staples Availability - Senegal (kg/capita/year)



Source: Author's computation using FAO's Food Balance Sheet data.

Gossen (2002) found that in Rwanda income growth led to higher Irish potato consumption, both in rural and urban areas (short-term income elasticity: rural 1.45 and urban 1.25). The income elasticity of Irish potatoes demand in the Coastal Sahel region also appears to be high. The growth in the supply of Irish potatoes in Cape Verde could be the result of the rapid economic growth experienced in the last 20 years (Table 2-2). Another possible explanation for

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[15] FAO's FBS shows no data (or less than 1000 tons/year) of wheat production in Senegal.

the growth in the supply of Irish potatoes in Cape Verde is changes in lifestyle–i.e., growth in the consumption of more potato chips (French fries) as people adopt a more Western diet. While the growth in the supply of Irish potatoes could be the result of the westernization of diets and economic growth, the rapid growth in the supply of cassava (Senegal and Guinea Bissau), and to a lesser extent sweet potatoes (Senegal) may represent a shift of the poor to cheaper sources of calories.

Also from empirical data, millet appears to be replacing rice in terms of per capita availability in the Gambia. The absolute change in per capita availability was plus 27 kg/year for millet and minus 34 kg/year for rice in the period 1980-85 through to 2004-09. However, it is worth pointing out that prior to the CFA franc devaluation, The Gambia had a large re-exportation trade of imported rice to Senegal. The drastic decline in per capita rice availability may just reflect the decline in those largely unrecorded previous re-exportations.

2.5.2.3.3. Major Starchy Staples Availability in the Coastal Non-Sahel

Empirical data on the per capita supply of major starchy staple types in the Coastal non-Sahel region reveals remarkable increases in the supply of starchy roots and tubers and to a lesser extent cereals (Table A2-18 Appendix). Ghana for example, experienced an absolute increase in per capita availability of cassava of 86 kg/year, while that of yams increased by 67 kg/year. Nigeria also experienced the largest absolute increases in per capita availability with cassava (36 kg/year) and with yams (57 kg/year). Per capita availability of sweet potatoes also increased in Nigeria by 14 kg/year and that of Irish potatoes by 4 kg/year in the study period. In Benin, per capita availability increased the most for yams (56 kg/year) and cassava (25 kg/year). In Guinea and Sierra Leone also, cassava availability per capita increased by 13 kg/year and 36 kg/year respectively in the period 1980-85 through to 2004-09.

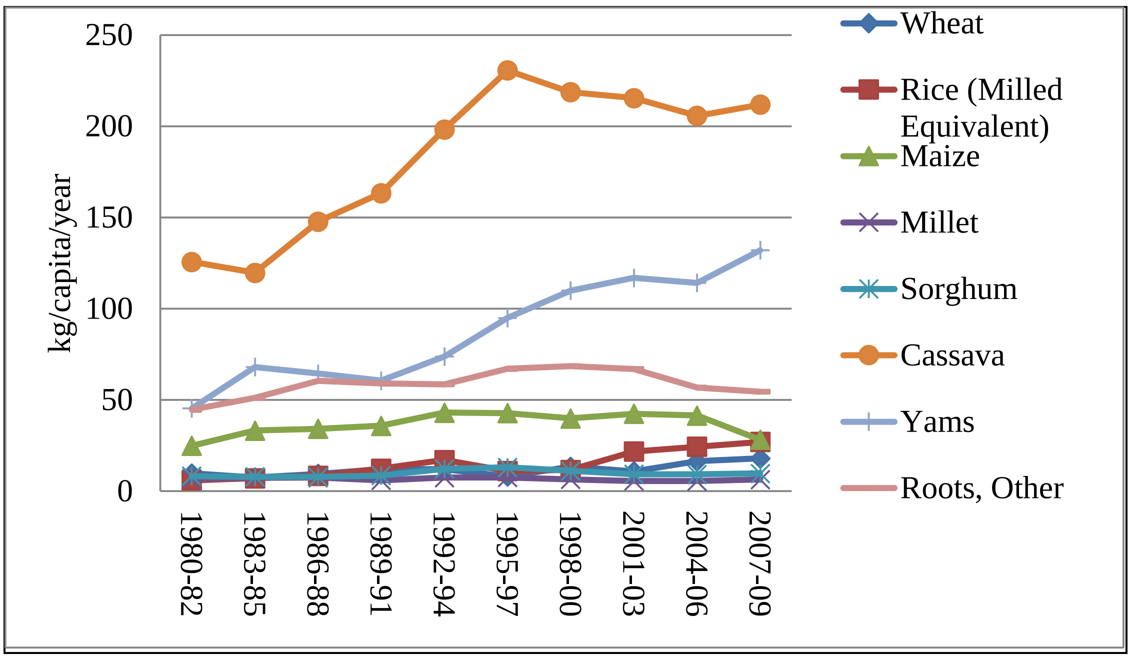
The increases in the annual per capita supply of specific cereals for Ghana were as follows: rice, 19 kg; wheat, 8 kg; and maize, 6 kg. In Nigeria, the increases in annual per capita availability over the study period were maize, 17 kg; wheat, 4 kg; rice, 7 kg; millet,[16] 10 kg and sorghum, 6 kg. Benin also experienced an increase in per capita availability of rice (22 kg/year) in the study period. However, given the importance of unrecorded trade between Benin and Nigeria, it is possible that some of the increase in recorded per capita rice availability in Benin actually represented rice transshipped into Nigeria. Maize has over the years maintained its position as the dominant cereal type in Benin. However, per capita maize consumption increased only by 3 kg/year in the period 1980-85 through to 2004-09. Rice availability per capita also increased by 27 kg/year in Guinea in the period 1980-85 through to 2004-09.

Contrary to the increase in rice supply in the other countries in this sub-region, rice supply per capita decreased by 7 kg/year in Sierra Leone and by 48 kg/year in Liberia during the study period. For Sierra Leone, the growth in per capita availability of cassava and the decline in rice availability per capita reflect some degree of substitution of cassava for rice, since both crops have been over time major starchy staples in Sierra Leone. For Liberia, following a period of low and relatively stable supply of wheat in the 1980s, per capita wheat supply jumped from an average of 9 kg/capita/year in the period 1992-1994 to 52 kg/capita/year in the period 1995-

[16] Nigeria has the largest apparent per capita supply of millet in the Coastal Non-Sahel. This is not surprising because Nigeria is the only one of these countries that also has a large Sudano-Sahelian zone, which is the major area where millet is produced.

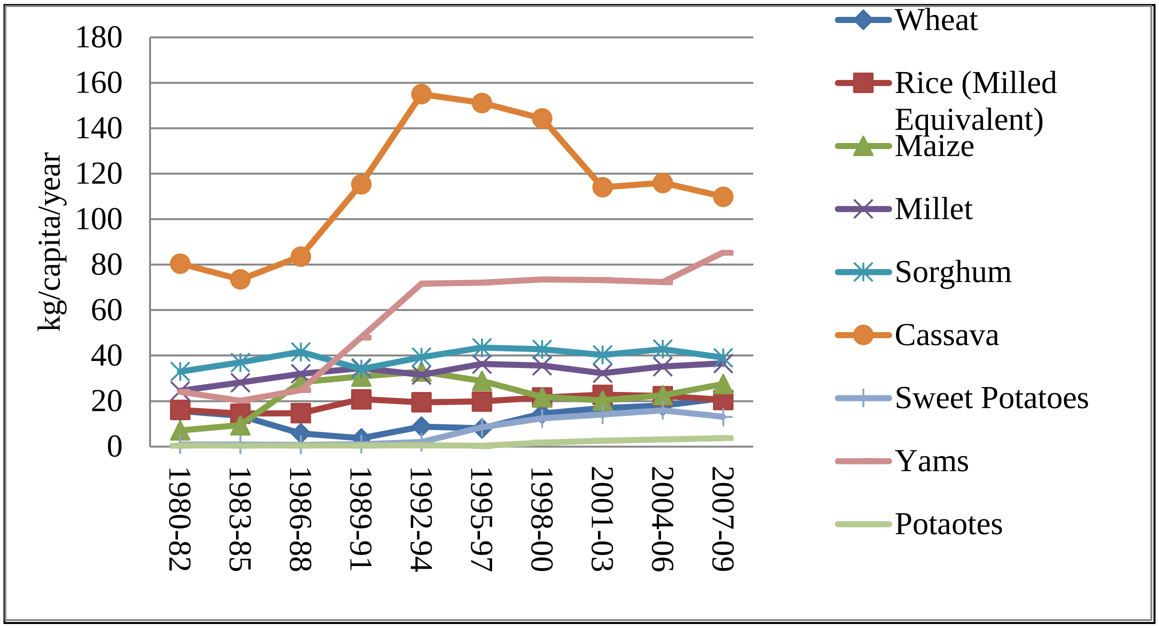
1997. This corresponded to the period when the first Liberian civil war ended. The spike in wheat supplies most likely reflects an influx of imported wheat to substitute for domestic rice production that had been decimated by the civil war. Overall, in the period 1980-85 through to 2004-09, per capita availability of wheat increased in Liberia by 19 kg/year. In Cote d'Ivoire, with the exception of millet, sweet potatoes and yams, per capita availability dropped for all other major starchy staples in the period 1980-85 through to 2004-09. In Togo, the largest increases in per capita availability were seen with rice (13 kg/year) and maize (24 kg/year. Figures 2-8 and 2-9 shows the trends in major starchy staples supply in Ghana and Nigeria.

Figure 2-8. Major Starchy Staples Availability - Ghana (kg/capita/year)



Source: Author's computation using FAO's Food Balance Sheet data.

Figure 2-9. Major Starchy Staples Availability - Nigeria (kg/capita/year)



Source: Author's computation using FAO's Food Balance Sheet data.

2.5.2.4. Trends in Per Capita Macronutrient Availability

This section examines the trends in macronutrient (fats and protein) in the ECOWAS region. To investigate changes in the quality of food supply over time, the section further breaks down for each country in the region, protein supply by source–animal (e.g., meats) and plant sources of protein (e.g., pulses). Protein quality varies depending on the balance of essential amino acids within a given food.[17] Animal protein generally has a better amino acid balance than plant protein[18], although that generalization has several exceptions. For instance, grain legumes, have a concentration of protein that is at least three times that of maize (the most common consumed staple in Sub-Saharan Africa) and grain legumes contain most essential amino acids (de Jager,

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[17] http://www.hsph.harvard.edu/nutritionsource/protein-full-story/

[18] http://www.hsph.harvard.edu/nutritionsource/protein-full-story/

2013). Grain legumes (beans, pulses, and oilseeds) are often called ‘poor people’s meat’ because of their high protein content and affordability. In addition, the amino acid balance of grain legume protein complements that of cereals when eaten together, greatly improving the protein quality of the combined food[19]. Thus, by appropriate mixing plant sources (e.g., maize and beans), one can obtain a mixture of amino acids similar to that available in many animal proteins.

Diaz-Bonilla et al. (2000) suggest that the availability of animal proteins is more directly correlated with measures of nutritional security than is the availability of total proteins. With increases in per capita incomes over time, one would expect an increase in the consumption of animal proteins (essentially from meats, eggs, dairy products, and related products). This section goes further to disaggregate total animal protein supply by type of product in order to identify the principal sources of animal protein and shifts in their absolute and relative contributions, as well as determine the trends in the availability of frozen chicken, whose imports have reputedly soared in certain countries over the past 10 years. Plant protein is further differentiated into pulse (beans and dry peas–-high quality protein) and other plant sources (generally cereals and of lower quality).

2.5.2.4.1. Analysis of Protein Supply

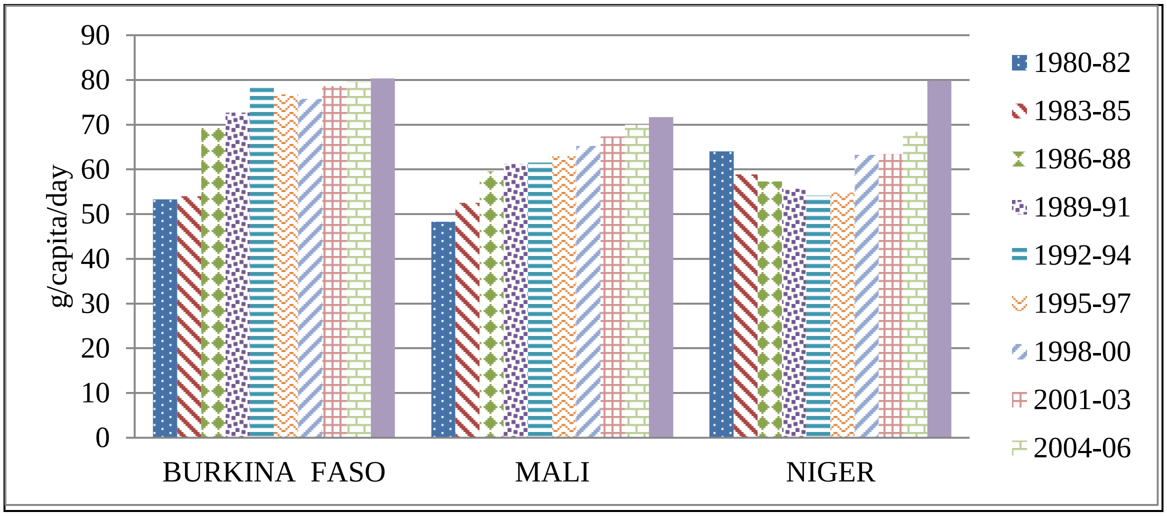
2.5.2.4.1.1. Trend in Total Daily Protein Availability Per Capita

The analysis of protein supply shows an overall increase in per capita protein supply for almost all 15 countries between 1998-2000 and 2007-2009. However, we observe different patterns across the 15 ECOWAS countries. Cape Verde (Coastal Sahel), Ghana and Nigeria (Coastal Non-Sahel)

[19] http://www.cgiar.org/our-research/cgiar-research-programs/cgiar-research-program-on-grain-legumes/

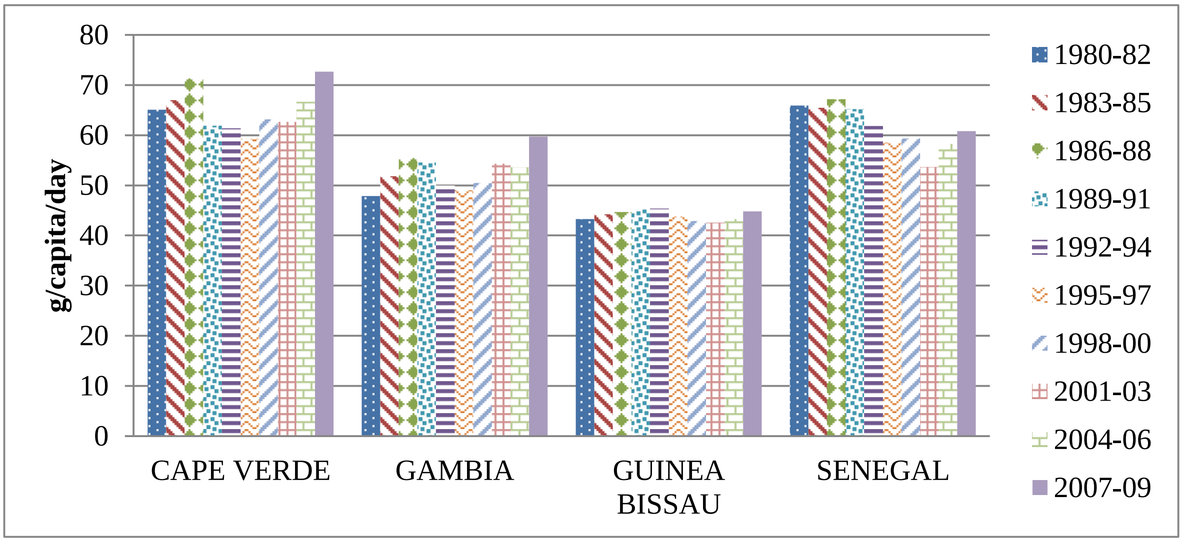
have shown remarkable growth in daily protein availability per capita. Mali (Non-Coastal Sahel) has also shown a steady increase in the supply of proteins per capita per day in the study period. Figures 2-10, 2-11, and 2-12 show the trends in total daily protein supply in the Non-Coastal Sahel, Coastal Sahel, and Coastal Non-Sahel sub regions.

Figure 2-10. Protein Availability (g/capita/day) Non-Coastal Sahel



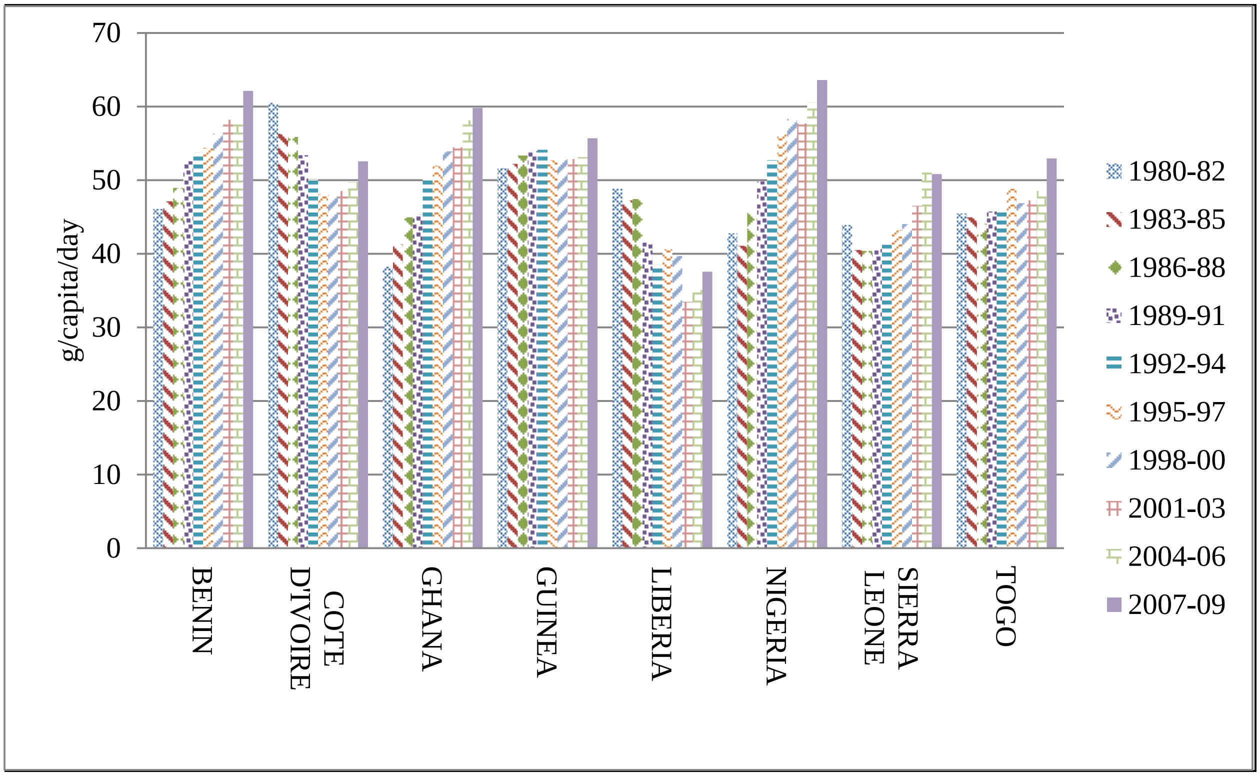
Source: Author's computation using FAO's Food Balance Sheet data.

Figure 2-11. Protein Availability (g/capita/day)-Coastal Sahel



Source: Author's computation using FAO's Food Balance Sheet data.

Figure 2-12. Protein Availability (g/capita/day)-Coastal Non-Sahel



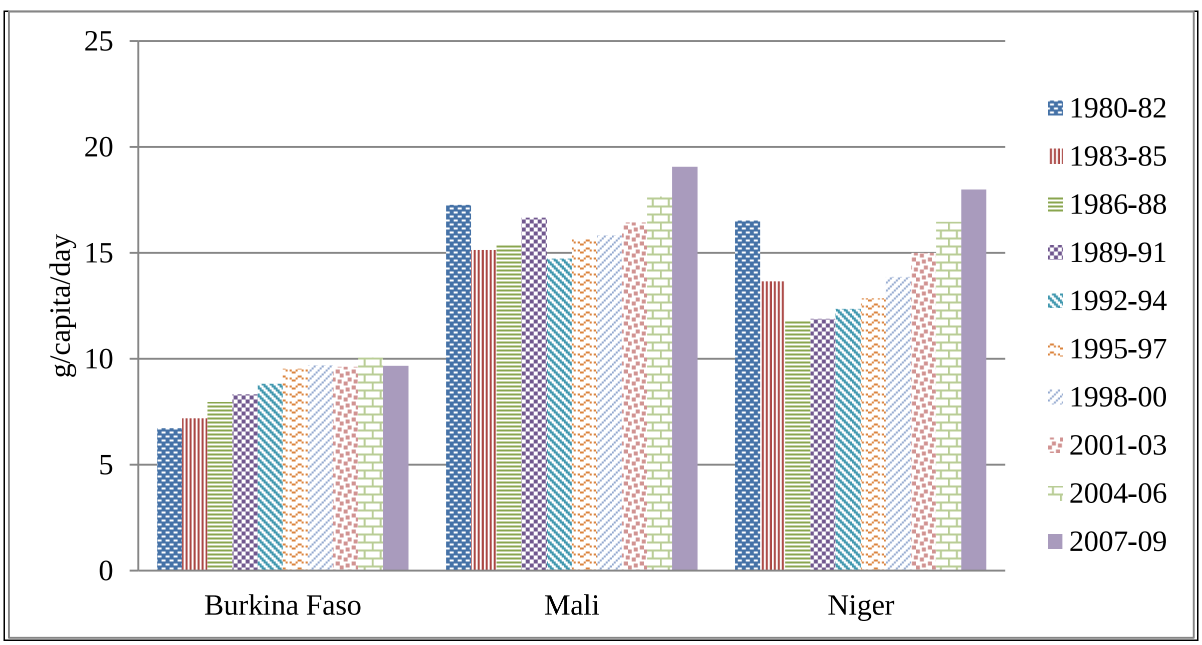
Source: Author's computation using FAO's Food Balance Sheet data.

2.5.2.4.1.2. Daily Protein Supply by Source-Animal versus Plant Protein

The analysis if daily protein supply per capita by source reveals that overall, plant protein is the principal source of protein for almost all countries in the region (with the exception of Cape Verde), and the growth in daily protein supply per capita was mostly driven by growth in plant protein in the period 1980-85 through to 2004-09. Animal protein supply has been increasing for most countries in the region. However, growth in the supply of animal protein has been remarkable in countries that have experienced rapid economic growth over time like Ghana and Cape Verde. Countries with modest economic growth over time like Mali have also shown modest changes in the supply of animal protein over time. Countries that have been through civil disruption like Liberia and Sierra Leone also showed significant declines in total protein and animal protein supply during periods of war.

Specifically, in the Non-Coastal Sahel (Table A2-19 in Appendix), the absolute contribution of animal protein to total daily protein supply in Burkina Faso is lower (less than an average of 10 g/capita/day) than that of Mali and Niger. However, Burkina Faso also exhibited the largest percentage growth in animal protein supply (43%) between 1980-85 and 2004-09, while animal protein supply in Mali and Niger during the same period grew by 16% and 10% respectively. In all three non-Coastal Sahel countries, growth in plant protein accounted for over 85% of the change in total protein supply in the period 1980-85 through to 2004-09. This increase largely reflects the substantial increase in cereal availability in these countries that was described earlier. Figure 2-13 is a graph of animal protein supply in the Non-Coastal Sahel sub-region.

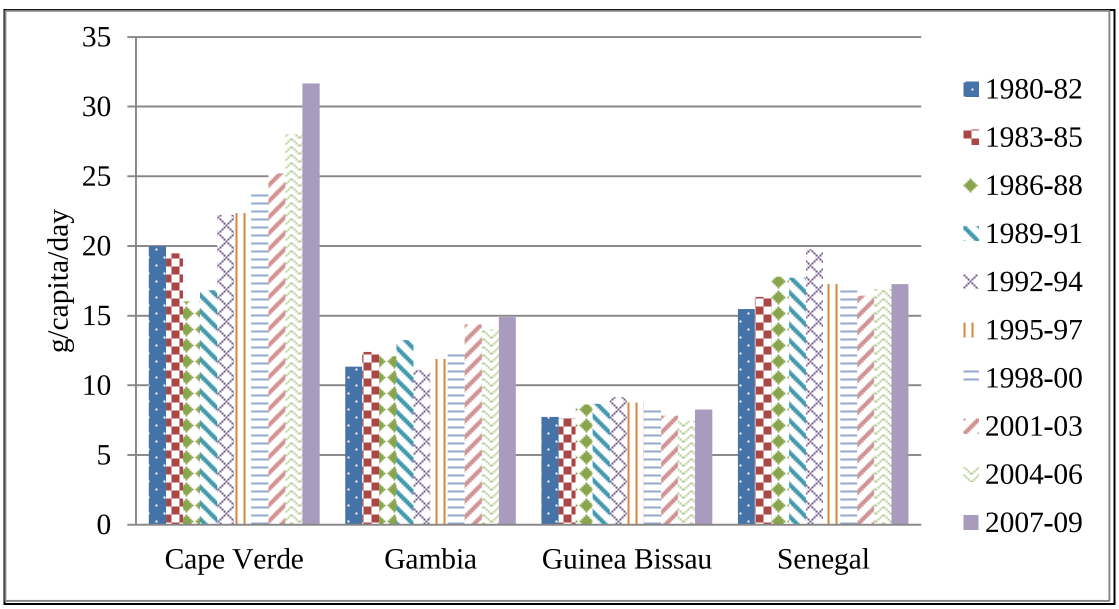
Figure 2-13. Animal Protein Availability (g/capita/day) Non-Coastal Sahel



Source: Author’s computation using FAO’s Food Balance Sheet data

In the Coastal Sahel a breakdown of per capita protein supply by source (Table A2-20 in Appendix) reveals that the supply of animal protein has not only been the highest for Cape Verde, but has also shown significant growth (+54%) between 1980-85 and 2004-09. The supply of animal protein has been greater than 20 g/capita/day since 1992-1994, and the share of animal protein in total daily protein supply in Cape Verde has been greater than 40% and increasing since 2000. In Cape Verde, animal protein growth accounts for about 263% of the growth in total daily protein supply experienced in the study period. The high per capita consumption of animal protein in Cape Verde and the corresponding growth over time is not surprising giving the rapid economic growth experienced by the country in the past two decades. Animal protein supply in Senegal has been between an average of 15-20 g/capita/day since the 1980s and increased by 9.7%, while plant protein declined by 14% in the period 1980-85 through to 2004-09. Figure 2-14 illustrates trends in per capita animal protein supply in these two countries as well as in The Gambia and Guinea Bissau.

Figure 2-14. Animal Protein Availability (g/capita/day) Coastal Sahel

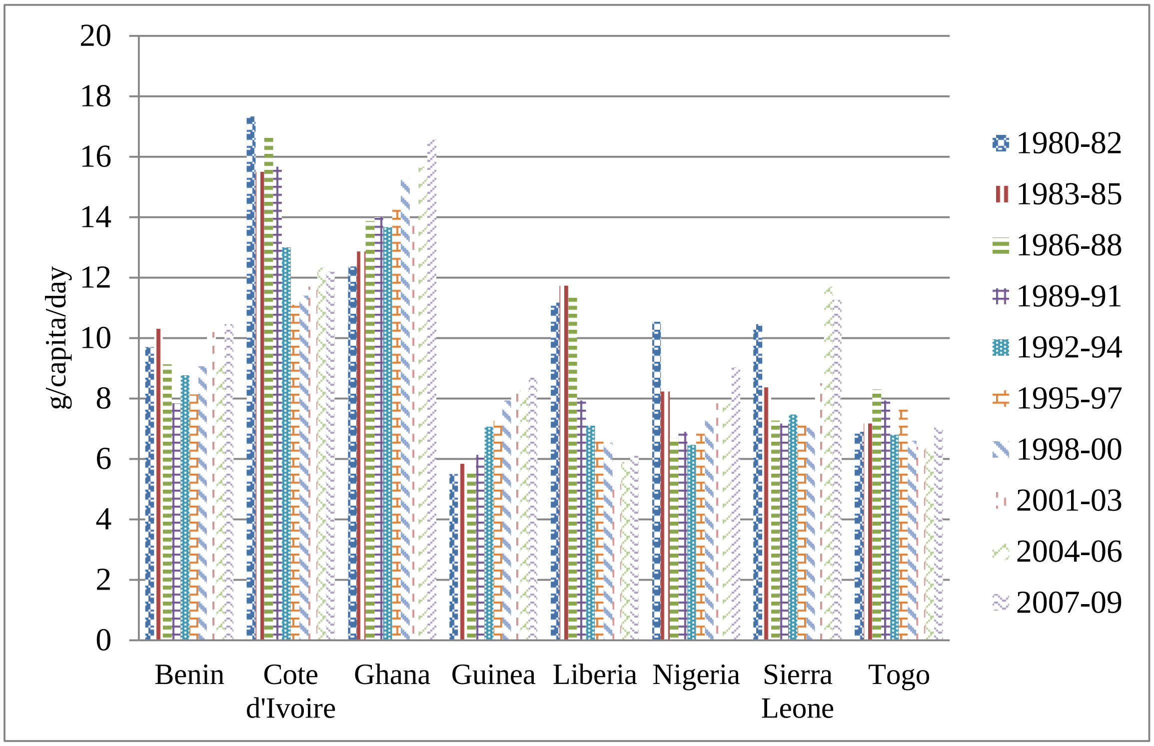


Source: Author’s computation using FAO’s Food Balance Sheet data.

In the Coastal Non-Sahel, a breakdown of daily protein supply by source (Table A2-21 in Appendix) reveals remarkable growth in Ghana with respect to the per capita supply of animal protein. Animal protein supply per person increased in Ghana by 32% between 1980-85 and 2004-09; this growth is likely explained by the strong economic growth experienced by Ghana in the last 15 years. In spite of being amongst the leaders in total daily protein supply per capita in the Coastal Non-Sahel, the supply of animal protein in Nigeria is relatively low–it has been less than an average of 10 g/capita/day since the period 1983-1985. Thus, plant protein largely dominates animal protein in Nigeria, and per capita plant protein increased by 66% while animal protein per person decreased by 11% in the study period. Thus, unlike in Ghana and Cape Verde, the growth in daily protein supply in Nigeria has been driven mainly by increases in cereals availability and, to a lesser degree, pulse availability. In contrast, in spite of the almost constant level of total daily protein supply in Guinea, the supply of animal protein has been increasing over time. Animal protein supply increased by 42% in Guinea in the study period.

Prior to the 1990s, Cote d'Ivoire sustained the largest supply per capita of animal protein in the sub-region. However, this supply dropped in the 1990s and the early 2000s. Since the mid-2000s, animal protein supply in Cote d'Ivoire has been between 11 and 12 g/capita/day, with an overall drop of 27% in the study period. Liberia, which also suffered a civil war as did Cote d'Ivoire, likewise exhibited a sharp decline in animal protein supply per person–from slightly over an average of 10 g/capita/day in the 1980s, to less than 8 g/capita/day in the 1990s, and finally to less than 6 g/capita/day in the 2000s. Overall, animal protein supply per capita in Liberia declined by 48% in the study period. Animal protein supply per capita in Togo was less than an average of 8 g/capita/day and declined by 7% in the study period. In contrast, animal protein supply per person has been increasing in Sierra Leone since 2001-2003 (the end of the country's civil war), with an overall increase of 28% in the study period. With the exception of Cote d'Ivoire, Guinea, and Liberia in the Coastal Non-Sahel region, more than 75% of the change in total daily supply of protein per person is accounted for by the growth in plant protein supply. Figure 2-15 shows the trend in animal protein availability per capita in the Coastal non-Sahel.

Figure 2-15. Animal Protein Availability (g/capita/day) Coastal Non-Sahel



Source: Author's computation using FAO'sFood Balance Sheet data

2.5.2.4.1.3. Animal Protein by Source

Overall, a disaggregation of animal protein by specific source (meats, fish and seafood, eggs, and milk) revealed some interesting trends across all countries in the region. To ensure comparability, the supply of milk reported in FAOSTAT is converted[20] to its dry milk equivalent given that fluid milk has a high water content. Particularly, the rate of growth in poultry meat supply per capita has been quite large for most countries in the region–from 45% in Togo to 1246% in Cape Verde, in the period 1980-85 through to 2004-09. In Benin, for instance, poultry meat supply per capita and milk increased at the expense of all other sources of animal protein, indicating some level of substitution. However, in the Coastal Non-Sahel, fish and seafood remains the most important animal protein source in spite of the increase in poultry meat availability. In Guinea and Sierra Leone, fish and seafood supply per capita grew in the study period. Fish and seafood supply per capita also increased in Niger and Mali (Non-Coastal Sahel), and Senegal and the Gambia (Coastal Sahel). In the Gambia, poultry meat, fish, and seafood and, to a small extent, eggs are substituting for all other sources of animal protein.

Empirical data for the Non-Coastal Sahel reveals that over time, beef, mutton, and goat meat have been the major sources of meat in the Non-Coastal Sahel region.

In Burkina Faso (Table 2-3), in the study period, per capita supply of beef increased by 4 kg/year (109%); that of mutton and goat meat increased by 1 kg/year (35%); that of pig meat by 2 kg/year (about 357%, albeit from a very low base); that of poultry meat by 49%; that of fish and

[20] Conversion factor is 10%, i.e., dry milk equals fluid milk divided by 10.

seafood by 15%; and that of eggs increased by 1 kg/capita (about 100%). Milk supply in dry milk equivalent decreased by 1 kg (29%) in Burkina Faso in the study period.

In Mali (Table 2-4), poultry meat supply grew the most in percentage terms (50%) in the study period but still remains well below the supply of beef, mutton and goat meat. Fish and seafood supply is largest for Mali in the Non-Coastal Sahel region, and has been fairly stable over time. Milk supply in Mali increased by 1 kg (13%) in the period 1980-85 through to 2004-09. Egg supply per capita was below 1 kg/year in the study period. In Niger (Table 2-5), beef supply per capita experienced the largest absolute increase–5 kg/year (56%) in the period 1980-85 through to 2004-09. Per capita consumption of fish and seafood also grew by 2 kg/year (218%), while that of poultry meat dropped by 40%.

Table 2-3. Three-Year Averages of Animal Protein Supply (kg/capita) in Non-Coastal Sahel- Burkina Faso

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	CAGR 1980/85 to 2005/09
Bovine Meat	3.2	3.9	4.4	5.7	6.4	6.8	7.1	7.4	7.7	7.2	109.30%	3.0%
Mutton & Goat Meat	2.1	2.6	2.8	3.2	3.3	3.3	3.3	3.3	3.2	3.1	34.80%	1.2%
Pigmeat	0.4	0.6	0.7	0.8	1.1	1.3	1.6	2	2.4	2.2	356.70%	6.3%
Poultry Meat	1.4	1.6	2	2.2	2.2	2.2	2.2	2.3	2.2	2.2	49.40%	1.5%
Meat, Other	0.9	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.6	0.6	-34.50%	-1.6%
Fish & Seafood	2	2	2	2	2	2	2	2	2	2		0.6%
Eggs	1	1	1	2	3	3	2	2	2	2	100%	2.8%
Milk - dry equivalent	2.6	2.2	2.3	1.6	1.6	1.7	1.8	1.6	1.7	1.7	-29%	-1.4%

Source: Author's calculations using FAO's Food Balance Sheet data.

Table 2-4. Three-Year Averages of Animal Protein Supply (kg/capita) in Non-Coastal Sahel - Mali

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	CAGR 1980/85 to 2005/09
Bovine Meat	5.8	6.7	7.8	8.3	6.0	6.1	6.6	7.4	8.2	9.0	37%	1.3%
Mutton and Goat Meat	6.5	4.7	4.2	4.9	4.3	4.5	4.8	5.1	5.5	6.9	10%	0.4%
Pig Meat	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	8%	0.0%
Poultry Meat	1.7	2.2	2.8	2.7	2.7	2.6	2.8	2.8	3.1	2.8	50%	1.7%
Meat, Other	3.3	2.9	2.7	2.6	2.4	2.4	2.5	2.6	2.9	2.9	-7%	-0.3%
Fish and Seafood	10.2	7.3	7.1	8.3	7.2	11.3	9.4	9.1	9.0	8.1	-2%	0.0%
Eggs	0.6	0.7	0.9	0.8	0.8	0.7	0.6	0.5	0.4	0.5	-37%	-1.8%
Milk - dry equiv.	5.9	4.7	4.6	5.1	5.1	4.8	5.2	5.2	5.7	6.3	13%	0.5%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table 2-5. Three-Year Averages of Animal Protein Supply (kg/capita) in Non-Coastal Sahel- Niger

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	CAGR 1980/85 to 2005/09
Bovine Meat	9.1	8.2	6.5	6.9	8	8.8	10.3	11.9	12.9	14.1	56.40%	1.8%
Mutton & Goat Meat	9.7	6.7	6.5	6.2	5.7	5.7	5.9	5.7	6.2	6.5	-22.60%	-1.0%
Pigmeat	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	-50.00%	-2.7%
Poultry Meat	1.4	1.3	1.2	1.2	1.1	1.1	1	1	0.9	0.7	-40.00%	-2.1%
Meat, Other	3	2.5	2.7	3	3.4	3.1	3	3.1	3.3	3.2	18.20%	0.7%
Fish & Seafood	1	0	0	1	0	1	1	1	3	3	217.86%	4.7%
Eggs	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	-46%	-2.4%
Milk - dry equivalent	5.7	5.2	4.2	4	4	4.3	4.5	4.8	4.9	5.9	-1%	0.0%

Source: Author's calculations using FAO’s Food Balance Sheet data

In the Coastal Sahel (Table 2-6) there was huge growth in the supply of poultry meat in the period 1980-85 and 2004-09. Poultry meat supply per capita increased by 1,246% in Cape Verde; 455% in The Gambia; 256% in Guinea Bissau; and 101% in Senegal in the study period. Pig meat has been the dominant source of meat over time in Cape Verde, and its supply per person also increased by about 290% in the study period. Unlike pig meat, most of the increase in Cape Verde's poultry meat was imported. Poultry meat supply from imports increased from less than 1,000 tons prior to 2000 to an average of 8,000 tons in the period 2007-09. In spite of the high per capita availability of fish and seafood in Cape Verde in the early and mid-1980s, per capita availability dropped by 59% in the study period as chicken apparently substituted for fish in consumption. Per capita supply of eggs also increased by 3 kg (an increase of 300%) while that dry milk also increased by about 5 kg (an increase of about 69%) in Cape Verde in the study period.

In Senegal and The Gambia, beef dominated in meat supply over time. However, its per capita supply declined over time in both countries. Pig meat is the dominant source of meat in Guinea Bissau (in spite of a 14% decline in per capita supply over time). The fish and seafood supply in Senegal grew from an average of 22 kg/person/year in the period 1980-85 to 25 kg/person/year.

Table 2-6. Three-Year Averages of Animal Protein Supply (kg/capita) in Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Cape Verde												
Bovine Meat	1.2	1.2	1.6	1.9	3.9	3.4	1.7	1.7	2.0	3.0	113%	3.0%
Mutton and Goat Meat	1.0	0.9	1.1	1.2	1.3	1.1	1.2	1.1	1.5	1.9	84%	2.4%
Pig Meat	4.8	5.7	8.9	10.7	17.8	15.1	18.3	18.8	19.4	21.6	290%	5.6%
Poultry Meat	1.0	1.1	1.4	1.5	1.9	1.5	2.8	7.1	12.5	16.7	1246%	11.1%
Meat, Other	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.2	0.1	-	n.d.
Fish and Seafood	34.1	29.1	14.9	16.8	14.0	18.3	19.9	18.6	14.3	11.6	-59%	-3.5%
Eggs	1	1	1	1	4	5	5	4	4	4	300%	5.7%
Milk - dry equiv.	6.5	7.2	6.5	5.9	8	8.3	8.2	8.7	10.7	12.4	69%	2.1%
Senegal												
Bovine Meat	6.1	6.0	6.2	5.9	5.4	4.9	4.7	4.5	5.1	6.4	-5%	-0.2%
Mutton and Goat Meat	1.9	2.0	2.6	2.7	2.7	2.7	2.5	2.4	2.6	2.9	41%	1.4%
Pig Meat	0.7	0.7	0.5	0.4	0.5	0.5	0.7	1.0	0.9	0.9	34%	1.0%
Poultry Meat	1.7	1.6	2.1	2.0	2.0	2.0	2.3	3.1	3.3	3.3	101%	2.8%
Meat, Other	1.3	1.3	1.4	1.5	1.5	1.3	1.3	1.3	1.2	1.3	-4%	-0.2%
Fish and Seafood	22.8	21.4	24.1	26.3	34.3	30.7	29.8	28.3	26.5	24.2	15%	0.6%
Eggs	1	1	1	1	1	1	1	2	2	2	100%	2.8%
Milk - dry equiv	3.6	4.4	4.3	3.9	4.2	2.9	2.7	2.3	2.9	3.2	-24%	-1.1%

Table 2-6. (cont'd)

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Gambia												
Bovine Meat	5.3	4.5	5.2	5.2	4	3.2	2.9	2.4	3	2.5	-43%	-2.3%
Mutton & Goat Meat	1.6	1.6	1.5	1.2	0.9	0.7	0.6	0.8	1	1	-37%	-1.9%
Pigmeat	0.6	0.5	0.5	0.6	0.5	0.4	0.3	0.3	0.4	0.5	-24%	-0.8%
Poultry Meat	0.7	0.7	0.8	0.9	1.1	0.9	1.5	1.2	4.4	3.4	455%	7.1%
Meat, Other	1.6	1.4	1.3	1.1	1	0.9	0.8	0.7	0.7	1	-43%	-2.2%
Fish, Seafood	16	17	16	22	18	24	23	29	24	28	58%	1.8%
Eggs	1	1	1	1	1	1	1	1	2	2	100%	2.8%
Milk - dry equiv.	2.5	3.4	2.8	1.6	1.8	1.7	2.4	2.8	2.4	3		-0.4%
Guinea Bissau												
Bovine Meat	2.7	3	3	3.5	3.9	3.8	3.9	3.6	3.6	3.9	32%	1.1%
Mutton & Goat Meat	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.2	1.4	18%	0.7%
Pigmeat	9.4	9.4	9.3	8.8	8.7	8.5	8.3	8	7.9	8.4	-14%	-0.6%
Poultry Meat	0.4	0.5	0.6	0.7	0.8	0.8	1.1	1.4	1.5	1.7	256%	5.2%
Meat, Other	0	0	0	0	0	0	0	0	0	0	-100%	n.d.
Fish, Seafood	3	2	4	4	5	5	4	2	2	1	-40%	-2.0%
Eggs	0.3	0.4	0.4	0.4	0.4	0.5	0.6	0.7	0.7	0.7	110%	3.0%
Milk - dry equiv.	1.6	1.7	2.1	2	2.1	1.7	1.5	1.5	1.5	1.6	-6%	-0.2%

Source: Author's calculations using FAO's Food Balance Sheet data.

In the Coastal Non-Sahel, Table 2-7 reveals that fish and seafood remain by far the dominant source of animal protein (in spite of the growth in poultry meat consumption). Among meats, poultry has been the dominant meat type in Benin over time. Poultry meat supply per capita increased by 115% between 1980-85 and 2004-09, while the supply of all other types of meats declined in the same period. It is important to note that some of this apparent increase in per capita chicken consumption in Benin may reflect chicken that was clandestinely exported to Nigeria, which had a ban on frozen chicken import during some of this period. While fish and seafood have been dominant sources of animal protein in Benin, per capita supply has been declining over time–from an average of 11 kg/capita/year in 1980-85 to an average of 8.5 kg/capita/year in 2004-09. Egg supply per person per year declined by 1 kg (50%) in the study period, and annual milk supply per capita remained around an average of 1 kg throughout the period of study.

In Cote d'Ivoire, the supply per capita of all meat types declined over time, and the largest percentage decline (62%) was for beef and milk. In Ghana, poultry meat supply per capita increased by 570%, while that of fish and seafood increased by 38% in the study period. Fish and seafood supply per capita is largest for Ghana (mostly greater than 25 kg/capita/year) in the Coastal Non-Sahel. Milk supply per person in Ghana increased from an average of 4 kg in the beginning of the period to an average of 8 kg at the end of the period. Poultry meat supply per person in Nigeria dropped by 8% and that of fish and seafood dropped by 10% in the study period. Guinea, Liberia, Sierra Leone, and Togo experienced increases in poultry meat supply per capita of 190%, 168%, 63%, and 45% respectively. Guinea and Sierra Leone also experienced increases in fish and seafood supply per capita of 45% and 36% respectively.

Table 2-7. Three-Year Averages of Meat Supply (kg/capita) in Coastal Non-Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Benin												
Bovine Meat	3.5	3.6	3.4	3.4	4.1	2.8	2.9	2.8	2.8	2.9	-20%	-0.9%
Mutton & Goat Meat	1.6	1.9	1.3	1.2	1	1.1	1	0.9	0.9	0.9	-49%	-2.6%
Pigmeat	1.5	1.5	1.5	1.1	1.2	1.2	0.5	0.6	0.6	0.7	-57%	-3.3%
Poultry Meat	4.1	6.2	4.3	3.2	4.7	4.9	7.8	10	8.5	13.6	115%	3.1%
Meat, Other	1.6	1.5	1.4	1.3	1.2	1.1	0.9	2.2	0.8	0.8	-50%	-2.6%
Fish, Seafood	12	10	11	9	10	10	8	9	9	8	-23%	-1.0%
Eggs	2	2	2	1	1	1	1	1	1	1	-50%	-2.7%
Milk - dry equiv	0.8	0.8	0.8	0.6	0.6	0.8	1.2	1.1	1	0.8		0.5%
Cote d'Ivoire												
Bovine Meat	5.8	5.2	4.7	5.3	4	2.7	2.4	1.9	2.1	2.1	-62%	-3.8%
Mutton & Goat Meat	1.2	1.1	0.9	0.8	0.7	0.7	0.6	0.6	0.7	0.6	-44%	-2.3%
Pigmeat	1.1	0.9	0.9	0.9	0.8	0.6	0.4	0.4	0.7	0.8	-23%	-1.1%
Poultry Meat	2.4	2.2	2.5	2.1	1.8	1.6	1.4	1.6	1.6	1.3	-38%	-1.8%
Meat, Other	10.2	9.8	9.3	9	8.2	7.4	7.1	7.4	7.6	8.2	-21%	-0.9%
Fish, Seafood	18	16	20	18	14	13	14	14	14	13	-21%	-0.9%
Eggs	1	1	1	1	1	1	2	2	1	1	0%	0.0%
Milk - dry equiv	2.1	1.8	2.1	1.4	1.3	0.9	0.7	0.7	0.8	0.7		-3.7%

Table 2-7. (cont'd)

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Ghana												
Bovine Meat	1.6	1.8	1.6	2.1	2.7	1.6	1.4	1.3	1.4	1.7	-7%	-0.4%
Mutton & Goat Meat	0.9	0.7	0.7	0.7	0.7	0.7	0.9	1.1	1.2	1.3	56%	1.8%
Pigmeat	0.8	0.7	0.8	0.9	0.7	0.8	0.7	0.7	0.7	0.9	9%	0.3%
Poultry Meat	0.8	0.5	0.5	1	1.1	1.2	1.7	2.7	3.7	5.2	570%	8.0%
Meat, Other	6.7	7.3	6.5	6.1	5.6	5.3	5	4.8	4.6	4.5	-35%	-1.7%
Fish, Seafood	21	21	26	25	24	28	31	25	28	29	36%	1.2%
Eggs	1	0	0	1	1	1	1	1	1	1	100%	2.8%
Milk - dry equiv	0.2	0.5	0.4	0.4	0.3	0.2	0.5	0.7	0.8	0.8		3.4%
Guinea												
Bovine Meat	2.6	2.7	2.1	2.7	3.2	3.7	3.8	4.1	4.6	5.1	81%	2.4%
Mutton & Goat Meat	0.5	0.6	0.5	0.6	0.6	0.8	0.9	1	1.2	1.5	150%	3.7%
Pigmeat	0.4	0.3	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	-38%	-2.2%
Poultry Meat	0.4	0.3	0.4	0.4	0.6	0.5	0.6	0.6	0.9	1.2	190.90%	4.5%
Meat, Other	0.8	0.8	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.5	-29.20%	-1.5%
Fish, Seafood	7	8	8	9	11	11	12	13	11	10	40%	1.4%
Eggs	1	1	1	1	1	1	1	2	2	2	100%	2.8%
Milk - dry equiv	1	1.2	1.1	1	1.2	1.2	1.3	1.2	1.3	1.4		0.8%

Table 2-7. (cont'd)

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Liberia												
Bovine Meat	1.4	1.3	0.9	0.9	1.7	0.7	0.6	0.5	0.4	0.3	-73%	-5.3%
Mutton & Goat Meat	0.6	0.6	0.6	0.6	0.7	0.6	0.5	0.4	0.4	0.5	-28%	-1.1%
Pigmeat	2.1	2	2.2	2.3	2.3	2.2	1.9	1.9	2.4	2.6	21%	0.8%
Poultry Meat	1.5	1.8	2.4	2.7	2.9	3.1	3.4	3	4.2	4.6	168%	4.0%
Meat, Other	6.9	6.3	6.7	3.6	3.6	3.6	3.2	2.5	2.2	2.4	-65%	-4.1%
Fish, Seafood	13	15	15	10	6	6	6	4	5	5	-64%	-4.0%
Eggs	1	2	2	2	2	2	2	1	2	2	33%	1.2%
Milk - dry equiv	1	1.3	0.8	0.4	0.3	0.3	0.3	0.2	0.4	0.3		-4.6%
Nigeria												
Bovine Meat	5	5.2	3	2.2	2.3	2.5	2.4	2.2	2	1.9	-62%	-3.8%
Mutton & Goat Meat	1.2	1.4	1.6	1.7	1.8	2.1	2.6	2.8	2.8	2.8	110%	3.1%
Pigmeat	0.5	0.6	1	1.1	1.1	1.2	1.3	1.4	1.4	1.4	158%	3.8%
Poultry Meat	1.8	1.7	1.7	1.8	1.6	1.5	1.4	1.5	1.6	1.6	-8%	-0.4%
Meat, Other	1.3	1.2	1.1	1	1	0.9	0.9	0.9	0.9	0.9	-31%	-1.3%
Fish, Seafood	16	9	7	10	6	7	7	9	9	13	28%	-0.5%
Eggs	3	3	3	3	4	3	3	3	3	4	12%	0.6%
Milk - dry equiv	1.5	0.9	0.5	0.6	0.6	0.6	0.5	0.7	0.8	0.8		-1.6%

Table 2-7. (cont'd)

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980/85 to 2004/09	CAGR 1980/85 to 2005/09
Sierra Leone												
Bovine Meat	1.7	1.6	1.4	1.4	1.8	1.5	1.4	1.1	1.3	1.5	-14.30%	-0.7%
Mutton & Goat Meat	0.4	0.4	0.3	0.3	0.4	0.3	0.3	0.2	0.4	0.5	16.70%	0.5%
Pigmeat	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.6	-3%	-0.3%
Poultry Meat	1.8	1.8	2	2.1	2.2	2.3	2.5	3.4	2.8	3	63%	1.9%
Meat, Other	0.6	0.6	0.5	0.5	0.5	0.5	0.6	1.1	1.8	1.8	203%	4.5%
Fish, Seafood	22	17	14	14	14	14	15	18	27	25	33%	1.2%
Eggs	1	1	1	1	1	2	2	2	1	2	50%	1.6%
Milk - dry equiv	1.6	0.9	0.9	0.8	0.8	0.5	0.3	0.4	0.5	0.5		-3.6%
Togo												
Bovine Meat	2	3	3.1	1.6	1.2	1.4	1.3	1.5	1.5	1.7	95%	-1.8%
Mutton & Goat Meat	0.9	1	1.5	1.7	1.1	1	1.3	1.3	1.3	1.4	50%	1.4%
Pigmeat	1.2	1.1	1.2	1.5	1.5	1	1.2	1.3	1.4	1.6	20%	1.0%
Poultry Meat	2.2	2	3.2	2.4	2.2	2.6	2.9	3.9	3.7	5.2	45%	3.0%
Meat, Other	1.4	1.2	1.2	1.1	1	0.9	0.8	0.9	0.8	0.9	89%	-1.8%
Fish, Seafood	11	10	12	12	11	14	10	7	7	7	-38%	-1.6%
Eggs	0	1	1	1	1	1	1	1	1	1	0%	2.8%
Milk - dry equiv	0.4	0.4	0.4	0.5	0.4	0.5	0.3	0.4	0.6	0.5		1.3%

Source: Author's computation using FAO's Food Balance Sheet data

2.5.2.4.1.4. Plant Protein by Source

To further examine the quality of protein supplied, plant protein was disaggregated between the portion due to pulses and all other plant sources. Pulses are an important share of plant protein supply in Cape Verde, Niger, and Nigeria. Pulses have accounted for 9% (Burkina Faso) to 57% (Niger) of the change in plant protein supply in the period 1980-85 through to 2004-09. Compared to the Non-Coastal Sahel, and with the exception Cape Verde, pulses contribute less than 10 g/capita/day of protein and have had small shares (less than 10%) in daily plant protein supply in the Coastal Sahel.

In the Coastal Non-Sahel sub-region, protein supply from pulses has been less than 10 g/capita/day, and pulses accounted for from 16% (Nigeria) to 257% (Guinea—from a small base) of the growth in plant protein in the period of study. The growth in the share of pulses in daily plant protein supply reflects some degree of diet upgrading. Thus, in spite of the relatively low per capita availability of high quality animal protein in most countries in the region, the positive growth in protein supply from pulses as well as in the share of pulses in daily plant protein supply supports the emergence of pulses as *poor people's meat* in the region. Tables 2-8, 2-9, and 2-10 shows the contribution of pulses to daily plant protein supply per capita in the Non-Coastal Sahel, the Coastal Sahel and the Coastal Non-Sahel sub regions, respectively.

Table 2-8. The Contribution of Pulses to Plant Protein Supply (g/capita/day) Non-Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% of total change	% change 1980-85 to 2004-09
Burkina Faso												
Plant - Total	46.6	46.8	61.4	64.3	69.9	67.2	66.1	69.1	69.6	70.7		
Pulses -Total	5.8	5.4	6.9	7.2	7.5	6.7	7.0	6.8	7.7	7.8	9%	
Pulse Share	13%	11%	11%	11%	11%	10%	11%	10%	11%	11%		-8%
Mali												
Plant - Total	31.0	37.3	44.3	44.6	46.8	47.2	49.4	51.0	52.3	52.6		
Pulses -Total	2.2	2.5	3.2	3.4	6.0	5.5	7.5	6.8	6.1	4.5	16%	
Pulse Share	7%	7%	7%	8%	13%	12%	15%	13%	12%	9%		46%
Niger												
Plant - Total	47.5	45.2	45.4	43.8	41.7	41.9	49.4	48.4	51.9	61.9		
Pulses -Total	13.9	10.8	11.4	9.2	8.4	8.4	14.8	11.8	14.5	22.1	57%	
Pulse Share	29%	24%	25%	21%	20%	20%	30%	24%	28%	36%		20%

Source: Author's calculations using FAO’s Food Balance Sheet data

Table 2-9. The Contribution of Pulses to Plant Protein Supply (g/capita/day)-Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% of total change	% change 1980-85 to 2004-09
Cape Verde												
Plant- Total	45.1	47.5	55.3	45.0	39.2	36.9	39.1	37.4	38.6	41.0		
Pulses -Total	7.1	8.4	16.3	9.6	3.9	4.9	5.6	4.8	4.6	6.5	33%	
Pulse Share	16%	18%	29%	21%	10%	13%	14%	13%	12%	16%		-16%
Gambia												
Plant- Total	36.5	39.4	43.3	41.3	38.8	37.2	37.9	40.0	39.6	44.9		
Pulses -Total	3.1	2.8	2.5	2.2	2.0	1.6	1.7	2.6	1.3	1.2	-40%	
Pulse Share	8%	7%	6%	5%	5%	4%	4%	7%	3%	3%		-62%
Guinea Bissau												
Plant- Total	35.6	36.6	36.0	36.5	36.2	35.0	34.4	34.7	35.8	36.6		
Pulses -Total	1.3	1.3	1.2	1.2	1.1	1.1	1.1	0.9	0.9	1.8	38%	
Pulse Share	4%	3%	3%	3%	3%	3%	3%	3%	2%	5%		3%
Senegal												
Plant- Total	50.4	49.2	49.4	47.5	42.1	41.3	42.5	37.2	41.3	43.6		
Pulses -Total	1.9	2.8	3.0	1.4	2.1	2.0	3.1	1.1	2.2	3.5	-7%	
Pulse Share	4%	6%	6%	3%	5%	5%	7%	3%	5%	8%		40%

Source: Author's calculations using FAO’s Food Balance Sheet data

Table 2-10. The Contribution of Pulses to Plant Protein (g/capita/day) Coastal Non-Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% of total change	% change 1980-85 to 2004-09
Benin												
Plant - Total	36.4	36.9	39.8	44.7	45.0	46.3	47.2	48.0	48.8	51.7		
Pulses -Total	3.3	3.7	4.3	4.7	5.2	4.9	5.6	5.7	6.4	8.9	31%	
Pulse Share	9%	10%	11%	11%	12%	11%	12%	12%	13%	17%		59%
Cote d'Ivoire												
Plant - Total	43.2	40.8	39.1	37.7	37.1	37.0	36.6	36.8	37.4	40.4		
Pulses -Total	0.5	0.4	0.4	0.4	0.3	0.5	1.0	1.0	1.2	1.3	-26%	
Pulse Share	1%	1%	1%	1%	1%	1%	3%	3%	3%	3%		200%
Ghana												
Plant - Total	25.9	28.4	31.1	31.3	36.5	37.6	38.6	40.6	42.5	43.3		
Pulses -Total	0.7	0.5	0.6	0.6	0.5	0.4	0.4	0.3	0.4	0.4	-1%	
Pulse Share	3%	2%	2%	2%	1%	1%	1%	1%	1%	1%		-55%
Guinea												
Plant - Total	46.2	46.4	47.8	47.9	47.1	45.4	44.9	44.6	44.8	47.0		
Pulses -Total	4.4	4.4	4.7	5.1	4.5	4.1	4.0	3.8	3.6	3.3	257%	
Pulse Share	10%	9%	10%	11%	10%	9%	9%	9%	8%	7%		-22%

Table 2-10. (cont'd)

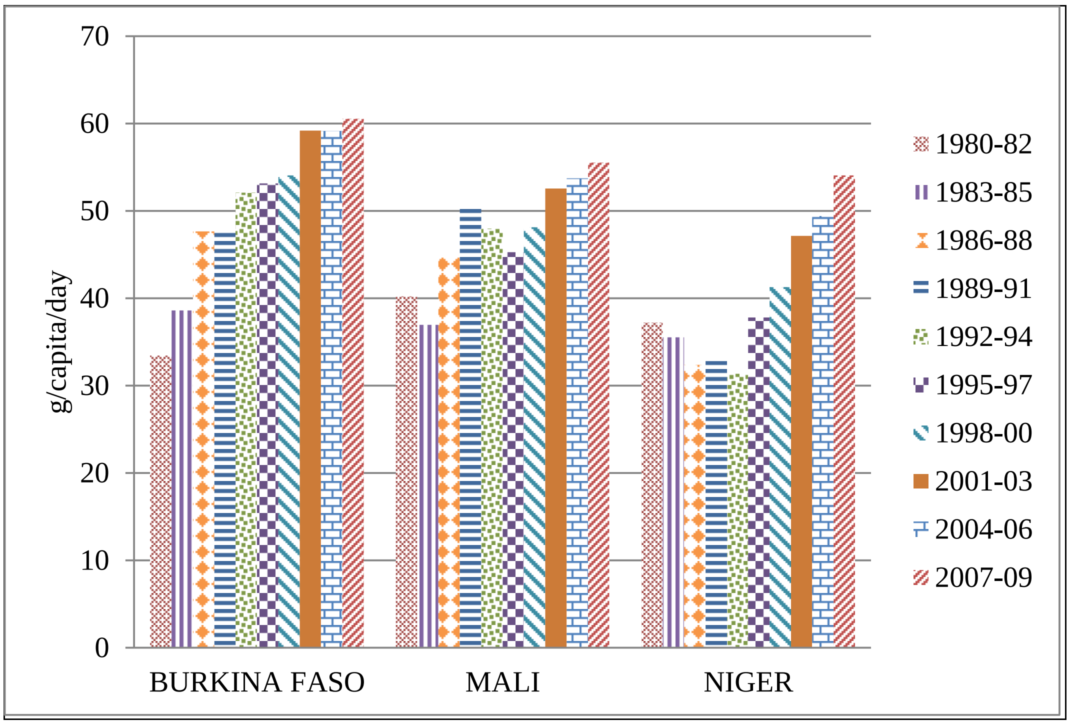
	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% of total change	% change 1980-85 to 2004-09
Liberia												
Plant- Total	37.6	35.5	36.0	33.6	31.5	34.0	33.2	28.3	29.2	31.5		
Pulses -Total	0.8	0.8	0.8	1.1	1.8	2.4	2.6	1.4	1.7	1.5	-13%	
Pulse Share	2%	2%	2%	3%	6%	7%	8%	5%	6%	5%		142%
Nigeria												
Plant- - Total	32.3	32.9	38.9	42.9	46.3	49.2	51.1	49.8	52.7	54.6		
Pulses -Total	2.6	2.3	2.9	4.6	4.8	5.3	5.9	5.4	5.6	6.3	16%	
Pulse Share	8%	7%	7%	11%	10%	11%	11%	11%	11%	11%		46%
Sierra Leone												
Plant- - Total	33.4	32.2	33.2	33.4	33.8	36.1	37.0	38.0	40.0	39.5		
Pulses -Total	4.8	4.6	4.6	4.8	4.7	5.5	6.9	7.5	7.6	7.2	39%	
Pulse Share	14%	14%	14%	14%	14%	15%	19%	20%	19%	18%		30%
Togo												
Plant- - Total	38.6	37.8	35.7	37.8	39.3	41.0	40.3	40.9	42.2	45.9		
Pulses -Total	4.1	4.7	3.9	2.7	3.8	5.0	4.3	4.3	4.9	6.1	19%	
Pulse Share	11%	12%	11%	7%	10%	12%	11%	11%	12%	13%		8%

Source: Author's computation using FAO's Food Balance Sheet data.

2.5.2.4.2. Analysis of Fat Supply

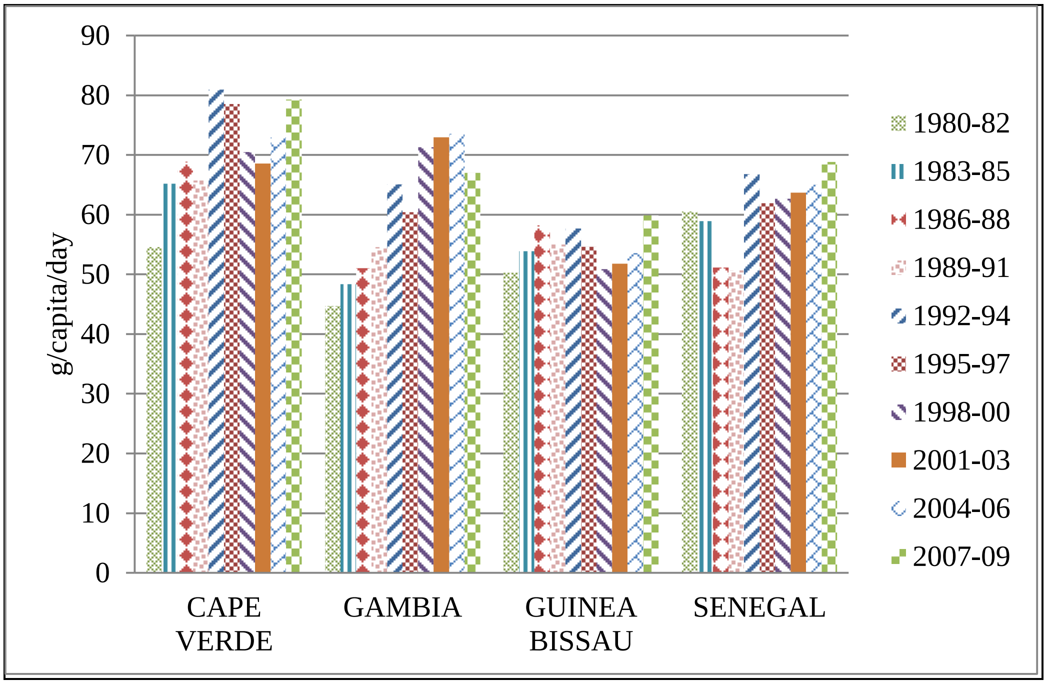
With the exception of Sierra Leone, total fat availability per capita increased for all countries in the period 1980-85 and 2004-09, and has been generally highest for Coastal Sahelian countries. Notwithstanding, the percentage increases in per capita fat supply were largest for non-Coastal Sahelian countries. Figures 2-16 to 2-18 show the trends in daily fat supply (g/capita/day) by sub-region.

Figure 2-16. Fat Availability (g/capita/day) Non-Coastal Sahel



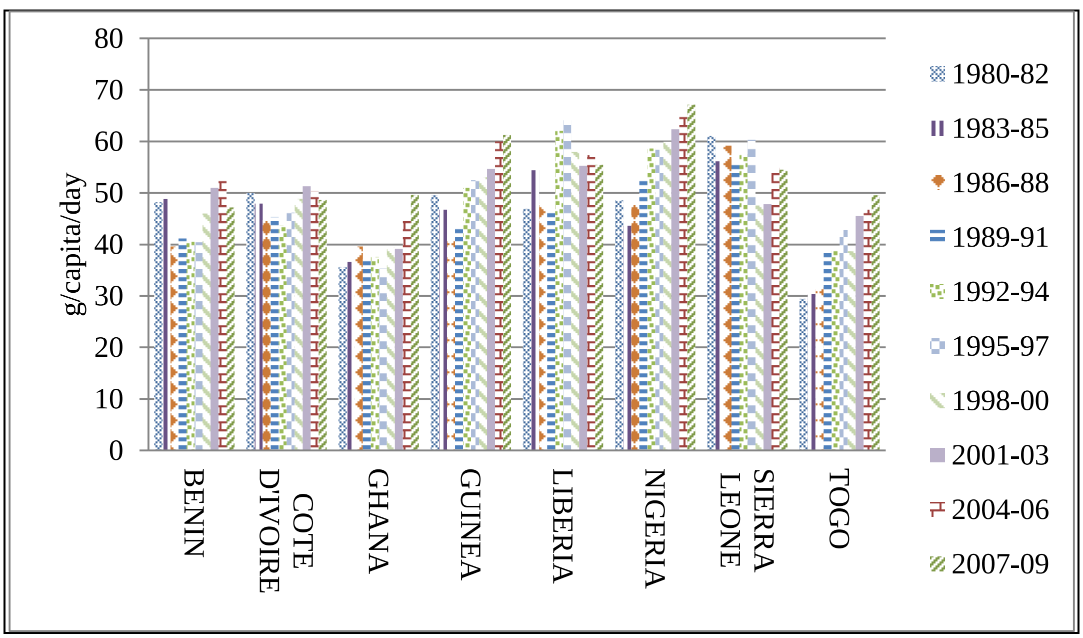
Source: Author’s computation using FAO’s Food Balance Sheet data.

Figure 2-17. Fat Availability (g/capita/day) Coastal Sahel



Source: Author's computation using FAO'sFood Balance Sheet data.

Figure 2-18. Fat Availability (g/capita/day) Coastal Non-Sahel



Source: Author's computation using FAO's–Food Balance Sheet data

2.5.2.5. Trends in the Share of Macronutrient Group in Daily Per Capita Energy Supply

The contribution of various macronutrient groups to total daily per capita energy supply is one indicator of diet quality. This section examines whether the composition of per capita food supply in terms of major macronutrient groups is becoming more balanced, based on the joint FAO/WHO guidelines for various nutrients for a balanced diet—55-75% of total calories from carbohydrates, 15-35% from fats and 10-15% from proteins (Nishida et al. 2004). The analysis reveals that over time, while most countries in ECOWAS-WA have remained close to the upper bound of the daily recommended share of carbohydrates in energy supply, few of these countries deviate from the lower bound of the recommended share of protein and fats in daily energy supply.

2.5.2.5.1. Non-Coastal Sahel

Figure 2-19 shows the trends in the share of various macronutrient groups in total daily energy supply per capita in the Non-Coastal Sahel. (See Me-Nsope and Staatz (2013) for the underlying data for this and the other sub-regions.) The share of protein, fats, and carbohydrates in total daily energy supply has not changed much. In particular, the share of protein seems almost constant over time, as minor redistributions takes place between fats and carbohydrates. Nonetheless, since total per capita calorie availability increased markedly for these countries over the study period, the absolute levels of fat and protein consumption also increased substantially. In addition, we saw from the analysis of protein by source in the Non-Coastal Sahel that the contribution of animal protein has been growing since the early 2000s. Thus, in spite of the almost constant share of protein in total daily energy supply, the quality of protein supply has improved to some extent due to the growth in consumption of animal protein.

2.5.2.5.2. Coastal Sahel

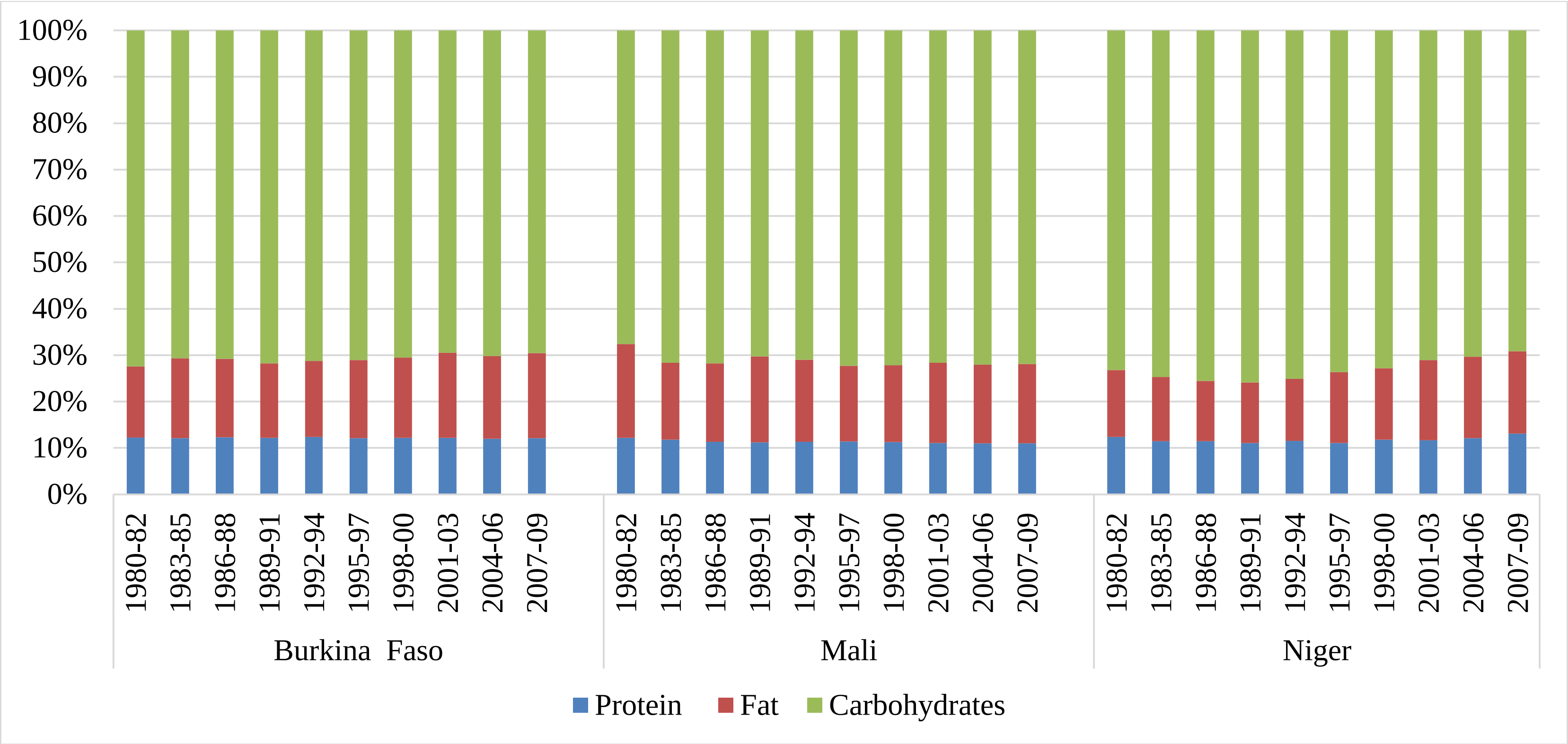
In the Coastal Sahel (Figure 2-20), the share of carbohydrates still remains close to the upper bound of the daily-recommended share. The share of protein has also remained close to its daily-recommended lower bound (10-15%). The Gambia and Guinea Bissau over time have fallen below the minimum daily protein share in total daily energy supply. As was the case in the Non-Coastal Sahel, just focusing on the share of protein in total daily energy supply obscures the important changes that have taken place (in particular in Cape Verde) in terms of the quality of protein supply. The share of fat in daily energy supply has been much higher in the Coastal Sahel than in the Non-Coastal Sahel.

2.5.2.5.3. Coastal Non-Sahel

In the Coastal Non-Sahel region, a similar pattern of not much variation in the share of each macronutrient group in daily per capita energy supply is observed (Figure 2-21). However, unlike in the case of the Coastal and Non-Coastal Sahel, the share of protein in daily energy, over time, and for almost all Coastal Non-Sahelian countries, has remained below the recommended daily protein share (10%) in total daily energy supply. With the exception of Sierra Leone, which has shown a slight increase in protein share over time, protein share in all the other countries has been either constant or declining. It is, however, worth noting that while the share of protein in total daily energy supply has not shown much change, the analysis of protein supply in absolute terms as well as of the contribution of animal protein to total protein supply seen earlier revealed not only an increase in the amount of protein supplied over time (Benin, Ghana, Nigeria, Sierra Leone), but also an increase in the quality of protein supply over time (Ghana, Nigeria[21] and Sierra Leone). Ghana and Cote d'Ivoire have consistently had higher than the daily-recommended carbohydrate share over time, and this seems not to be changing much. This is not surprising because of the high consumption of starchy roots and tubers in these countries. Guinea, Liberia, and Togo, in contrast, have experienced a decline in the share of carbohydrates towards the upper bound of the recommended daily share.

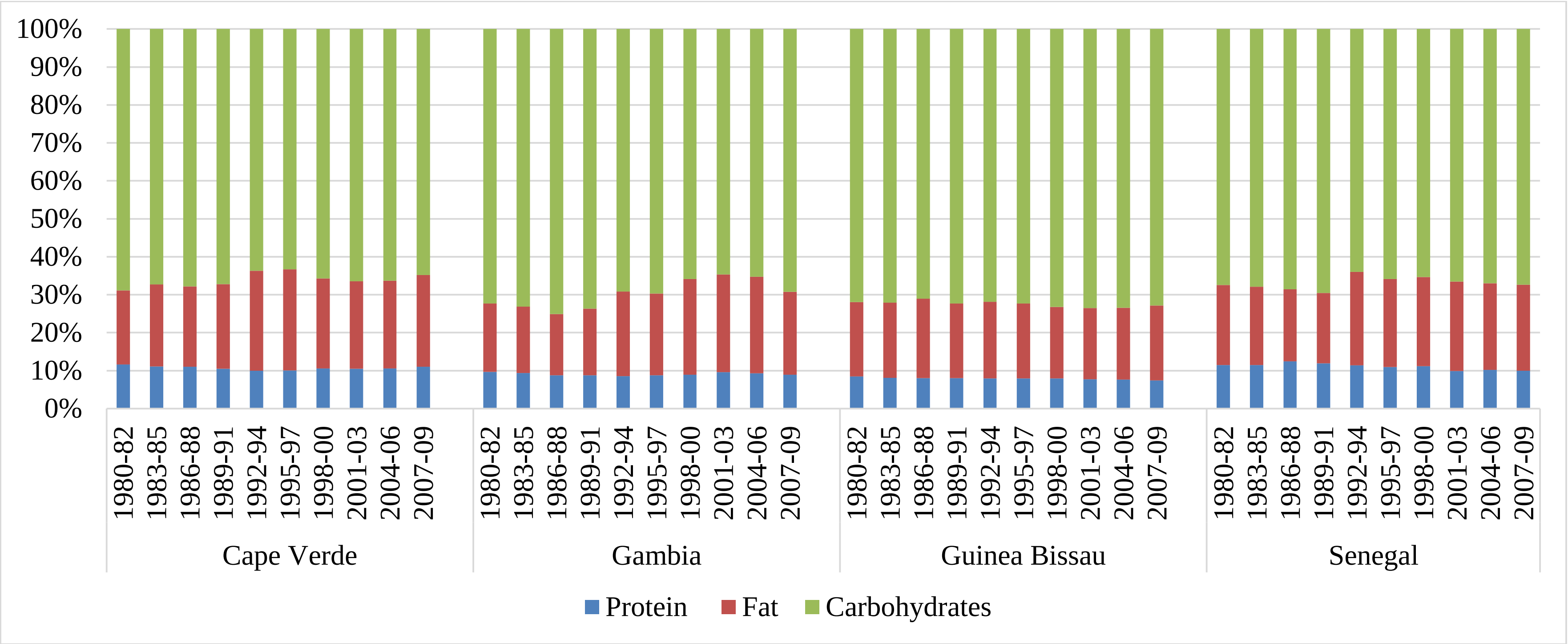
[21] In Nigeria, the increase in the supply of protein from pulses per capita over time offsets the decline in animal protein supply per capita, so that overall, the supply of high quality protein (pulses and animal sources) increased over time.

Figure 2-19. Daily Caloric Share (%) by Macronutrients - Non-Coastal Sahel



Source: Author's computation using FAO's Food Balance Sheet data

Figure 2-20. Daily Caloric Share (%) by Macronutrients - Coastal Sahel



Source: Author's computation using FAO's Food Balance Sheet data.

Figure 2-21. Daily Caloric Share (%) by Macronutrients - Coastal Non-Sahel

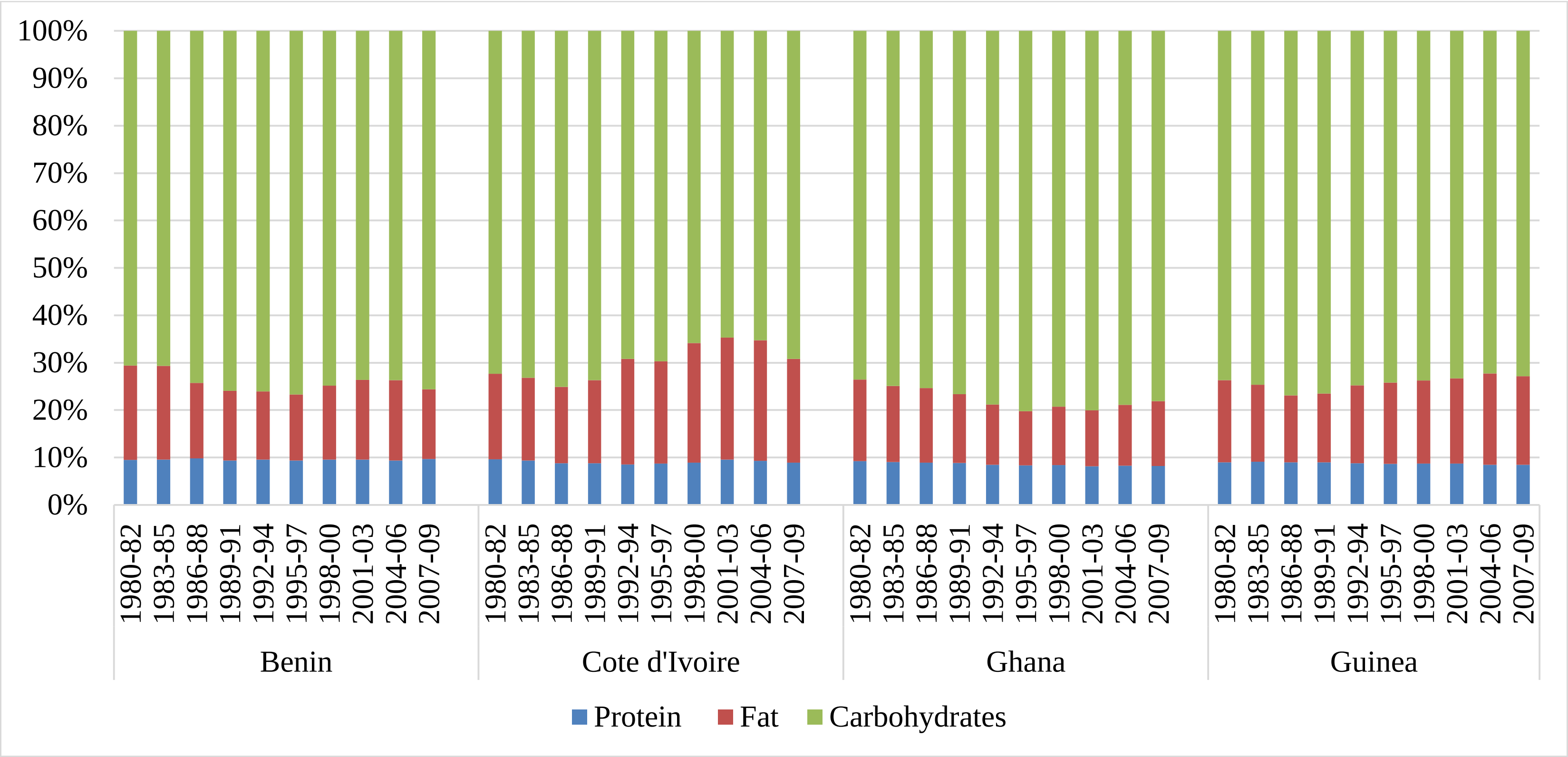
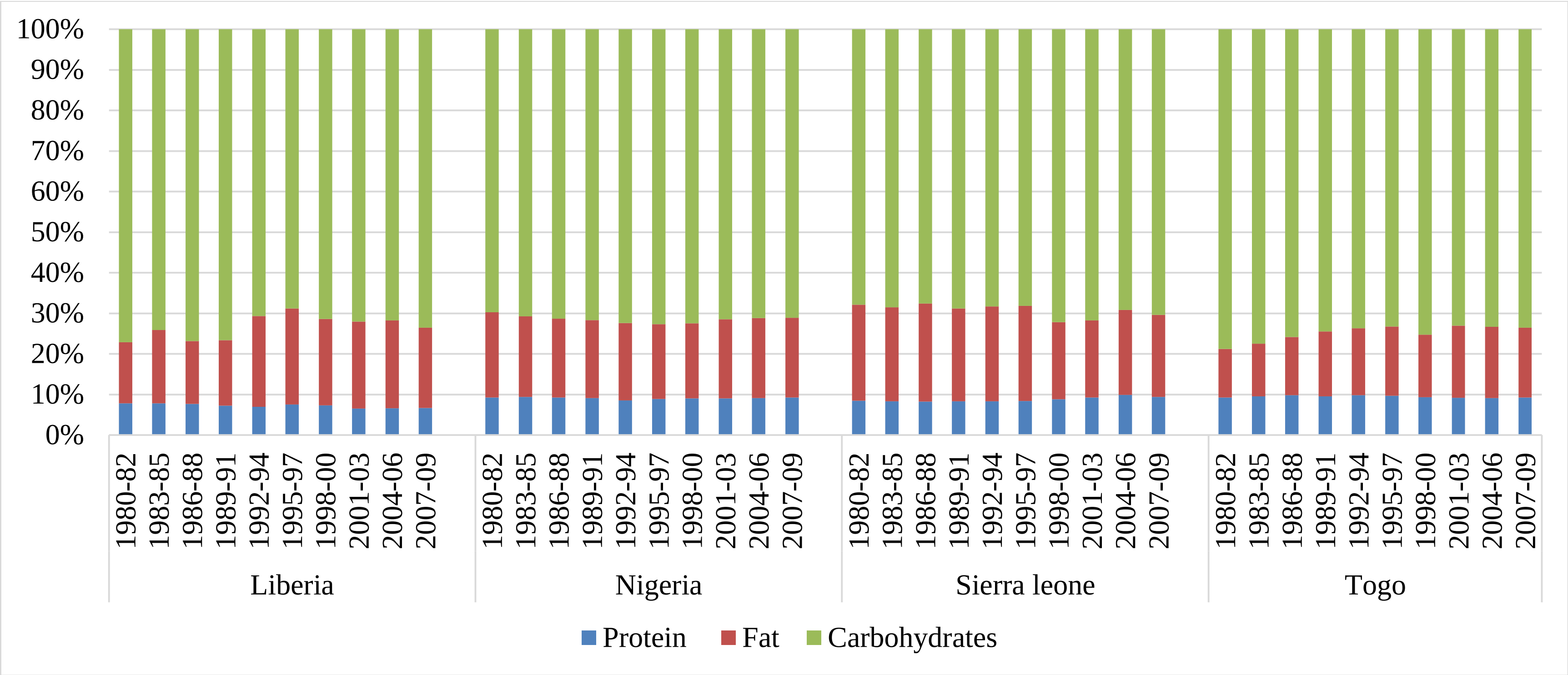


Figure 2-21. (cont'd)



Source: Author's computation using FAO's Food Balance Sheet data.

2.6. Chapter Summary

The goal of this chapter was to provide evidence of shifts in per capita food availability patterns in ECOWAS West Africa. In particular, the analysis was intended to identify major contributors to diets, changes in the levels as well as in the composition of per capita food supply at the country-level and to enhance understanding of the food supply situation within the ECOWAS using national-level FAOSTAT's food balance sheet data from 1980-2009. The analysis reveals a trend towards greater calorie supply for most ECOWAS countries. The growth in daily energy availability has been much more pronounced and consistent for countries experiencing rapid economic growth (e.g., Ghana and Cape Verde), but has been disrupted in countries that have been through civil disruptions like Cote d'Ivoire, Liberia and Sierra Leone.

The analysis also provides evidence of a diversification in the composition of food supply. The relative importance of starchy roots and tubers in total food availability, particularly in the Sahel region, has grown over time. The analysis reveals evidence consistent with the "cassava revolution" that has taken place in some of the Coastal Non-Sahelian countries such as Nigeria, Ghana, and Sierra Leone (Nweke et al., 2002). The growth in the per capita availability of cassava (e.g., Senegal) and sweet potatoes (e.g., Mali) most likely reflects the lower income population shifting towards cheaper calorie sources. Per capita availability of yams also showed huge increases in some Coastal Non-Sahelian countries (e.g., Ghana and Nigeria). There has also been positive growth in the supply of Irish potatoes in some countries (e.g., Cape Verde and Senegal), supporting evidence of a westernization of diets (increased consumption of potato chips/French fries). The analysis also provides evidence of a striking growth in per capita availability of maize in the Sahel (Burkina Faso, Mali, and Senegal). Per capita rice availability increased for most countries in the study period. In Cape Verde, for example, there is been a replacement of maize with rice as the dominant type of cereal. Although food availability is only one dimension of food security, rising starchy staple availability is likely to have a positive impact for food security in the region.

With respect to the quality of the per capita food supply, the supply of daily protein per capita has been increasing for most countries since the early 2000s. Proteins from plant sources are the dominant source of protein in the entire region. Although plant protein dominates as the major source of protein for most of these countries, some of these countries (e.g., Niger, Sierra Leone, Nigeria and Cape Verde) derive an important share of vegetable protein from pulses, which are also a source of high-quality protein. Some countries have shown a positive trend in the supply of animal protein. The countries that have shown evidence of diet upgrading through increased per capita availability of animal protein have been mostly those that have also shown evidence of rapid and strong economic growth over time (e.g., Ghana and Cape Verde). Countries with modest economic growth, such as Mali, have also shown modest growth in the consumption of animal protein over time. Apparent per capita daily fat supply increased for most countries in the study period. The share of carbohydrates, fats, and proteins in total daily energy (calorie) supply, however, did not change much over time. While most countries meet and even exceed the WHO/FAO recommended daily allowance (measured as shares) for carbohydrates, the share of protein in daily energy continues to remain close to the lower bound of the recommended daily value. However, this has not always meant that the diets have not improved over time, as some countries have experienced not only a positive growth in the supply of proteins in absolute terms, but also have been improving in terms of the availability of animal protein as well as pulses. Although fish and seafood remain the main animal protein source for most of the coastal states in the ECOWAS zone, most of the countries in the region have experienced growth in the per capita supply of poultry meat over time, primarily from imports.

APPENDIX

Table A2-1. Food Availability by Major Food Group–Non-Coastal Sahel- Burkina Faso (kg/capita/year)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	148	148	196	217	229	224	218	224	232	228	55%
Starchy R & T	17	17	15	7	7	6	6	6	7	8	-56%
Sugar & Sweeteners	4	4	4	4	4	5	4	5	5	5	25%
Pulses	10	9	12	12	13	11	12	12	13	13	37%
Oilcrops	6	8	11	9	12	11	12	15	12	14	86%
Vegetable Oils	3	4	4	4	4	5	5	5	6	6	71%
Fruits Excl. wine	8	8	7	7	7	6	6	6	5	5	-38%
Vegetables-	21	23	22	24	23	21	19	17	17	15	-27%
Meat & offal	9	11	12	15	16	16	17	18	19	18	85%
Eggs	1	1	1	2	3	3	2	2	2	2	100%
Milk - Excl. Butter	26	22	23	16	16	17	18	16	17	17	-29%
Fish & Seafood	2	2	2	2	2	2	2	2	2	2	15%
Alcoholic Beverages	50	46	55	54	63	61	52	55	54	54	13%

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-2. Food Availability by Major Food Group - Mali (kg/capita/year)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals	125	155	185	181	176	181	181	189	198	204	44%
Starchy R&T	4	3	3	5	8	9	13	18	26	32	729%
Sugar & Sweeteners	4	4	6	10	10	11	13	13	13	12	213%
Pulses	4	4	5	6	10	9	12	11	10	7	113%
Vegetable Oils	6	5	7	8	8	7	8	8	8	8	45%
Fruits - Excl. Wine	17	17	18	17	19	23	24	26	30	28	71%
Vegetables	46	49	51	54	51	53	52	52	47	52	4%
Meat & offal	20	19	20	21	18	18	19	21	23	25	23%
Eggs	1	1	1	1	1	1	1	1	0	0	-100%
Milk Excl. Butter	59	47	46	51	51	48	52	52	57	63	13%
Fish, Seafood	10	7	7	8	7	11	9	9	9	8	0%
Alcoholic Beverages	5	6	7	7	5	6	5	6	6	6	9%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-3. Food Availability by Major Food Group–Non-Coastal Sahel - Niger (kg/capita/year)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	%change 1980-85 to 2004-09
Cereals Excl. Beer	197	201	199	211	200	200	200	202	200	209	3%
Starchy R & T	31	32	29	21	14	17	22	14	14	13	-57%
Sugar & Sweeteners	4	7	7	5	3	6	7	6	7	6	18%
Pulses	23	18	18	15	14	14	24	19	23	36	44%
Vegetable Oils	3	3	2	3	2	4	4	5	5	4	50%
Fruits - Excl. Wine	7	7	6	6	5	5	6	10	12	15	93%
Vegetables	21	16	16	30	34	41	49	54	49	51	170%
Meat and offal	27	22	19	20	21	21	23	25	27	28	12%
Eggs	1	1	1	1	1	1	0	0	0	0	-100%
Fish & Seafood	1	0	0	1	0	1	1	1	3	3	218%
Milk Excl. Butter	57	52	42	40	40	43	45	48	49	59	-1%
Alcoholic Beverages	2	1	1	1	0	1	1	0	0	1	-67%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-4. Food Availability by Major Food Group - Coastal Non-Sahel- Benin (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals – Excl. Beer	93	92	97	109	107	108	108	108	114	115	24%
Starchy R&T	205	212	229	268	266	283	287	289	278	296	38%
Sugar & Sweeteners	0	2	3	4	6	7	6	6	4	6	400%
pulses	6	7	8	9	9	9	10	10	12	17	123%
Oilcrops	7	7	7	8	8	9	9	10	9	8	21%
Vegetable Oils	9	9	6	6	5	5	7	8	9	7	-11%
Fruits Excl. wine	36	35	33	34	31	32	29	30	30	37	-6%
Vegetables-	37	38	42	43	46	49	54	49	48	48	28%
Meat & offal	13	16	13	11	13	12	14	17	14	20	17%
Eggs	2	2	2	1	1	1	1	1	1	1	-50%
Milk – Excl. Butter	8	8	8	6	6	8	12	11	10	8	13%
Fish & Seafood	12	10	11	9	10	10	8	9	9	8	-23%
Alcoholic Beverages	14	12	12	12	11	12	11	12	14	15	12%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-5. Food Availability by Major Food Group–Coastal Non-Sahel - Cote d'Ivoire (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals – Excl. Beer	116	111	105	99	98	96	89	90	92	102	-15%
Starchy R&T	314	295	282	274	268	269	286	281	287	309	-2%
Sugar & Sweeteners	10	10	11	10	10	9	8	9	10	9	-5%
Oilcrops	5	4	4	4	4	4	5	5	4	4	-11%
Vegetable Oils	10	10	9	10	10	11	12	13	12	11	15%
Fruits Excl. wine	106	92	87	83	88	91	90	74	75	76	-24%
Vegetables-	40	39	37	43	41	39	34	39	37	35	-9%
Meat & offal	22	21	20	20	17	14	13	14	16	16	-26%
Eggs	1	1	1	1	1	1	2	2	1	1	0%
Milk – Excl. Butter	21	18	21	14	13	9	7	7	8	7	-62%
Fish & Seafood	18	16	20	18	14	13	14	14	14	13	-21%
Alcoholic Beverages	44	40	36	33	31	35	34	40	44	46	7%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-6. Food Availability by Major Food Group–Coastal Non-Sahel-Ghana (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals – Excl. Beer	56	63	67	75	92	83	83	91	97	90	57%
Starchy R&T	216	239	273	283	331	396	402	404	381	403	72%
Sugar & Sweeteners	2	2	6	6	7	5	6	7	10	11	425%
Oilcrops	22	17	13	11	11	12	13	13	13	13	-33%
Vegetable Oils	5	6	7	7	7	5	6	6	8	9	55%
Fruits Excl. wine	79	92	83	69	82	106	111	117	136	158	72%
Vegetables	20	18	23	25	24	31	34	31	34	34	79%
Meat & offal	11	12	11	11	11	10	10	11	13	15	22%
Eggs	1	0	0	1	1	1	1	1	1	1	100%
Milk – Excl. Butter	2	5	4	4	3	2	5	7	8	8	129%
Fish & Seafood	21	21	26	25	24	28	31	25	28	29	36%
Alcoholic Beverages	18	17	18	18	24	25	22	20	21	23	26%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-7. Food Availability by Major Food Group–Coastal Non-Sahel – Guinea (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals – Excl. Beer	118	123	135	131	129	127	125	126	126	136	9%
Starchy R&T	119	112	111	115	114	113	117	116	123	126	8%
Sugar & Sweeteners	5	8	10	9	10	11	12	11	12	13	92%
Pulses	7	7	8	8	8	7	7	6	6	6	-14%
Oilcrops	4	4	3	3	4	4	4	5	6	6	50%
Vegetable Oils	12	11	10	10	13	13	13	13	15	15	30%
Fruits Excl. wine	117	116	114	117	119	110	104	106	103	104	-11%
Vegetables	82	77	73	68	65	60	57	55	55	51	-33%
Meat & offal	5	5	4	5	6	7	7	8	9	10	90%
Eggs	1	1	1	1	1	1	1	2	2	2	100%
Milk – Excl. Butter	10	12	11	10	12	12	13	12	13	14	23%
Fish & Seafood	7	8	8	9	11	11	12	13	11	10	40%
Alcoholic Beverages	1	1	1	2	2	1	2	2	2	2	100%

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-8. Food Availability by Major Food Group-Coastal Non-Sahel- Liberia (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	132	126	123	112	91	98	97	86	93	107	-22%
Starchy R&T	173	140	190	179	156	132	160	178	166	161	4%
Sugar & Sweeteners	5	7	7	5	5	5	5	5	6	7	8%
Oilcrops	5	5	5	5	6	5	4	4	4	3	-30%
Vegetable Oils	12	15	12	12	18	19	17	16	17	16	22%
Fruits Excl. wine	57	55	48	48	56	62	53	51	48	46	-16%
Vegetables	31	33	34	32	35	34	27	23	23	24	-27%
Meat & offal	13	12	13	10	12	11	10	9	10	11	-16%
Eggs	1	2	2	2	2	2	2	1	2	2	33%
Milk - Excl. Butter	10	13	8	4	3	3	3	2	4	3	-70%
Fish & Seafood	13	15	15	10	6	6	6	4	5	5	-64%
Alcoholic Beverages	11	11	11	9	10	10	8	7	8	8	-27%

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-9. Food Availability by Major Food Group-Coastal Non-Sahel -Nigeria (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	97	103	123	124	133	137	137	133	141	145	43%
Starchy R&T	107	95	111	166	231	235	238	210	215	223	117%
Sugar & Sweeteners	11	8	6	5	6	7	8	10	10	10	5%
Pulses	4	4	5	8	8	9	10	9	9	10	138%
Oil Crops	5	4	4	5	5	6	7	7	8	8	78%
Vegetable Oils	11	9	10	12	14	13	13	14	15	15	50%
Fruits Excl. wine	61	62	58	61	66	64	65	63	62	59	-2%
Vegetables	38	39	41	44	47	52	57	57	60	59	55%
Meat & offal	11	11	9	8	8	9	9	10	9	10	-12%
Eggs	3	3	3	3	4	3	3	3	3	4	34%
Milk - Excl. Butter	15	9	5	6	6	6	5	7	8	8	-34%
Fish & Seafood	16	9	7	10	6	7	7	9	9	13	-10%
Alcoholic Beverages	75	67	65	60	59	62	69	68	69	67	-4%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-10. Food Availability by Major Food Group–Coastal Non-Sahel- Sierra Leone (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	117	111	113	115	112	107	114	112	110	116	-1%
Starchy R&T	37	36	34	34	45	79	69	71	68	74	95%
Sugar & Sweeteners	7	6	5	5	5	4	5	5	6	7	0%
Pulses	8	8	8	8	8	9	11	12	13	12	56%
Oilcrops	3	3	5	4	5	7	5	6	9	7	167%
Vegetable Oils	18	16	17	16	16	16	13	12	13	14	-21%
Fruits Excl. wine	36	37	37	36	36	36	36	36	35	36	-3%
Vegetables	46	47	45	43	44	44	42	46	47	47	1%
Meat & offal	6	5	5	6	6	6	6	7	7	8	36%
Eggs	1	1	1	1	1	2	2	2	1	2	50%
Milk - Excl. Butter	16	9	9	8	8	5	3	4	5	5	-60%
Fish & Seafood	22	17	14	14	14	14	15	18	27	25	33%
Alcoholic Beverages	46	48	46	44	43	44	44	50	49	51	6%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-11. Food Availability by Major Food Group–Coastal Non-Sahel – Togo (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	98	102	100	111	112	116	115	119	123	130	27%
Starchy R&T	243	200	177	187	178	188	202	187	185	198	-14%
Sugar & Sweeteners	8	9	7	5	2	3	4	4	6	8	-19%
Pulses	8	8	7	5	7	9	8	8	8	10	15%
oilcrops	6	5	4	5	6	5	5	7	7	7	24%
Vegetable Oils	4	4	5	7	6	8	7	8	9	9	126%
Fruits Excl. wine	13	12	12	11	10	9	9	8	8	9	-32%
Vegetables	23	25	30	39	37	31	25	25	26	29	14%
Meat & offal	8	9	11	9	8	7	8	9	9	11	20%
Eggs	0	1	1	1	1	1	1	1	1	1	85%
Milk - Excl. Butter	4	4	4	5	4	5	3	4	6	5	37%
Fish & Seafood	11	10	12	12	11	14	10	7	7	7	-29%
Alcoholic Beverages	28	24	25	18	14	13	10	10	11	14	-52%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-12. Food Availability by Major Food Group - Coastal Sahel-Cape Verde (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals –Excl. Beer	152	160	152	137	140	124	128	123	125	126	-20%
Starchy R& T	33	22	57	51	33	33	38	42	45	48	69%
Sugar & Sweeteners	13	16	16	17	19	20	22	26	25	23	66%
Pulses	12	14	27	16	6	8	9	8	8	11	-27%
Oilcrops	17	15	11	9	7	7	7	8	7	7	-56%
Vegetable Oils	6	8	10	8	13	13	8	8	9	8	21%
Fruits Excl. wine	32	30	31	33	44	49	44	44	53	75	106%
Vegetables	5	8	20	24	26	33	43	46	53	61	777%
Meat & offal	9	10	14	16	26	22	26	30	37	45	332%
Eggs	1	1	1	1	4	5	5	4	4	4	300%
Milk –Excl. Butter	65	72	65	59	80	83	82	87	107	124	69%
Fish & Seafood	34	29	15	17	14	18	20	19	14	12	-59%
Alcoholic Beverages	12	14	17	17	24	24	30	33	38	40	200%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-13. Food Availability by Major Food Group–Coastal Sahel- Gambia (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	145	153	170	160	145	140	137	141	140	175	6%
Starchy R& T	9	9	8	8	8	6	9	10	11	9	11%
Sugar & Sweeteners	20	30	48	48	37	36	32	26	28	28	12%
Oilcrops	5	7	7	7	7	7	8	7	6	6	0%
Vegetable Oils	10	10	10	12	16	14	17	18	18	15	65%
Fruits Excl. wine	5	5	4	4	3	4	5	5	4	6	0%
Vegetables	12	11	20	29	35	27	31	27	34	32	187%
Meat & offal	11	10	10	10	8	7	7	6	10	9	-10%
Eggs	1	1	1	1	1	1	1	1	2	2	100%
Milk - Excl. Butter	25	34	28	16	18	17	24	28	24	30	-8%
Fish & Seafood	16	17	16	22	18	24	23	29	24	28	58%
Alcoholic Beverages	16	20	28	23	22	21	31	33	35	35	94%

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-14. Food Availability by Major Food Group–Coastal Sahel – Guinea Bissau (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	139	146	140	143	148	140	138	145	146	145	2%
Starchy R& T	46	50	68	63	59	64	71	69	69	75	50%
Sugar & Sweeteners	3	3	2	3	2	4	4	6	12	7	217%
Oilcrops	4	3	4	4	4	4	4	3	4	11	114%
Vegetable Oils	9	11	12	11	13	11	11	12	12	16	40%
Fruits Excl. wine	43	44	48	51	52	50	48	46	44	15	-32%
Vegetables	20	18	17	17	17	18	17	16	16	40	47%
Meat & offal	15	15	15	15	16	16	16	16	15	17	7%
Eggs	0	0	0	0	0	1	1	1	1	1	-
Milk - Excl. Butter	16	17	21	20	21	17	15	15	15	16	-6%
Fish & Seafood	3	2	4	4	5	5	4	2	2	1	-40%
Alcoholic Beverages	31	31	26	24	25	23	20	21	29	26	-11%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-15. Food Availability by Major Food Group–Coastal Sahel-Senegal (kg/capita)

Food Group	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09
Cereals - Excl. Beer	177	180	175	179	157	154	150	154	163	167	-8%
Starchy R& T	8	7	11	9	9	7	13	18	23	29	247%
Sugar & Sweeteners	16	14	11	15	15	18	14	14	13	15	-7%
Oilcrops	11	7	9	7	6	5	4	5	6	5	-39%
Vegetable Oils	11	12	7	9	15	15	15	15	14	16	30%
Fruits Excl. wine	12	12	13	13	13	14	13	15	14	17	29%
Vegetables	17	16	20	27	27	43	47	53	56	64	264%
Meat & offal	13	13	15	14	14	13	13	14	15	17	23%
Eggs	1	1	1	1	1	1	1	2	2	2	100%
Milk - Excl. Butter	36	44	43	39	42	29	27	23	29	32	-24%
Fish & Seafood	23	21	24	26	34	31	30	28	27	24	16%
Alcoholic Beverages	5	4	4	4	4	4	4	4	4	3	-22%

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-16. Starchy Staples Availability (kg/capita/year) - Non-Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	Absolute change 1980-85 to 2004-09
Burkina Faso											
Wheat	4	4	4	3	5	7	7	3	7	7	3
Rice (Milled)	7	14	13	13	15	21	21	20	19	18	8
Maize	16	15	20	34	28	30	35	39	45	49	32
Millet	49	49	69	78	76	65	70	70	72	65	20
Sorghum	71	66	89	87	104	99	82	89	88	87	19
Cassava	4	3	1	0	0	0	0	0	0	0	-4
Sweet Potatoes	4	3	3	2	1	1	2	3	4	4	1
Yams	10	10	11	4	5	4	4	3	3	3	-7
Mali											
Wheat	6	7	9	5	4	4	8	8	9	9	3
Rice (Milled)	22	25	27	26	32	39	50	50	54	55	31
Maize	8	16	20	18	20	23	23	26	28	29	17
Millet	47	58	75	70	56	61	54	59	62	64	11
Sorghum	37	45	52	60	62	53	44	44	44	44	3
Potatoes	0	0	0	2	5	5	5	6	7	4	6
Sweet potatoes	1	1	1	1	1	1	3	6	10	19	14
Cassava	0	0	0	0	0	0	1	2	3	1	2
Yams	2	2	1	1	1	1	3	3	4	6	3
Niger											
Wheat	6	7	6	8	7	4	5	6	5	5	-2
Rice (Milled)	8	11	10	10	9	10	12	18	20	11	6
Maize	2	3	2	1	1	3	6	4	4	2	1
Millet	136	142	140	155	149	147	145	141	130	148	0
Sorghum	44	38	40	37	35	35	30	33	39	42	-1
Cassava	28	25	24	16	9	13	16	10	9	8	-18
Sweet Potatoes	3	7	5	4	4	4	4	3	3	3	-2

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-17. Starchy Staples Availability (kg/capita) in Selected Countries in Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	Absolute change 1980-85 to 2004-09
Cape Verde											
Wheat	41	45	45	35	37	35	36	37	38	43	-3
Rice (Milled)	17	21	22	24	29	34	39	41	50	49	31
Maize	94	94	85	78	75	52	53	44	36	32	-60
Cassava	8	5	14	12	7	7	7	6	7	8	1
Potatoes	10	12	14	13	17	17	22	26	29	29	18
Sweet potatoes	14	6	29	27	7	7	8	8	8	10	-1
Senegal											
Wheat	20	19	19	25	23	23	25	28	30	33	12
Rice (Milled)	68	66	60	64	57	62	69	69	69	74	5
Maize	13	16	17	16	14	11	9	11	27	28	13
Millet	54	54	62	60	51	47	36	34	28	25	-28
Sorghum	21	24	16	15	12	11	11	12	9	8	-14
Cassava	4	3	8	6	6	4	9	12	16	19	14
Potatoes	2	3	3	3	3	2	3	3	5	6	3
Sweet Potatoes	1	1	1	0	0	0	1	3	2	3	2

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-18. Starchy Staples Availability (kg/capita/year) in Selected Coastal Non-Sahel Countries

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	Absolute change 1980-85 to 2004-09
Benin											
Wheat	14	9	11	11	12	9	9	8	5	9	-5
Rice (Milled)	7	11	10	16	17	20	12	18	31	33	23
Maize	56	53	56	60	58	60	67	61	58	57	3
Millet	1	1	3	3	3	3	3	3	3	3	2
Sorghum	15	17	17	17	16	15	17	18	16	13	-2
Cassava	116	118	119	145	145	160	144	144	137	146	25
Sweet Potatoes	8	8	7	6	7	9	8	8	6	7	-2
Yams	81	86	102	116	114	114	134	137	135	143	56
Cote d'Ivoire											
Wheat	22	20	20	17	15	14	16	16	15	16	-6
Rice (Milled)	61	59	56	54	53	53	46	50	53	64	-2
Maize	29	28	26	24	26	26	23	21	20	19	-9
Millet	1	1	2	2	2	2	2	1	1	1	0
Sorghum	2	1	1	1	1	1	1	1	1	1	-1
Cassava	109	106	102	100	98	101	110	103	101	110	-2
Potatoes	1	1	1	1	1	1	1	1	1	1	0
Sweet Potatoes	1	1	2	2	2	2	3	2	2	2	1
Yams	189	177	170	166	165	162	170	172	180	193	4

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-18 con'td. Starchy Staples Availability (kg/capita/year) in Selected Coastal Non-Sahel Countries

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	Absolute change 1980-85 to 2004-09
Ghana											
Wheat	10	8	10	12	12	8	13	11	16	18	8
Rice (Milled)	6	7	9	12	17	11	12	22	24	27	19
Maize	25	33	34	36	43	43	40	42	41	28	6
Millet	7	7	7	6	7	8	6	6	6	6	-1
Sorghum	8	8	8	9	12	13	11	9	9	10	2
Cassava	126	120	148	163	198	231	219	215	206	212	86
Sweet Potatoes	0	0	0	0	0	3	5	4	4	5	5
Yams	45	68	64	61	74	95	110	117	114	132	67
Other roots	45	51	60	59	59	67	69	67	57	55	8
Nigeria											
Wheat	16	14	6	4	9	8	15	17	18		3
Rice (Milled)	16	14	15	21	20	20	22	23	22		7
Maize	7	9	28	31	33	29	22	20	23		15
Millet	24	28	32	35	32	36	36	32	35		9
Sorghum	33	37	42	34	39	44	43	40	43		8
Cassava	81	74	84	115	155	151	144	114	116		39
Sweet Potatoes	1	1	1	1	2	9	12	14	16		15
Yams	24	20	25	48	72	72	74	73	72		50
Potatoes	0	0	0	0	1	0	2	3	3	4	4

Source: Author's computation using FAO's Food Balance Sheet data.

Table A2-19. Daily Protein Availability by Source (kg/capita) Non-Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	% of total change
Burkina Faso												
Plant	47	47	61	64	70	67	66	69	70	71	50.0%	88.7%
Animal	7	7	8	8	9	10	10	10	10	10	42.9%	11.3%
Total	54	54	69	72	79	77	76	79	80	81	49.1%	
Mali												
Plant	31	37	44	45	47	47	49	51	52	53	54.4%	88.1%
Animal	17	15	15	17	15	16	16	16	18	19	15.6%	11.9%
Total	48	52	59	62	62	63	65	67	70	72	42.0%	
Niger												
Plant	48	45	45	44	42	42	49	48	52	62	22.6%	87.5%
Animal	17	14	12	12	12	13	14	15	16	18	9.7%	12.5%
Total	65	59	57	56	54	55	63	63	68	80	19.4%	

Source: Author’s computation using FAO’s Food Balance Sheet data.

Table A2-20. Daily Protein Availability by Source (g/capita) Coastal Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	% of total change
Cape Verde												
Plant	45	48	55	45	39	37	39	37	39	41	-14.0%	-162.5%
Animal	20	19	16	17	22	22	24	25	28	32	53.8%	262.5%
Total	65	67	71	62	61	59	63	62	67	73	6.1%	
Gambia												
Plant	37	39	43	41	39	37	38	40	40	45	11.8%	60.0%
Animal	11	12	12	13	11	12	13	14	14	15	26.1%	40.0%
Total	48	51	55	54	50	49	51	54	54	60	15.2%	
Guinea Bissau												
Plant	36	37	36	36	36	35	34	35	36	37	0.0%	0.0%
Animal	8	8	9	9	9	9	8	8	7	8	-6.3%	100.0%
Total	44	45	45	45	45	44	42	43	43	45	-1.1%	
Senegal												
Plant	50	49	49	48	42	41	42	37	41	44	-14.1%	*127.3%
Animal	15	16	18	18	20	17	17	16	17	17	9.7%	*-27.3%
Total	65	65	67	66	62	58	59	53	58	61	-8.5%	

Source: Author's calculations using FAO’sFood Balance Sheet data.
Note: * Represents the percentage of the decline in total protein supply.

Table A2-21. Daily Protein Availability by Source (g/capita) in Selected Countries in Coastal Non-Sahel

	1980 to 1982	1983 to 1985	1986 to 1988	1989 to 1991	1992 to 1994	1995 to 1997	1998 to 2000	2001 to 2003	2004 to 2006	2007 to 2009	% change 1980-85 to 2004-09	% of total change
Benin												
Plant	36	37	40	45	45	46	47	48	49	52	38.4%	103.7%
Animal	10	10	9	8	9	8	9	10	9	10	-5.0%	-3.7%
Total	46	47	49	53	54	54	56	58	58	62	29.0%	
Ghana												
Plant	26	28	31	31	37	38	39	41	42	43	57.4%	79.5%
Animal	12	13	14	14	14	14	15	14	16	17	32.0%	20.5%
Total	38	41	45	45	51	52	54	55	58	60	49.4%	
Nigeria												
Plant	32	33	39	43	46	49	51	50	53	55	66.2%	104.9%
Animal	11	8	7	7	6	7	7	8	8	9	-10.5%	-4.9%
Total	43	41	46	50	52	56	58	58	61	64	48.8%	

Source: Author's calculations using FAO’s Food Balance Sheet data.

CHAPTER 3. AGGREGATE-LEVEL DETERMINANTS OF STARCHY STAPLES DEMAND IN WEST AFRICA: THE CASE OF BENIN, MALI AND SENEGAL

3.1. Background and Problem Statement

Studies on food demand in West Africa (WA) are generally very few, and most were conducted between the late 1980s and late 1990s (Reardon et al. 1988[22]; Delgado, 1989[23]; Rogers and Lowdermilk, 1991[24] and Diagana et al. 1999). Still, a few consumption studies have been conducted in the 2000s (Camara, 2004; Joseph and Wodon, 2008; and Taoundyande and Yade, 2012). Knowledge of food demand parameters and of how consumption patterns have changed over time is critical for informed policymaking. Sadoulet and de Janvry (1995) also observe that food demand estimates are essential for planned investments and future prosperity of business ventures in a country. However, in WA information on food demand parameters is limited, thus restricting policymakers' ability to make sound food policy decisions. An attempt is made in this chapter to bridge this gap by estimating a Linear Approximate Almost Ideal Demand System (LA-AIDS) for starchy staples in Benin, Mali, and Senegal.

National aggregate-level demand is the sum of demand by all groups within a country at a given point in time. Rapid population growth, high urbanization rates, growth in per capita incomes, and changes in relative prices have been identified as factors influencing aggregate-level shifts in food consumption in WA (Delgado and Reardon, 1991; Staatz et al. 2008; Taoundyande and Yade, 2012; and Kelly et al. 2012). The size of the population has an obvious effect on aggregate food demand—more people mean more food demand because everyone needs food to survive. The

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[22] Using data household-level data from urban Burkina Faso
[23] Using country level data for Burkina Faso, Cote d'Ivoire, Mali, Niger and Senegal
[24] Using household-level data from urban Mali.

location of the population (urban/rural) also affects food availability and consumption patterns. A shift to urban living entails important changes in lifestyles, economic activities, expanded food choices, and different food consumption observations and experiences. These changes can encourage structural shifts away from traditional diets towards quite different food consumption patterns (Desisle, 1990). In WA, the degree of urbanization is hypothesized to be a significant determinant of shifts in consumption away from traditional coarse grains towards rice and wheat (Delgado and Miller, 1985; Delgado, 1989; Reardon et al. 1988; Kennedy and Reardon, 1994; Rogers and Lowdermilk, 1991; Delgado and Reardon, 1991).

Economic considerations also play an important role in determining food demand. By Engel's law, the proportion of income spent on food is expected to fall as income rises. Also, the composition of food demanded is expected to vary with income level. The specific effects of urbanization on consumption also differ depending on economic conditions (Regmi and Dyck, 2001). When urbanization is accompanied by rising per capita incomes (e.g., due to better employment opportunities), there is likely to be an increase in per capita consumption, the quality of diets is also likely to improve, and other factors (such as the opportunity cost of time) become important in determining food choices.

The role of relative cereal prices in determining cereal expenditure patterns has been an important debate in WA. Using aggregate country-level data from Burkina Faso, Cote d'Ivoire, Mali, Niger, and Senegal, Delgado et al. (1989) examined aggregate food demand. In all countries except Senegal, they did not find cereals prices to be a significant factor. Delgado and Reardon (1991) examined the period from the 1970 to 1986, during which world cereals prices as a group fell about one-third relative to the price of manufactured goods. Rice prices in particular were more than one-third cheaper relative to the world price of sorghum during 1982-1986 compared to the late 1960s. Contrary to Delgado (1989), Delgado and Reardon (1991) found that relatively low rice prices were responsible for the shift towards rice from sorghum, noting that changing relative prices have promoted past substitution in cereals consumption patterns but that the substitution process could be reversed if rice and wheat prices were to increase very substantially over those of millet and sorghum. In the current global food situation, an understanding of how food demand responds to changes in structural factors and food prices is crucial.

3.2. Research Objective and Hypotheses

This chapter examines aggregate-level determinants of food demand for Benin, Mali, and Senegal using a theoretically appropriate framework for demand analysis. The choice of the countries is limited by the availability of starchy staples price data in capital city markets in the period 1990-2009. An individual country analysis is carried out for all three countries. Demand parameters are expected to vary across these countries because of differences in taste and preferences, availability of substitutes, as well as differences in income levels. The approach allows testing for the role that various long-term trends and structural factors have on starchy staples consumption patterns, as well as the role of long-term trends in relative prices and real per capita GDP in influencing aggregate food demand. The following hypotheses will be tested:

Hypothesis 3.1: Holding other factors constant (e.g., relative cereal prices), there is a negative relationship between the share of urban population and the demand for traditional coarse grains such as millet and sorghum. When urbanization is accompanied by increased employment outside the home, the opportunity of cost of time involved in the preparation of coarse grains becomes an important consideration in consumption choices—the higher the time involved in preparation, the less preferred the commodity is to urban consumers.

Hypothesis 3.2: The cross-price elasticities between traditional coarse grains (millet and sorghum) and rice are positive.

Hypothesis 3.3: Demands for traditional coarse grains are income-inelastic.

Hypothesis 3.4: For Mali, with a more diversified cereal basket (greater availability of substitutes), the cross-price effects will be greater than in the countries with less diversified cereal baskets (Senegal — predominantly rice; and Benin—predominantly maize).

3.3. Data and Methodology

National-level per capita availability data (kg/year) for the period 1990-2009 were obtained for Benin, Mali, and Senegal from FAO's FBS. Monthly nominal retail prices by major starchy staple type from the capital city markets of Benin, Mali, and Senegal over the period 1990-2009 were obtained from each country's national agricultural statistics office or market information service. Annual average prices per starchy staple type are calculated from the monthly price series. Data on urban population shares over 1990-2009 per country were obtained from the World Development Indicators.[25] Annual expenditure by major starchy staple type is calculated by multiplying the annual per capita supply by the annual average of deflated prices. Total expenditure is computed as the sum of expenditures on all major starchy staples. The expenditure share for a starchy staple type is the ratio of expenditure on the starchy staple type to the total expenditure on all starchy staples.

To assess the statistical relationship between prices, urbanization, per capita income, and the consumption of starchy staples, a theoretically consistent demand model is used. The Almost Ideal

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[25] The indicators are available at http://data.worldbank.org/indicator and were last assessed on 01/25/2013.

Demand System (AIDS) of Deaton and Muellbauer (1980) has been a popular functional form to model demand behavior. The AIDS specification allows estimation of multivariate demand equations for interrelated commodities and ensures that the system is consistent with consumer theory (Deaton and Muellbauer 1980). It also has the advantage of being flexible and allowing tests of underlying demand and preference restrictions. As a member of the Price-Independent Generalized Logarithmic class of demand models (Muellbauer, 1976), the AIDS model has budget shares that are linear functions of log total expenditure. Despite the advantages of the AIDS model, there is increasing evidence that higher order terms in total expenditure may be required for at least some of the budget share equations (Lewbel, 1991; Blundell *et al*., 1993). The AIDS model is linear in log expenditure and it makes the restrictive assumption that expenditure elasticities are constant at all expenditure levels (Bopape, 2006). In this study, no formal test is carried out to investigate the appropriateness of the AIDS or the Quadratic Almost Ideal Demand System (QUAIDS) model. Moreover, the QUAIDS model estimates a larger number of parameters than the AIDS model. With the short data series available for this section, the estimation of several parameters will pose a degrees of freedom problem.

3.4. Aggregate Food Demand Model Specification and Estimation Method

A common problem in system demand equations is over-parameterization. This problem is dealt with by assuming separability–choosing only a subset of related commodities to include in the system and including only the total expenditures on these commodities. Separability requires that the utility function be separable so that the consumer engages in multi-stage budgeting. The analysis in this chapter is based on a two-stage budgeting approach under the assumption of weak separability. The idea is that: i) the majority of households are low-income, with food taking up a significant share of total budget expenditures; and ii) starchy staples are a major share of household's food budget. Therefore, consumption expenditures are first allocated between starchy staples and other consumption goods. Conditional on that choice, the starchy staples budget is allocated to individual starchy staple types. This chapter examines the factors that influence the allocation of the starchy staples budget to individual starchy staple types within a systems framework.

For the Sahelian countries–Mali and Senegal–starchy staples are predominantly cereals while for a non-Sahelian country, such as Benin, roots and tubers (yams and cassava) are also important starchy staples. For each country a complete price data series is available from 1990-2009. With the FAO's FBS per capita availabilty data ending in 2009, the resultant sample period for each country has 20 annual observations, which are analyzed separately. Furthermore, the starchy staples demand model is specified to account for the possibility of structural change originating from the 1994 devaluation of the CFA franc. Presumably, the devaluation of the CFA franc acted through its impact on incomes and relative prices. However, if it led to changes in consumption habits or changes in income distribution, it could have had a structural effect. To explore this, the model specification includes a dummy variable for the year of the devaluation.

The n-good system specification of the AIDS share equations for modeling the determinants of starchy staples demand (budget stage two), augmented to allow for the urban population share to influence the intercept term, is formulated as follows:

$$w_{it} = \alpha_i + \theta_i SHARE\_URB_t + \tau_i d_1 + \sum_{j=1}^{n} \gamma_{ij} lnp_{\mathrm{jit}} + \beta_i ln\left[\frac{X_t}{a(\boldsymbol{p})}\right] + \varepsilon_{it} \qquad (3-1)$$

The dependent variable (w_{it}) is the budget share associated with starchy staple type i at time t. d_1 is a dummy variable which takes the value 1 if year >=1994 and 0 otherwise. α_i is the constant coefficient in the ith share equation, and γ_{ij} is the slope coefficient associated with the jth starchy staple type in the ith share equation. p_{jit} is the normalized real price of starchy staple type j in the share equation for starchy staple type i at time t. X_t is the total per capita expenditure on the system of starchy staples given by $X_t = \sum_{i=1}^{n} p_{it} q_{it}$, where q_{it} is the annual apparent per capita consumption of the ith starchy staple type at time t, and p_{it} is the normalized annual real price for starchy staple type i at time t. **p** is a vector of normalized real prices, a (**p**) is a function that is homogenous of degree one in prices, and ln$a$(**p**) is specified as the translog equation:

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i lnp_{it} + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij}\, lnp_{it} lnp_{jt} \qquad (3-2)$$

Where i = 1…n denote commodities.

The translog price index in equation (3-2) is non-linear, thereby posing some difficulties when aggregate annual time-series data are used. As a result, most studies employ a linear approximation to the non-linear price index. The most usual approximation to the translog aggregator function a(**p**) in the AIDS model has been the Stone price index suggested by Deaton and Muellbauer (1980). Moschini (1995), in the context of the AIDS, showed that employing Stone's price index ($\ln \mathbf{P}^* = \sum_{i=1}^{n} w_{it} lnp_{it}$) in place of a(**p**) can seriously bias elasticity estimates partly because this price index is influenced by changes in units of measurement. He therefore suggested using the following alternative price indices: the Törnqvist price index [$\log P^T = 0.5 \sum_{i=1}^{n} (w_{it} + w_{it}^0) log\,(P_{it}/P_{it}^0)$], the loglinear analogue of the Paasche price index–also known as the "corrected" Stone price index [$\log P^s = \sum_{i=1}^{n} w_{it} log\,(P_{it}/P_{it}^0\,)$], and the loglinear analogue of the Laspeyres price index [$\ln \mathrm{P}^{\mathbf{L}} = \sum_{i=1}^{n} w_{it}^0 lnp_{it}$] , all of which are exact for a linearly homogeneous Cobb–Douglas aggregator function (Diewert 1976) and invariant to changes in units.

For the purpose of this study, the translog price aggregator, $a(\mathbf{p})$, is approximated by the Laspeyres price index:$\ln \mathrm{P}^{\mathrm{L}} = \sum_{i=1}^{n} w_{it}^{0} lnp_{it}$, where w_{it}^{0} is the share of the ith commodity in the base period. Owing to its simplicity, LA-AIDS is very popular in empirical studies.

The theoretical restrictions of homogeneity, adding up and symmetry are imposed on the parameters to ensure integrability of the demand system. Adding-up requires that expenditure shares sum to one (i.e., $\sum_{i=1}^{n} w_i = 1$), and can be expressed in terms of model parameters as:

$$\sum_{i=1}^{n} \alpha_i = 0, \sum_{i=1}^{n} \beta_i = 0, \sum_{i=1}^{n} \gamma_{ij} = 0, \quad \forall j$$

An additional requirement for adding up is that

$$\sum_{i=1}^{n} \theta_i = 0$$

Hicksian demands are homogenous of degree zero in prices, which implies

$$\sum_{j=1}^{n} \gamma_{ij} = 0 \qquad \forall j$$

The Slutsky symmetry restriction requires that

$$\gamma_{ij} = \gamma_{ji} = 0 \qquad \forall \text{ i, j}$$

These restrictions (adding-up, homogeneity, and symmetry) are imposed during estimation. Negativity is not automatically introduced, but by estimating all the compensated own-price elasticities one can test for their negativity.

The expenditure elasticity, which varies depending on the type of good (normal or inferior), for good i is given as:

$$\eta_i = \frac{\beta_i}{w_i} + 1 \qquad (3-3)$$

In equation (3-3) parameter $\beta_i$determines the effect of a change in total per capita starchy-staple expenditure on the budget share of starchy-staple type i and determines whether this good is normal or inferior.

The Marshallian (uncompensated) own-price and cross-price elasticities are calculated in the following manner:

$$\varepsilon_{ij} = \frac{\gamma_{ij}}{w_i} - \frac{\beta_i}{w_i} w_j^0 - \delta_{ij} \qquad (3-4)$$

Where δ_{ij} is the Kronecker delta equaling 1 if i=j and 0 otherwise.

In the LA-AIDS model the Hicksian or compensated price elasticities are derived using the Slutsky equation and are given by:

$$\varepsilon_{ij}^* = \varepsilon_{ij} + w_j \eta_i \qquad (3-5)$$

It is well known that most economic time series data are very persistent, suggesting the possibility of non-stationary behavior. The presence of unit roots may invalidate the asymptotic distribution of estimators and influence elasticity estimates and their standard errors. Consequently, the appropriate model specification depends on the time-series properties of the data. The time-series properties of the data are investigated to determine whether long-run relationships are economically meaningful or not. A formal test for unit roots is performed on all the data series used in the estimation. The unit roots test is first carried out with the pioneering Augmented Dickey-Fuller (ADF) test proposed in 1981. Wang and Tomek (2004) argue that the results of unit root tests are conditional on the remaining specification of the right hand side of the estimation equation — with and without a linear deterministic trend; and the length of lags, if any, to include. The tests here were conducted with and without a trend and on the natural logarithm of deflated[26] prices, the natural logarithm of starchy staples expenditure and the commodity budget shares. The number of lags included in the test was chosen so as to make the error term white noise. Due to the criticism of the ADF test – its low statistical power to reject a unit root, an alternative test–the Phillips-Perron (PP) test, proposed in 1988 and known for better finite sample properties than the ADF test—is also employed to check the robustness of the ADF results. The ADF and PP test for unit roots have non-stationarity as the null hypothesis. The difficulty of rejecting this hypothesis has been pointed in the literature. Hence to further test for the robustness of the ADF and PP results, the KPSS (Kwiatkowski, et al. 1992) test for unit roots that has stationarity as the null hypothesis is also applied. A similar unit roots testing approach is used in the data for the threee countries covered in this chapter.

According to theory, regression of two variables that are integrated of order one I(1)[27] but are not cointegrated results in a spurious regression. A cointegrating relationship exists when a linear combination of two or more I(1) variables results in residuals that are I(0)–implying that although the variables are non-stationary, a linear combination of them is stationary, thus generating an equilibrium relationship in the long-run. Karagiannis et al. (2000) observe that it is also possible to have a cointegrated regression even though the variables of interest have different time-series properties and thus, a different order of integration. According to the Granger representation theorem, a linear combination of series with a different orders of integration may still be a cointegrating regression. He notes further that if cointegration cannot be established for at least

[26] Using the GDP deflator.
[27] Such that first-differencing makes the variables stationary.

one share equation, we cannot proceed further, and more likely a different functional specification may be used or the data set should be enlarged.

Once the order of integration is determined, a simple test for cointegration that assumes a single cointegrating relationship is performed on the share equations given by:

$$w_{it} = \alpha_i + \theta_i SHARE\_URB_t + \sum_{j=1}^{n} \gamma_{ij} lnp_{\mathrm{jit}} + \beta_i ln\left[\frac{X_t}{M}\right] + \varepsilon_{it} \qquad (3-6)$$

All the variables in equation 3-6 are as defined in equation 3-1 and M is the price index linearized using Laspereyes formula. The test is conducted by estimating equation 3-6 separately for each starchy staple type by Ordinary Least Squares (OLS). The residuals from the OLS estimation are predicted. Using the PP regression[28] and the Breusch-Pagan test for serial correlation, the number of lags that make the residuals white noise is determined. The Phillips-Perron unit root tests are applied on the residuals from the cointegrating regression. The null hypothesis is that the residuals have unit roots in them (no cointegration). Rejecting the null hypothesis implies the series is cointegrated. Once it is determined that all the variables are cointegrated, a dynamic Error Corrected Linearized Almost Ideal Demand System (ECLAIDS) is specified for starchy staples demand.

Few studies employ formal testing procedures for unit-roots and cointegration needed to justify a dynamic specification for food demand systems (Balcombe and Davis, 1996; Karagiannis et al. 2000; and Nzuma and Sarker, 2008). The general approach followed in the dynamic specification of the demand system is conditioned on the view that there could be a long-run

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[28] Mainly because of its advantage over the ADF in small samples.

equilibrium cointegrating demand system measuring the long-run effects of prices and income on the demand for goods. New information and fluctuation in prices and income might disrupt the equilibrium, and the process of adjustment may be incomplete in any single period of time. In the period before these adjustments are completed, consumers will be 'out of equilibrium,' and their short-run responses to changes in prices and income may provide little guide as to their long-run effects.

In modeling the dynamics in starchy staples consumption, this study uses Karagiannis et al. (2000) methodology for setting up an ECLAIDS. The approach entails estimating the system of linearized AIDS equations using the first-differenced variables and plugging in the first differenced lagged shares and the residuals obtained from the first step cointegrating regressions into each share equation to account for unit roots and cointegration. The ECLAIDS is specified as follows:

$$\Delta w_{it} = \emptyset_i \Delta w_{it-1} + \theta_i \Delta SHARE_{URB_t} + \tau_i d_1 + \sum_{j=1}^{n} \gamma_{ij} \Delta ln p^*_{jit}$$

$$+ \quad \beta_i \Delta ln \left[\frac{X_t}{a(\boldsymbol{p})}\right] + \pi_i v_{it-1} + \epsilon_{it} \qquad (3-7)$$

In Equation (3-7), Δ refers to the difference operator, v_{it-1} are the estimated residuals from cointegration equations, and π_i<0. Equation 3-7 is specified for starchy staples in Benin, Mali and Senegal and estimated using the iterative seemingly unrelated regression (ISUR) approach. The model is normalized to unity at the base period (2000) and all elasticities are evaluated at this point. As shown by Asche and Wessells (1997), there are no differences in formulas used to calculate price and expenditure elasticities between the AIDS and the linearized AIDS as long as calculations are made at the point of normalization. Consequently, the elasticity formula proposed by Chalfant (1987) correctly evaluates the elasticities of the ECLAIDS to equal those of the AIDS at the point of normalization.

3.5. Findings

This section presents findings from the analysis of the determinants of aggregate demand for starchy staples in Senegal, Benin, and Mali. In particular, it provides estimates of the relationship between structural factors expected to influence consumption (urbanization and per capita incomes) as well as estimates of price and income elasticities of starchy staples demand for each major starchy staple type. The results are presented by country.

3.5.1. Determinants of Starchy Staples Demand – Senegal

The analysis of trends in per capita food availability in Senegal (Chapter 2) revealed an overall decrease of 14 kg/year in the per capita availability of cereals and an increase in the supply of starchy roots and tubers (R&T) of about 18 kg/capita between the period 1980/85 and 2004/2009. A breakdown of the cereals and starchy R&T food groups by individual commodities revealed a growth in the per capita availability of rice and maize at the expense of millet and sorghum in the cereals food group. Cassava availability per capita also rose during the study period. However, it stayed relatively low compared to grains. This sub-section therefore aims to examine if there is any statistical relationship between above-mentioned descriptive trends and the factors hypothesized to influence aggregate level demand shifts (urbanization, relative prices, and growth in per capita incomes). In the absence of good time-series R&T price data, the analysis of the determinants of starchy staple demand in Senegal in this chapter is limited to cereals (rice, maize, millet, and sorghum).

Table 3-1 presents summary statistics of the data used in estimating aggregate demand for Senegal. Average budget shares per starchy staple type in the study period were 48% for rice; 30% for millet; 12% for maize, and 10% for sorghum. The urban population share rose only by 3.64% in the study period. The small variation in the urban population share is not very surprising because Dakar (the capital city of Senegal), which is the largest city in Senegal and characterized by rapid land occupation, may have reached its limits. The next largest cities in Senegal include Thiès and Kaolock, but these do not match up to Dakar in size/area and number of inhabitants.

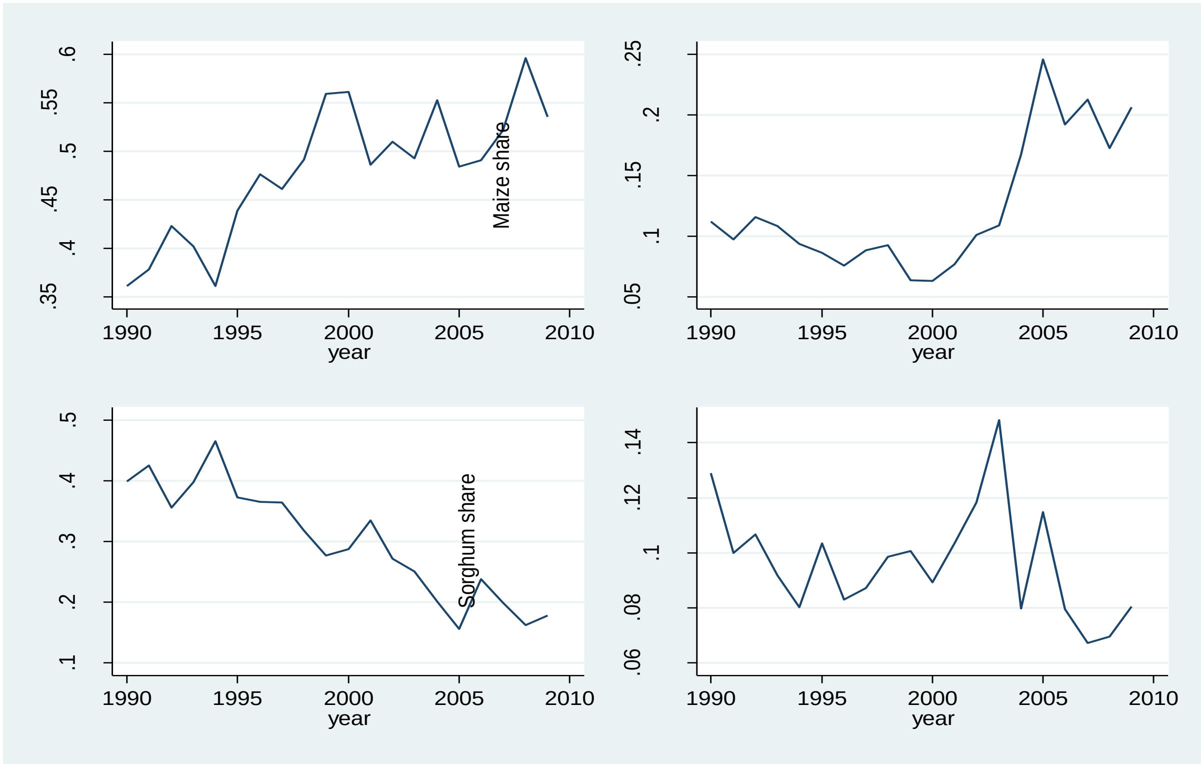
Table 3-1. Descriptive Summary of Variables in the Regression - Senegal: 1990-2009

Variable	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Share urban	40.64	1.11	39.00	42.64
Lnprice	5.40	0.15	5.21	5.77
Lnpmil	5.08	0.13	4.82	5.37
Lnpsorg	5.04	0.15	4.72	5.30
Lnpmaize	5.11	0.11	4.86	5.36
lnX	10.14	0.14	9.99	10.46
Rice share	0.48	0.07	0.36	0.60
Millet share	0.30	0.09	0.16	0.46
Maize share	0.12	0.05	0.06	0.25
Sorghum share	0.10	0.02	0.07	0.15

Prices are log transformed deflated prices.

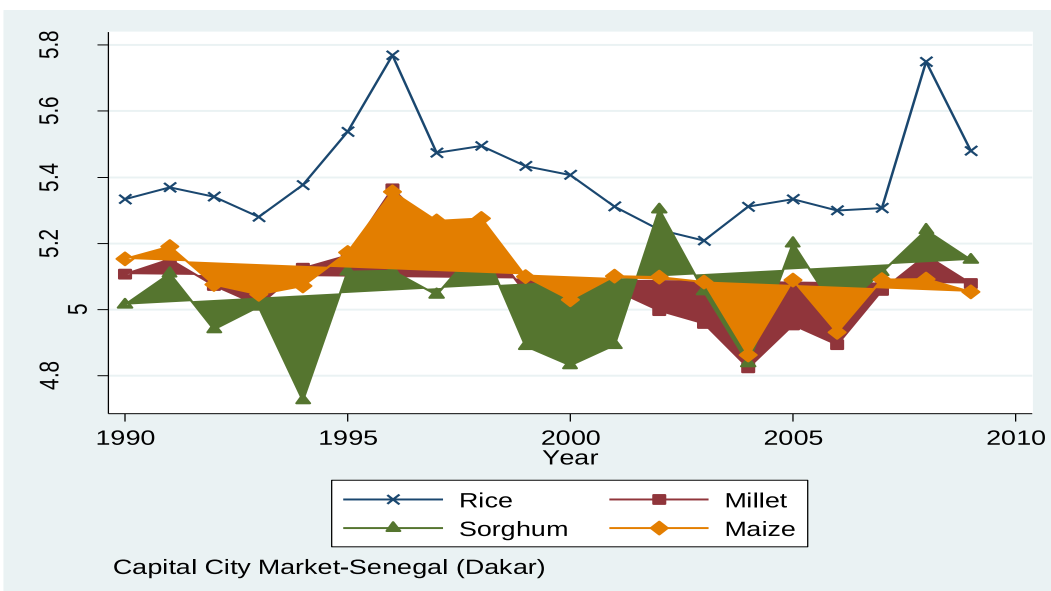
Figure 3-1 also illustrates the trend in the share of individual cereals in total cereals budget over time. It is observed from the graphs that rice share in the cereals budget remained above 35% throughout the study period. Although the average share of millet in the study period was quite high, the graph illustrates a declining trend in the share of millet in the cereals budget over time. Prior to the year 2000, the share of maize in per capita cereal budget declined. However, the declining trend was reversed in the early 2000s. The graph of log-transformed deflated cereals prices (Figure 3-2) also shows fluctuations in cereals prices over time.

Figure 3-1. Shares in Cereals Budget - Senegal: 1990-2009



Source: Author. Budget shares were computed using cereal availability (kg/capita/year) data from FAO's Food Balance Sheet and price data from Senegal's Agricultural Market Information System.

Figure 3-2. Natural Logarithm of Deflated Cereals Prices - Senegal: 1990-2009



Source: Author, using price data from Senegal's Agricultural Market Information System.

An examination of the correlation coefficient between the urban population share and starchy staples budget shares reveals a strong positive relationship with the rice budget share (0.78) and with the maize budget share (0.71). Millet and sorghum on the other hand were found to be negatively correlated with the urban population share with correlation coefficients of -0.92 and -0.34 respectively. These relationships are not surprising because millet is a basic rural food in Senegal, although over time, rice has deeply penetrated rural markets and diets.

The results of the ADF and PP test for non-stationarity of the variables in the demand estimation are reported in Table A3-1 in Appendix (case with trend) and Table A3-2 in Appendix (the case without trend). In both cases, results suggest most variables are stationary and few are non-stationary in levels. First differencing also fails to make all the variables stationary when the ADF test is applied in the case with and without trend. Based on a PP test, a unit root is rejected at a 5% significance level for some of the variables in the case with and without a trend. Performing the PP-test on first-differenced variables, non-stationarity is rejected at a 1% level of significance for all the variables in the case with and without trend.[29] Using the KPSS test for unit roots (Appendix, Tables A3-3 and A3-4), we reject the null of stationarity in some of the variables to be used in the demand estimation in the case with and without trend. When all the variables are treated as non-stationary in levels and first differenced, we do not reject stationarity in the case with and without trend in all the variables to be used in the estimation. Thus, in all three tests we do not reject stationarity in some of the variables in levels. The inconclusive result of the unit root tests on the variables in levels supports existing arguments on the low power of unit root tests in small samples.

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[29] Since a trend in levels becomes a constant in first differences, no trend needs to be included here, making the option of first differencing with no trend more appropriate.

In the absence of any reasons why in the same market some prices would be generated by a unit process and others are not, and also given that the consequences of ignoring the stochastic properties of the data are likely to be severe, the demand analysis is carried out assuming non-stationarity in prices in levels. A dynamic model which corrects for non-stationarity is specified.

Table 3-2 contains the results of the unit roots test on the residuals from the cointegrating regression (v_{it-1}). We reject unit roots in the residuals from each equation in the case without trend at a 5% level in three out of the four regressions– i.e., the residuals are stationary with a long-run equilibrium relationship between the dependent variables (the shares) and a linear combination of the independent variables. In the case with trend, we reject unit roots in two of the four share equations.

Table 3-2. Tests of Regression Residuals for Unit Roots - Senegal

Equation	With Trend			Without Trend		
	T-Stat.(rh0)	T-Stat. (t)	p-value	T-Stat.(rh0)	T-Stat.	p-value
Rice Share	-11.732	-2.724	0.2261	-11.82	-2.787	0.0601
Maize Share	-13.363	-2.978	0.1385	-13.39	-3.062	0.0295
Millet Share	-20.643	-4.706	0.0007	-20.841	-4.852	0.0000
Sorghum Share	-20.885	-4.289	0.0033	-20.975	-4.443	0.0002
Critical values	1%			5%	10%	
PP test (t)-Trend	-4.380			-3.600	-3.240	
PP test (rho)- Trend	-22.500			-17.900	-15.600	
PP test (t)- No Trend	-3.750			-3.000	-2.630	
PP test (rho)-No	-17.200			-12.500	-10.200	

Null Hypothesis: Residuals are non-stationary – i.e., unit roots (no cointegration).

Having established the existence of a long run equilibrium relationship, an ECLAIDS model (equation 3-7) is estimated for the four major grain types (rice, maize, millet, and sorghum) consumed in Senegal. The model was estimated with and without the dummy variable that captures the effect of any structural change in consumption habits due to devaluation. The inclusion of the dummy variable failed to provide any noticeable improvement in the estimated parameters. As a result, the reported parameter estimates are from the model without the dummy for devaluation. Table 3-3 contains the estimated parameters of the ECLAIDS for cereals demand in Senegal 1990-2009. The estimated parameters of the error correction terms (π_i) are all statistically significant and have the correct signs, indicating that deviations from long-run equilibrium are corrected within the time period. It is also worth noting that the significance of the error correction terms in SUR estimates is consistent with the previously obtained results of cointegration analysis. The estimated R-squares are 74% for rice, 72% for millet, and 30% for sorghum. Furthermore, the log of per capita starchy staples expenditure and the urban population share are not statistically significant in any of the budget share equations, meaning that starchy staples expenditure behavior as well as the urban population shares are influenced neither by changes in aggregate expenditures on starchy staples per capita or growth in urban population shares when aggregate consumption data are considered. However, this may be an inappropriate conclusion given that the distribution of income across different consumers and/or by place of residence may be a more critical determinant of cereals consumption than national level per capita expenditures. Furthermore, the urban population did not change much (increased by 3.64%) in Senegal during the study period. This may explain why urbanization is not statistically significant in the starchy staple demand model.

As shown by Asche and Wessells (1997), there are no differences in formulas used to calculate price and expenditure elasticities between the AIDS and the linearized AIDS as long as calculations are made at the point of normalization. Consequently, the elasticity formula proposed by Chalfant (1987) correctly evaluates the elasticities of the ECLAIDS to equal those of the AIDS at the point of normalization (Nzuma and Sarker, 2008). The model (equation 3-7) is normalized to unity at the base period (2000) and all elasticities are evaluated at this point.

The short-run Marshallian price elasticities are measured as in equation 3-4 and the expenditure elasticities are measured as in equation 3-3 and using the estimated ECLAIDS parameters from equation (3-7). The Hicksian short run elasticities are then obtained through Slutsky equation as in equation 3-5. The short-run ECLAIDS parameter estimates are also used to compute their long-run counterparts using the partial adjustment formulation proposed by Johnson et al. (1992).

Table 3-3. Parameter Estimates from Error-Corrected Linear AIDS Model - Senegal

	driceshare			dmilshare			dsorgshare		
Variables	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
D1.lriceshare	-0.060	0.115	0.604	-	-	-	-	-	-
D1.lmilshare	-	-	-	0.128	0.103	0.216	-	-	-
D1.lsorgshare	-	-	-	-	-	-	0.638	0.195	0.001
share_urban	0.000	0.006	0.978	-0.003	0.006	0.652	-0.002	0.005	0.661
D1.lnprice	0.278	0.043	0.000	-0.259	0.044	0.000	-0.010	0.016	0.548
D1.lnpmil	-0.259	0.044	0.000	0.457	0.069	0.000	-0.099	0.023	0.000
D1.lnpmaize	0.006	0.054	0.909	-0.175	0.058	0.003	0.152	0.047	0.001
D1.lnpsorg	-0.010	0.016	0.548	-0.099	0.023	0.000	0.054	0.011	0.000
Dln(X/P)	-0.232	0.127	0.067	0.266	0.143	0.062	-0.005	0.103	0.961
$\boldsymbol{\pi_{rice}}$	-0.490	0.171	0.004	-	-	-	-	-	-
$\boldsymbol{\pi_{millet}}$	-	-	-	-0.843	0.186	0.000	-	-	-
$\boldsymbol{\pi_{sorghum}}$	-	-	-	-	-	-	-1.321	0.326	0.000
Constant	-0.002	0.244	0.992	0.109	0.256	0.669	0.089	0.202	0.661

Source: Author.

Thus, the long-run estimates equal the negative of the short-run estimates (equation 3-7) divided by the EC term's parameter (- β_0/π_i). Similarly, the long-run elasticities are measured using the formulas in equation (3-3 to 3-5) and the long-run parameter estimates.

The estimated short-run and long-run elasticities are reported in Table 3-4 and Table 3-5 respectively. The short-run expenditure elasticity for millet is greater than one and significant at a 1% level. This indicates luxury good-like behavior for millet. Rice is short-run expenditure inelastic, making rice a necessity in the short-run. In the long run, only the expenditure elasticity for millet is significant at a 5% level and millet continues to behave as a luxury good in the long-run.

Table 3-4. Estimated Error-Corrected Short-Run Demand Elasticities - Senegal

Commodity	Rice	Millet	Sorghum	Maize
	Expenditure Elasticities			
	0.587*	1.927*	0.943	0.539
	Uncompensated Price Elasticities			
lnprice	-0.272	-1.423*	-0.075	0.357
lnpmil	-0.344*	0.328	-1.094*	-2.641*
lnpsorghum	0.020	-0.428*	-0.386**	2.454*
lnpmaize	0.037	-0.668*	1.710*	-0.709
	Compensated Price Elasticities			
lnprice	0.057	-0.342**	0.454**	0.659
lnpmil	-0.175**	0.880*	-0.823*	-2.487*
lnpsorghum	0.072**	-0.256*	-0.302**	2.503*
lnpmaize	0.074	-0.547*	1.769*	-0.675

Source: AuthorSignificant at 1% (*); 5% (**); and 10% (***)

Table 3-5. Senegal: Estimated Error-Corrected Long-Run Demand Elasticities

Commodity	Rice	Millet	Sorghum	Maize
	Expenditure Elasticities			
	0.157	2.099*	0.957	3.556
Uncompensated Price Elasticities				
lnprice	0.485	-1.687*	-0.057	-1.233
lnpmil	-0.701*	0.575	-0.828**	-4.023**
lnpsorghum	0.040	-0.507*	-0.536*	1.598**
lnpmaize	0.076	-0.792**	1.294*	0.101
Compensated Price Elasticities				
lnprice	0.573	-0.510***	0.480*	0.761
lnpmil	-0.656***	1.177**	-0.553***	-3.002**
lnpsorghum	0.054	-0.320**	-0.450*	1.916*
lnpmaize	0.086	-0.660**	1.354*	0.326

Source: Author

Note: Significant at 1% (*); 5% (**); and 10% (***)

With the exception of millet, all the short-run own-price Marshallian elasticities are negative, and thus the corresponding demand curves are downward sloping (see Table 3.4). However, only the uncompensated short-run own-price elasticity of sorghum is statistically significant at a 5%, and sorghum is found to be own-price inelastic in the short-run. When the long-run own-price Marshallian elasticities are considered, sorghum remains price inelastic and statistically significant, with long-run Marshallian own-price elasticity greater than the short-run. Not all short-run own-price Hicksian elasticities are negative as expected. The positive and statistically significant compensated demand curves for millet in both the short-run and the long-run are not theoretically reasonable, and therefore warrant further investigation.

The short-run Hicksian cross-price elasticities (Table 3-4) reveal a relationship of complementarity between millet and rice in the short-run; and a relationship of substitution between sorghum and rice in the short-run, and these relationships are statistically significant at a 5% level. For instance, in the short-run, a 1% increase in the price of sorghum will result in a compensated increase in rice consumption of 0.072%, while an increase in the price of millet will decrease rice consumption by 0.175%. The finding in earlier studies (Delgado and Reardon, 1992; Kennedy and Reardon, 1994) that rice is a substitute for coarse grains (millet and sorghum) and vice versa is supported only in the case of sorghum in the short-run. This relationship of complementarity between millet and rice; and substitution between sorghum and rice is maintained in the long-run. However, only the former remains statistically significant.

Also in the short-run, sorghum and millet have a relationship of complementarity, and maize and millet are complements with statistically significant compensated short-run cross-price elasticities of -0.256 and -0.547 respectively. Still in the short run, maize is a substitute for sorghum (1.769) and the relationships are statistically significant at 1% level. The descriptive analysis of the trend in per capita cereals consumption (Chapter 2) and the graphical examination of trend in the share of specific cereals type in the per capita cereals budget discussed earlier in this chapter both revealed that per capita consumption of maize and the share of maize in the cereal budget in Senegal increased in the study period. Millet and sorghum on the other hand experienced declining per capita consumption and declining shares. The findings from the statistical analysis support the substitution of maize for sorghum seen in the descriptive analysis (see also Taoundyande and Yade, 2012). However, the relationship of complementarity between maize and millet seen in the statistical analysis does not correspond with the opposite trend seen in the descriptive analysis. Contrary to the short-run, the compensated cross-price relationship between sorghum and rice is not statistically significant in the long-run. All other cross-price relationships in the short-run are maintained in the long-run.

To conclude for Senegal, the results of the error-corrected demand model also provide evidence of substitution between rice and sorghum as hypothesized. However, the relationship of complementarity between rice and millet in both the short-run and long-run are contrary to findings from earlier studies that rice is a substitute for coarse grains. Hence, the hypothesis that rice is a substitute for coarse grains (millet and sorghum) is only partially accepted in Senegal. The dynamic specification (long-run and short-run) of cereals demand in Senegal provide evidence of substitution of maize for sorghum and complementarity between maize and millet. Rice and maize have the same behavior towards millet and sorghum. The finding that millet is expenditure elastic is contrary to the expectation that as per capita income (and hence the budget share allocated to starchy staples) increases, the share of the budget allocated to coarse grains will decrease and that to rice will increase.

3.5.2. Determinants of Starchy Staples Demand – Benin

Table 3-6 contains a descriptive summary of the data used to estimate aggregate demand of starchy staples for Benin. Millet and sorghum combined represent less than 5% of the starchy staple food budget. As a result, due to small size of the sample and also to avoid degrees of freedom problems, both were left out of the analysis of starchy staples demand in Benin. Starchy staples for Benin in this chapter include rice, maize, yams, and cassava. Cassava alone represents an average of 53% of the starchy staple budget, yams represent 30%, rice[30] represents 4%; and maize represents 14%.

[30] Imported rice prices are used since almost all of the rice available for consumption in Benin comes from imports.

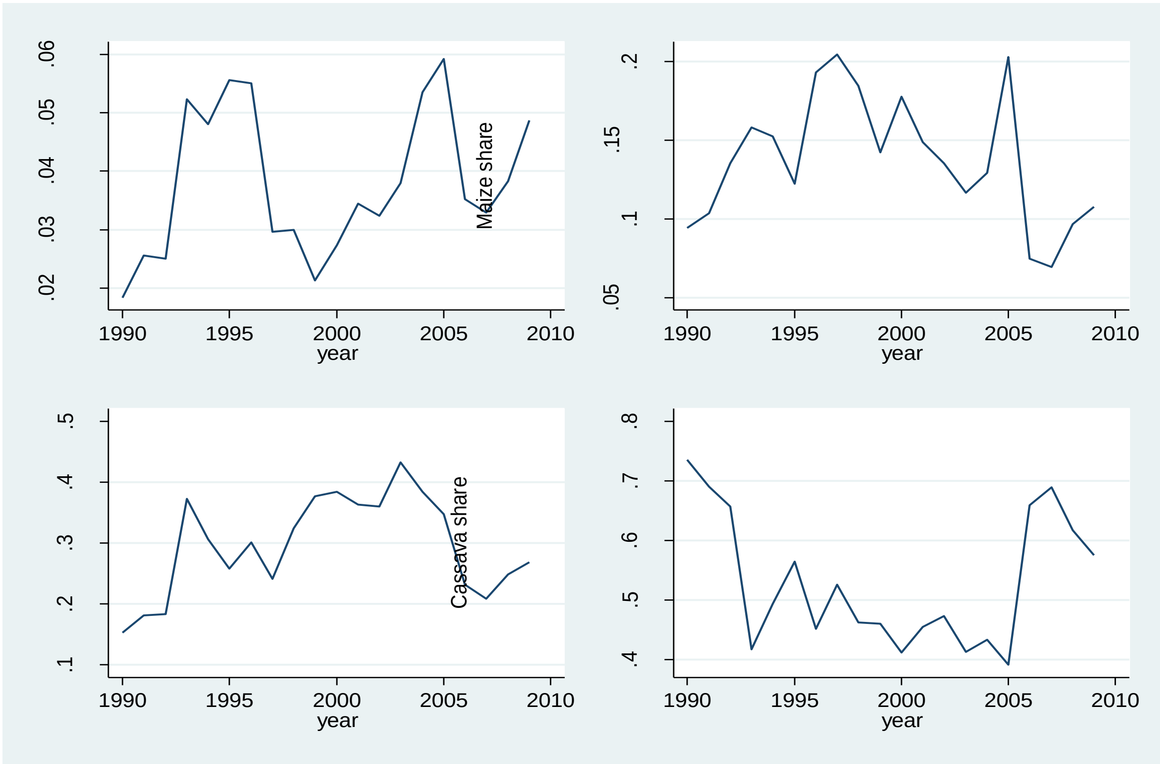
Table 3-6. Benin - Descriptive Statistics of Variables in the Regression, 1990-2009

Variable	Mean	Std. Dev.	Minimum	Maximum
Share urban	38.15	2.11	34.50	41.60
lnprice	5.76	0.10	5.60	5.98
lnpmaize	4.90	0.25	4.50	5.25
lnpcassava	4.80	0.55	4.14	5.75
lnpyams	4.77	0.18	4.41	5.01
lnX	10.83	0.20	10.43	11.19
rice share	0.04	0.01	0.02	0.06
maize share	0.14	0.04	0.07	0.20
yams share	0.30	0.08	0.15	0.43
cassava share	0.53	0.11	0.39	0.74

Source: Author. Prices are log transformed deflated prices.

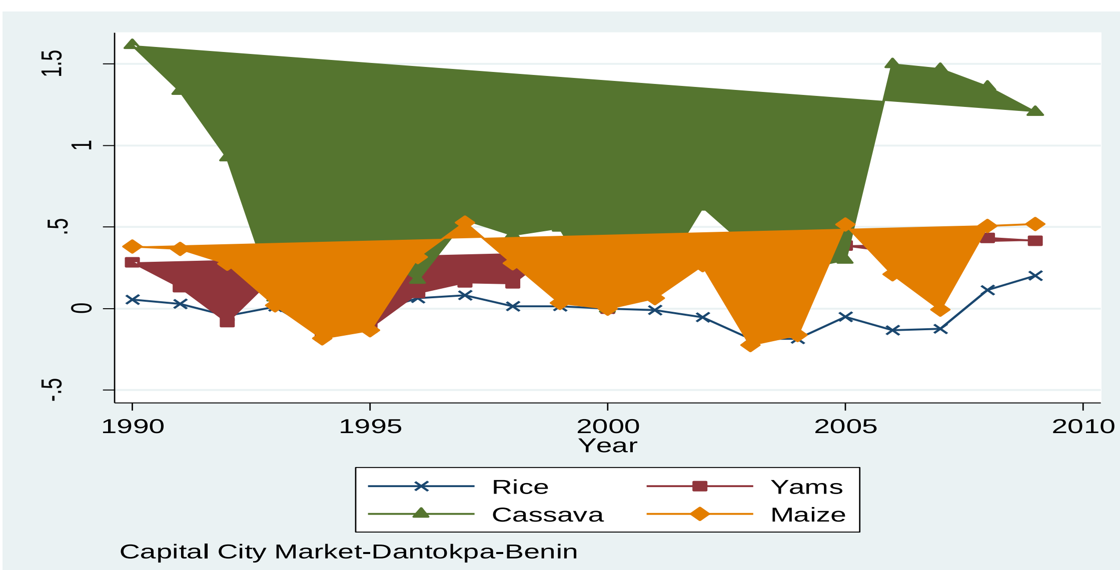
Figure 3-3 shows time series of the share of individual starchy staple types in total per capita starchy staples budget. The share of rice in starchy staples expenditures fluctuated between 2 and 6% in the study period. The upward movement experienced between 1999 and 2005 changed to a decline between 2005 and 2007. Since 2007, the share of rice has been on the rise, and this period corresponds to the period of much higher world rice prices. The share of maize was between 7 and 20% in the study period, and in spite of the drop between 2005 and 2007, it increased in 2008 and 2009. In the study period, the share of cassava in per capita starchy staples budget was above 40%. However, since 2007, the share of yams has slowly increased (but remained less than 30%) while that of cassava dropped but stayed above 50%. The graph of the logarithm transformed deflated starchy staples prices (Figure 3-4) also shows huge fluctuations in starchy staples prices over time.

Figure 3-3. Shares in Starchy Staples Budget - Benin: 1990-2009



Source: Author. Budget shares were computed using cereal availability (kg/capita/year) data from FAO's Food Balance Sheet and price data from Benin's Agricultural Market Information System.

Figure 3-4. Logarithm Transformed Deflated Starchy Staples Prices - Benin: 1990-2009



Source: Author, using price data from Benin's Agricultural Market Information System.

An examination of the correlation coefficient between the urban population share and starchy staples consumption shares reveals a positive relationship between the yam budget share and the urban population share (0.29); and the rice budget share and the urban population share (0.28). Cassava and maize budget shares, on the other hand, were found to be correlated negatively, with the urban population share with correlation coefficients of -0.23 and -0.16 respectively.

Formal investigation of unit roots was also performed using the ADF, the PP and the KPSS tests. Tables A3-5 and A3-6 in Appendix contain the results of the ADF and PP tests for unit roots. The results of the ADF test for unit roots with and without trend provide evidence of non-stationarity in all the variables to be used in the demand estimation. While in the case without trend, first differencing makes all the variables stationary (at the 5% significance level), in the case with trend, first differencing fails to make all the variables stationary. Applying the PP-test for unit roots, we reject stationarity in all the variables in the case without trend and fail to reject stationarity in one out of the nine variables in the case with trend. First differencing with and without trend with the PP-test makes all the variables stationary at a 5% significance level. The KPSS test for unit roots was also performed using the same lag structure as in the ADF and PP tests. In the case with and without trend (Table A3-7 and A3-8 in Appendix) we reject stationarity at a 5% significance level in some of the variables. Applying the test to first-differenced variables, we do not reject the null of stationarity in all the variables in the case with and without trend. Thus, with respect to stationarity, we reach the same conclusion as for Senegal, and the model is estimated handling the stochastic properties of the data.

To proceed with the dynamic specification of starchy staples demand in Benin, a test for cointegration in the regression residuals is carried out to determine if there is a long-run equilibrium relationship between the variables in the demand equations. The results of the test are presented in

Table 3-7. In the case with trend, we reject the null of unit roots (no cointegration) in two of the four equations. In the case without trend, we reject the null of no cointegration in three of the four regressions at a 5% level of significance and in one regression at a 10% level of significance.

Table 3-7. Tests of Regression Residuals for Unit Roots – Benin

Equation	With Trend			Without Trend		
	T-Stat.(rh0)	T-Stat. (t)	p-value	T-Stat.(rh0)	T-Stat. (t)	p-value
Rice Share	-10.561	-2.47	0.3432	-10.702	-2.577	0.0978
Maize Share	-12.358	-2.747	0.217	-12.394	-2.835	0.0534
Yams Share	-18.629	-3.891	0.0125	-18.666	-4.016	0.0013
Cassava Share	-21.338	-4.511	0.0015	-21.391	-4.667	0.0001
Critical values	1%			5%	10%	
PP test (t)-Trend	-4.380			-3.600	-3.240	
PP test (rho)- Trend	-22.500			-17.900	-15.600	
PP test (t)- No Trend	-3.750			-3.000	-2.630	
PP test (rho)-No Trend	-17.200			-12.500	-10.200	

Null Hypothesis: Residuals are non-stationary – i.e., unit roots (no cointegration).

Having established the existence of a long-run equilibrium relationship, the dynamic specification as in equation 3-7 is used to measure the long-run effects of prices and income on the demand for starchy staples in Benin. As was the case in Senegal, the dummy variable for devaluation is not statistically significant in all share equations. Table 3-8 contains the estimated parameters from the ECLAIDS model for starchy staples in Benin. The relationship between urban population share and starchy staples demand is not statistically significant in all three share equations. The lagged residuals from the cointegrating regression have the appropriate sign (negative), and are significant in all three share equation regressions. The coefficient of the log of per capita starchy staples budget is not statistically significant in all three regressions. Most of the coefficients of prices are statistically significant at 1% level.

Table 3-9 and Table 3-10 report the estimated short-run and long-run elasticities from the dynamic demand specification for starchy staples in Benin. Only the estimates of the expenditure elasticities for maize and cassava are statistically significant at a 5% level. The estimates reveal that maize and cassava are expenditure elastic in the short-run, such that an increase in per capita starchy staple budget would result in a more than proportionate increase in expenditure on these commodities. The short-run Marshallian own-price elasticities are negative and statistically significant at a 1% level for maize, cassava, and yams, indicating that an increase in the price of any of these commodities would result in a decrease in its expenditure. The uncompensated own-price elasticity for rice, on the other hand, is positive but not significant at a 5% level. The compensated own-price elasticities are negative for yams and maize and these are also statistically significant at a 1% level. Overall, the demand for all of these starchy staples appears to be price-inelastic as expected.

Furthermore, the cross-price compensated short-run elasticities reveal that maize is a substitute for yams in the short run – a 1% increase in the price of maize will result in a 0.095% increase in yam expenditures. All other short-run compensated cross-price relationships are not statistically significant. In the long-run, only the expenditure elasticity for cassava is statistically significant at a 1% level. All uncompensated own-price elasticities are not statistically significant in the long-run. The compensated own price elasticity for maize is negative and statistically significant. All compensated cross-price relationships are not statistically significant in the long-run.

Table 3-8. Parameter Estimates in ECLAIDS for Starchy Staples in Benin

	Cassava			Yams			Maize		
	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
D1.lcasshare	0.009	0.044	0.837	-	-	-	-0.051	0.054	0.349
D1.lyamshare	-	-	-	0.029	0.064	0.644			
D1.lmaizehare	-	-	-						
share_urban	0.000	0.004	0.968	0.001	0.004	0.813	-0.002	0.002	0.183
D1.lnprice	-0.015	0.006	0.013	-0.007	0.011	0.531	-0.005	0.007	0.451
D1.lnpyams	-0.124	0.022	0.000	0.162	0.028	0.000	-0.032	0.011	0.004
D1.lnpcass	0.212	0.021	0.000	-0.124	0.022	0.000	-0.074	0.009	0.000
D1.lnpmaize	-0.074	0.009	0.000	-0.032	0.011	0.004	0.110	0.010	0.000
D1.ln(X/P)	0.108	0.167	0.519	-0.119	0.178	0.502	0.047	0.072	0.516
$\boldsymbol{\pi_{cass}}$	-0.753	0.161	0.000	-	-	-	-	-	-
$\boldsymbol{\pi_{yams}}$	-	-	-	-0.708	0.163	0.000			
$\boldsymbol{\pi_{\mathrm{maize}}}$	-	-	-	-	-	-	-0.368	0.169	0.030
Constant	-0.007	0.139	0.961	-0.034	0.150	0.818	0.081	0.062	0.186

Source: Author.

Table 3-9. Estimated Error-Corrected Short-Run Demand Elasticities - Benin

Commodity	Yams	Maize	Cassava	Rice
	Expenditure Elasticities			
	0.689	1.265*	1.262*	-0.292
Uncompensated Price Elasticities				
lnpyams	-0.458*	-0.280**	-0.401*	0.243
lnpmaize	-0.027	-0.426*	-0.226*	0.043
lnpcassava	-0.194	-0.523**	-0.592*	-0.007
lnprice	-0.009	-0.036	-0.043**	0.013
Compensated Price Elasticities				
lnpyams	-0.193*	0.205*	0.083	0.131
lnpmaize	0.095*	-0.201*	-0.001	-0.009
lnpcassava	0.089	-0.003	-0.074	-0.127
lnprice	0.009	-0.001	-0.008	0.005

Source: Author.
Note: Significant at 1% (*); 5% (**); and 10% (***)

Table 3-10. Estimated Error-Corrected Long-Run Demand Elasticities - Benin

Commodity	Yams	Maize	Cassava	Rice
	Expenditure Elasticities			
	0.561	1.721	1.348*	-2.751
Uncompensated Price Elasticities				
lnpyams	-0.235	-0.763	-0.533**	1.083
lnpmaize	-0.039	0.563	-0.300*	0.160
lnpcassava	-0.274	-1.423**	-0.458	0.827
lnprice	-0.013	-0.098	-0.057***	0.682
Compensated Price Elasticities				
lnpyams	-0.019	-0.102	-0.016	0.027
lnpmaize	0.061	-2.513*	-0.060	-0.329
lnpcassava	-0.043	-0.715	0.096	-0.304
lnprice	0.002	-0.051	-0.020	0.607

Source: Author.
Note: Significant at 1% (*); 5% (**); and 10% (***)

Overall for Benin, we observe the relationship between urban population share and starchy staples demand is not statistically significant in any of the share equations. However, the compensated cross-price relationship of substitution between maize and yams is maintained in the short-run, while all other compensated cross-price relationships continue to be statistically insignificant. A possible explanation for the substitution relationship between maize and yams is that both are used to make “fufu”, a basic carbohydrate main dish eaten with sauce. All compensated cross-price relationships are not statistically significant in the long-run. A possible explanation for the bizarre results for rice in Benin is due to the large unrecorded trade in rice between Benin and Nigeria, which has banned polished rice imports. Furthermore, given the erratic nature of Nigeria’s trade policies over the year, the rice figures for Benin are not inflated by a uniform amount across all years. Allen et al. (2011) outlines the details of the problems of using FBS data for Benin.

3.5.3. Determinants of Starchy Staples Demand – Mali

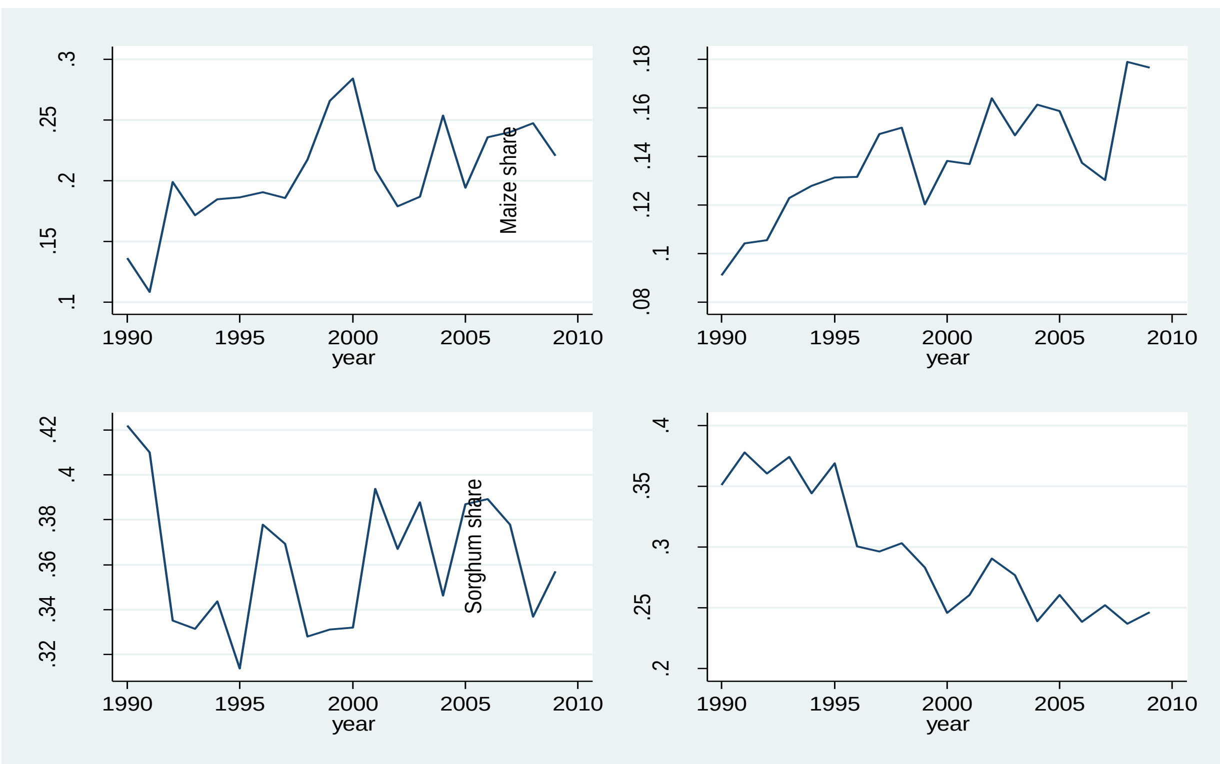
Descriptive statistics for the data used in examining starchy staples demand in Mali are presented in Table 3-11. The budget shares are 20% for rice, 36% for millet, 30% for sorghum, and 14% for maize. The average urban population share in the study period ranged from 23.3% to 32.7%. Figure 3-5 also shows the trend in the budget share allocated to individual cereal types in Mali. The share of sorghum in the cereals budget declined in the study period while that of maize has been on the rise. Millet occupied the largest share in per capita cereals expenditures. However, its share has been fluctuating over time.

Table 3-11. Descriptive Statistics of Variables in the Regression - Mali: 1990-2009

Variable	Mean	Std. Dev.	Min	Max
Share urban	27.80	2.94	23.30	32.74
lnprice	5.61	0.11	5.46	5.89
lnpmillet	4.94	0.22	4.52	5.35
lnpsorghum	4.90	0.22	4.44	5.33
lnpmaize	4.87	0.18	4.47	5.20
lnX	10.32	0.17	9.86	10.58
Rice share	0.20	0.04	0.11	0.28
Maize share	0.14	0.02	0.09	0.18
Millet share	0.36	0.03	0.31	0.42
Sorghum share	0.30	0.05	0.24	0.38

Source: Author. Prices are log transformed deflated prices

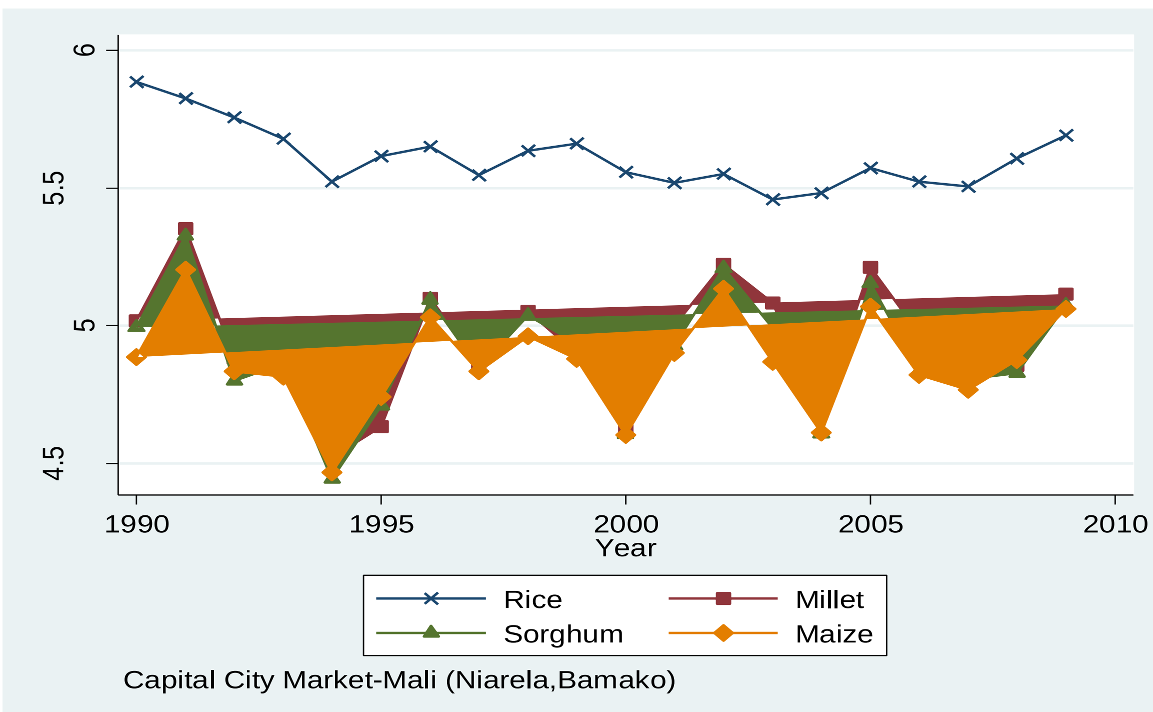
Figure 3-5. Shares in Cereals Budget - Mali: 1990-2009



Source: Author. Budget shares were computed using cereal availability (kg/capita/year) data from FAO's Food Balance Sheet and price data from Mali's Observatoire du Marché Agricole (OMA).

An examination of the correlation coefficients between the urban population share and budget shares reveals that rice and maize budget shares are positively related to the urban population share, with correlation coefficients of 0.62 and 0.80 respectively. The sorghum budget share is negatively related with the urban population share, while there is almost nil association between the millet budget share and the urban population share. The graph of the logarithm of deflated prices for cereals in Mali is displayed in Figure 3-6 and it illustrates that rice prices have been generally higher than the prices of all the other cereals, and also that millet, maize and sorghum prices have tended to move closely together in the same direction.

Figure 3-6. Logarithm Transformed Deflated Cereals Prices - Mali: 1990-2009



Source: Author, using price data from Mali's Observatoire du Marché Agricole (OMA).
Note: Prices are log transformed deflated prices

Tables A3-9 and A3-10 in Appendix contains the results of the ADF and PP test for unit roots. The results reveal that in the case with and without trend, seven of the nine variables are stationary in levels. First differencing also makes all the variables stationary in the case with and without trend using the ADF test. Applying the PP-test for unit roots, we find that evidence of non-stationarity is still mixed in the case with and without trend–two of the nine variables have unit roots in them in levels. First differencing with and without trend makes all the variables stationary. The KPSS test for unit roots also provides mixed evidence of non-stationarity in levels. But, first differencing in the case with and without trend makes all the variables stationary (Appendix, Tables A3-11 and A3-12). As was in the case with Senegal and Benin, mixed evidence of non-stationarity in the levels led to the estimation of the ECLAIDS model for starchy staples demand for Mali.

The test for cointegration (Table 3-12) in the regression residuals reveal that in the case with and without trend, we reject unit roots (no cointegration), thus indicating that there is a long run equilibrium relationship between the variables in the demand system. Following Karagiannis et al. (2000), a dynamic model for starchy staples demand in Mali is specified as in equation 3-7.

Table 3-12. Mali-Tests of Regression Residuals for Unit Roots

Equation	With Trend			Without Trend		
	T-Stat.(rh0)	T-Stat. (t)	p-value	T-Stat.(rh0)	T-Stat. (t)	p-value
Rice Share	-17.962	-3.746	0.0195	-18.026	-3.887	0.0021
Maize Share	-15.703	-3.566	0.0328	-15.719	-3.717	0.0039
Millet Share	-15.213	-5.119	0.0001	-15.77	-4.998	0.000
Sorghum Share	-14.715	-3.156	0.0935	-14.61	-3.223	0.0187
Critical values	1%			5%	10%	
PP test (t)-Trend	-4.380			-3.600	-3.240	
PP test (rho)- Trend	-22.500			-17.900	-15.600	
PP test (t)- No Trend	-3.750			-3.000	-2.630	
PP test (rho)-No Trend	-17.200			-12.500	-10.200	

Source: Author.
Note: Null Hypothesis: Residuals are non-stationary – i.e., unit roots (no Cointegration).

Table 3-13 shows the parameters estimated from a dynamic specification of starchy staples demand in Mali. The coefficient on the urban population share is positive and statistically significant at a 5% level only for millet. However, the effect of urbanization on shifts in millet expenditures seems to be small in magnitude.

Table 3-13. Parameter Estimates from Error-Corrected Linear AIDS model - Mali

	Rice Share			Millet			Sorghum		
Variables	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
D1.lriceshare	0.307	0.062	0.000						
D1.lmilshare				0.248	0.085	0.004			
D1.lsorgshare							0.520	0.098	0.000
share_urban	0.000	0.002	0.879	0.002	0.001	0.023	-0.002	0.002	0.482
D1.lnprice	0.045	0.058	0.437	-0.147	0.034	0.000	0.051	0.039	0.192
D1.lnpmil	-0.147	0.034	0.000	0.277	0.041	0.000	-0.065	0.033	0.047
D1.lnpmaize	0.008	0.033	0.803	-0.127	0.023	0.000	0.066	0.030	0.025
D1.lnpsorg	0.051	0.039	0.192	-0.065	0.033	0.047	0.007	0.032	0.824
Dln(X/P)	-0.491	0.165	0.003	0.159	0.085	0.062	0.235	0.171	0.169
$\boldsymbol{\pi_{rice}}$	-1.476	0.175	0.000	-	-	-	-	-	-
$\boldsymbol{\pi_{millet}}$	-	-	-	-1.257	0.174	0.000	-	-	-
$\boldsymbol{\pi_{sorghum}}$	-	-	-	-	-	-	-1.580	0.159	0.000
Constant	-0.001	0.061	0.991	-0.070	0.030	0.018	0.039	0.062	0.535

Source: Author.

The relationship between urban population share and rice and sorghum are not statistically significant. The lagged residuals from the cointegrating regressions are negative in all three share equations but only statistically significant in the rice and millet share equations. Per capita starchy staples expenditures are also statistically significant in the rice share equation and in the millet equation.

Tables 3-14 and 3-15 show the estimated short-run and long-run elasticities from the starchy staples demand model for Mali. The short-run expenditure elasticities are statistically significant at a 1% level and also greater than unity for millet, sorghum and maize, indicating these cereals are expenditure elastic. The same story is preserved in the long-run (Table 3-15). All the own-price uncompensated price elasticities exhibit the expected negative sign and are statistically significant in the short-run and in the long-run. Rice, sorghum, and maize also exhibit a downward sloping compensated demand curve in the short-run and long-run. The short-run compensated cross-price elasticities reveal that maize is a substitute for rice and sorghum, rice is a substitute for sorghum, and maize is a complement to millet. In the long-run all compensated cross-price relationships are that of substitution, with the exception of maize and millet that are complements, and millet and sorghum, and rice and millet with no statistically significant long-run relationship.

Table 3-14. Mali: Estimated Error-Corrected Short-Run Demand Elasticities

Commodity	Rice	Millet	Sorghum	Maize
	Expenditure Elasticities			
	-0.729	1.478*	1.957*	1.709*
Uncompensated Price Elasticities				
lnprice	-0.349*	-0.579*	-0.065	-0.142
lnpmil	0.057	-0.323**	-0.583**	-1.158*
lnpsorghum	0.604	-0.314**	-1.206*	0.307
lnpmaize	0.268***	-0.450*	0.138	-0.716*
Compensated Price Elasticities				
lnprice	-0.557*	-0.159	0.491*	0.344
lnpmil	-0.185	0.167	0.067	-0.590*
lnpsorghum	0.425*	0.049	-0.725*	0.726
lnpmaize	0.167	-0.246*	0.409*	-0.480*

Source: Author.
Note: Significant at 1% (*); 5% (**); and 10% (***)

Table 3-15. Mali: Estimated Error-Corrected Long-Run Demand Elasticities

Commodity	Rice	Millet	Sorghum	Maize
	Expenditure Elasticities			
	-0.172	1.380*	1.605*	1.421*
Uncompensated Price Elasticities				
lnprice	-0.559*	-0.460*	-0.041	-0.079
lnpmil	0.039	-0.462*	-0.369**	-0.873*
lnpsorghum	0.409*	-0.250**	-1.130*	0.201
lnpmaize	0.181	-0.358*	0.088	-0.669*
Compensated Price Elasticities				
lnprice	-0.608*	-0.068	0.415*	0.324**
lnpmil	-0.018	-0.003	0.164***	-0.402**
lnpsorghum	0.367*	0.089	-0.736*	0.550*
lnpmaize	0.158**	-0.167**	0.309*	-0.473*

Source: Author.
Note: Significant at 1% (*); 5% (**); and 10% (***)

3.6. Chapter Summary

The main objective of the preceding analysis was to examine the aggregate-level determinants of starchy staples demand in Benin, Mali and Senegal. An Error Corrected linearized Almost Ideal demand system (ECLAIDS) was specified following the results of the test for the stochastic properties of the data (unit roots and cointegration). A specific goal of the analysis was to determine any statistical association between the growth in urban population share and the demand for traditional coarse grains such as millet and sorghum. Although domestic price trends are not strictly uniform across all three countries, on the whole similar trends could be observed in all three countries for rice prices relative to coarse grains. Common to Mali and Senegal in the Sahel region of WA is an increasing trend in the share of maize and rice and a declining trend in the share of millet and sorghum in the starchy staples budget over time. In Benin, the shares of individual starchy staple types in the starchy staple budget in the period 1990-2009 have been fluctuating, not exhibiting any noticeable trend.

The analysis of cereals demand after correcting for the unit root properties of the data does not provide any support for a statistical association between the urban population share and cereals consumption behavior in Senegal, but points to a statistically significant, but small, relationship between millet and urban population share in Mali. A principal channel[31] through which urbanization affects consumption is by increasing per capita incomes. By including per capita expenditures on starchy staples as a separate variable in the estimated model, the model specification already controls for per capita expenditure. However, while the coefficient of urbanization and per capita expenditures picks up the individual effects of each of these

[31] Other channels include changes in lifestyle, for instance increased female employment outside their homes.

variables, both variables could interact to generate additional effects on consumption. The insignificance of the urbanization variable in the dynamic specification could be the result of the way in which the variable is introduced into the model. Ideally, one would like to add an interaction term between the urban population share and starchy staples expenditures. However, due to the small number of observations, additional terms will pose degrees of freedom problems, making it impossible to estimate the model. The manner in which the urban population share is incorporated in this study is therefore the most straightforward given starchy staples price data limitations.

As discussed in Chapter 1, evidence on the role of relative cereals prices in influencing cereals consumption in West Africa has been mixed. It has been argued that changes in rice consumption, for instance, are more linked to structural factors like urbanization and to a lesser extent short-term price changes. The Hicksian cross-price elasticities from the error-corrected demand model provide evidence of a statistically significant relationship of substitution in the short-run and long-run between rice and sorghum as hypothesized for Mali and Senegal. While in Senegal, rice is found to be a complement to millet in both the short-run and in the long-run, in Mali, rice and millet are substitutes but the relationship is not statistically significant. Furthermore, in Senegal and Mali the relationship between rice and maize is positive but not statistically significant in the short-run. However, while the latter relationship continues to be insignificant in the Senegal in the long-run, in Mali, rice and maize have a statistically significant relationship of substitution in the long-run. The dynamic specification (long-run and short-run) for Senegal provides evidence of substitution of maize for sorghum and complementarity between maize and millet. The results also reveal that in spite of the negative association between urbanization and coarse grains (millet and sorghum) shares as shown by the correlation coefficients, the expenditure elasticities are more elastic for millet and sorghum than they are for rice in Senegal and Mali. This finding is contrary to the expectation that traditional coarse grains are expenditure inelastic and warrants more investigation of starchy staples consumption behavior by place of residence within the same income group.

Overall for Benin, we observe that most compensated cross-price relationships are not statistically significant in both the short-run and long-run. A possible explanation for the bizarre results for rice in Benin is the large unrecorded trade in rice between Benin and Nigeria, which has banned polished rice imports. This unrecorded trade may make the FBS per capita rice availability figures for Benin unreliable indicators of the true consumption levels.

A limitation of the aggregate results is that they do not sufficiently capture the effects of structural change on consumption coming from changes in non-price factors, such as income distribution. Such estimations implicitly assume that many other factors remain constant. Even more, in most cases the national averages hide contrasting sub-national realities. The distribution of income at the sub-national or micro level is probably a more critical determinant of starchy staples consumption than is the level of aggregate national per capita expenditures. Another big limitation is the intra-annual aggregation that takes place when one uses annual data—e.g., annual price data. Delgado and Reardon (1991) argue that although aggregate results are still very useful for looking at long-term consumption trends, the diagnosis of what is really pushing consumption behavior requires micro-level work that takes into account the relevant non-price factors. Chapter 4 examines the micro-level factors that influence cereals consumption in Mali using Mali's 2006 household budget survey data. This allows us to explore further the discrepancies found in different regions of Mali and across households of different social and economic characteristics.

APPENDIX

Table A3-1. Unit Root Tests (H_0: Unit Roots) – Senegal

	ADF test			PP test		
Variable	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices with trend						
lnprice	-1.922	0.643	1	-11.083	-2.551	0.303
lnpmaize	-2.004	0.599	1	-12.733	-2.858	0.176
lnpmillet	-1.735	0.735	1	-8.414	-2.082	0.556
lnpsorghum	-3.93	0.011	1	-20.834	-4.545	0.001
Ln(P)	-1.964	0.621	1	-11.167	-2.593	0.283
Rice Share	-2.532	0.312	1	-13.187	-2.902	0.162
Maize Share	-1.562	0.807	1	-5.789	-1.826	0.692
Millet Share	-3.432	0.047	1	-18.012	-3.932	0.011
Sorghum Share	-1.856	0.677	1	-15.608	-3.51	0.038
Differenced Real Prices With Trend						
D.lnprice	-3.105	0.105	1	-24.082	-4.965	0.000
D.lnpmaize	-2.780	0.204	1	-25.312	-5.788	0.000
D.lnpmillet	-2.374	0.394	1	-21.639	-4.57	0.001
D.lnpsorghum	-4.868	0.000	1	-25.003	-6.668	0.000
D.ln(X)	-3.298	0.067	1	-24.836	-5.176	0.000
D.Rice Share	-4.447	0.002	1	-22.159	-4.915	0.000
D.Maize Share	-2.600	0.280	1	-21.442	-4.609	0.001
D.Millet Share	-5.292	0.000	1	-22.717	-5.473	0.000
D.Sorghum Share	-3.713	0.022	1	-26.801	-7.398	0.000

Critical values	1%	5%	10%
ADF test	-4.380	-3.600	-3.240
PP test (rho)	-22.500	-17.900	-15.600
PP test (t)	-4.380	-3.600	-3.240

Source: Author.

Note: D. denotes the first-difference of variable. Asterisk (*) means we reject unit roots at 10%.

Table A3-2: Unit root tests (H_0: Non-Stationarity/unit roots) - Senegal

	ADF test			PP test		
Variable	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices Without Trend						
lnprice	-2.02	0.278	1	-11.074	-2.627	0.088
lnpmaize	-1.83	0.366	1	-9.961	-2.498	0.116
lnpmillet	-1.694	0.434	1	-6.686	-1.910	0.327
lnpsorghum	-3.296	0.015	1	-19.798	-4.248	0.001
Ln(X)	-2.322	0.165	1	-10.534	-2.738	0.068
Rice Share	-1.756	0.403	1	-5.409	-2.007	0.283
Maize Share	-0.592	0.873	1	-1.841	-0.697	0.847
Millet Share	-0.802	0.819	1	-1.813	-0.836	0.808
Sorghum Share	-1.84	0.361	1	-14.726	-3.543	0.007
Real Normalized Prices Without Trend						
D.lnprice	-3.209	0.020	1	-23.768	-5.140	0.000
D.lnpmaize	-2.901	0.045	1	-25.288	-5.969	0.000
D.lnpmillet	-2.471	0.123	1	-21.413	-4.680	0.000
D.lnpsorghum	-4.988	0.000	1	-24.889	-6.779	0.000
D.ln(X)	-3.396	0.011	1	-23.064	-5.121	0.000
D.Rice Share	-4.561	0.000	1	-22.126	-5.049	0.000
D.Maize Share	-2.483	0.120	1	-20.966	-4.590	0.000
D.Millet Share	-5.353	0.000	1	-22.718	-5.693	0.000
D.Sorghum Share	-3.828	0.003	1	-26.845	-7.630	0.000
Critical values	1%			5%	10%	
ADF test	-3.750			-3.000	-2.630	
PP test (rho)	-17.200			-12.500	-10.200	
PP test (t)	-3.750			-3.000	-2.630	

Source: Author.

Note: Asterisk (*) means we reject unit roots at 10%.

Table A3-3. KPSS Test for Unit Roots-Levels (H_0: Stationarity) – Senegal

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
lnprice	1	0.107	0.104	
lnpmaize	1	0.097	0.374	
lnpmillet	1	0.107	0.354	
lnpsorghum	1	0.058	0.213	
Ln(X)	1	0.118	0.280	
Rice Share	1	0.147	0.819	
Maize Share	1	0.211	0.641	
Millet Share	1	0.073	0.999	
Sorghum Share	1	0.118	0.205	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note: Asterisk (*) means we do not reject stationarity at 5%.

Table A3-4. KPSS Test for Unit Roots- First Differenced (H_0: Stationarity) – Senegal

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
D.lnRice	1	0.070	0.070	
D.lnMaize	1	0.065	0.065	
D.lnMillet	1	0.086	0.087	
D.lnSorghum	1	0.041	0.047	
D.ln(X)	1	0.057	0.107	
D.Rice Share	1	0.042	0.085	
D.Maize Share	1	0.070	0.195	
D.Millet Share	1	0.051	0.057	
D.Sorghum Share	1	0.092	0.097	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note; Asterisk (*) means we do not reject stationarity at 5%.

Table A3-5: Unit Root Tests (Non-Stationarity as the Null Hypothesis) – Benin

	ADF test			PP test		
Variable	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices with trend						
lnprice	-1.621	0.7842	1	-8.251	-1.604	0.7908
lnpmaize	-2.274	0.4486	2	-11.233	-2.737	0.2211
lnpyams	-2.558	0.2998	2	-18.007	-5.316	0.0001
lnpcassava	-2.902	0.1616	1	-7.211	-2.496	0.3301
Ln(X)	-3.209	0.0827	1	-6.911	-2.517	0.3195
Rice Share	-2.594	0.2827	1	-10.423	-2.542	0.3072
Maize Share	-2.961	0.1432	1	-11.859	-3.031	0.1237
Yams Share	-2.027	0.5864	1	-7.357	-2.116	0.5371
Cassava Share	-2.388	0.386	1	-8.226	-2.443	0.3568
Differenced Real prices with Trend						
D.lnprice	-3.173	0.090	1	-19.691	-4.278	0.003
D.lnpmaize	-5.803	0.000	1	-19.465	-4.356	0.003
D.lnpyams	-5.554	0.000	1	-25.576	-7.524	0.000
D.lnpcassava	-4.062	0.007	2	-16.948	-4.035	0.008
D.ln(X)	-3.625	0.028	2	-15.183	-3.339	0.060
D.Rice Share	-2.532	0.312	2	-18.014	-3.946	0.011
D.Maize Share	-4.874	0.000	1	-22.409	-5.400	0.000
D.Yams Share	-2.938	0.150	2	-19.530	-4.793	0.001
D.Cassava Share	-3.904	0.012	1	-22.145	-5.057	0.000

Critical values	1%	5%	10%
ADF test	-4.380	-3.600	-3.240
PP test (rho)	-22.500	-17.900	-15.600
PP test (t)	-4.380	-3.600	-3.240

Source: Author.

Note: The asterisk (*) implies we reject non-stationarity at 10% significance level.

Table A3-6. Unit root tests (Non-Stationarity as the Null Hypothesis) – Benin

	ADF test			PP test		
	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices Without Trend						
lnprice	-2.124	0.2349	1	-9.846	-2.013	0.281
lnpmaize	-2.254	0.1873	2	-11.916	-2.844	0.052
lnpyams	-0.487	0.8945	2	-11.352	-2.577	0.098
lnpcassava	-2.309	0.169	1	-7.606	-2.233	0.194
Ln(X)	-2.236	0.1934	1	-6.648	-1.934	0.316
Rice Share	-2.68	0.0775	1	-10.255	-2.627	0.088
Maize Share	-2.344	0.1582	1	-11.341	-2.748	0.066
Yams Share	-2.400	0.1418	1	-7.997	-2.469	0.123
Cassava Share	-2.594	0.0942	1	-9.092	-2.706	0.073
Differenced Real Prices Without Trend						
D.lnprice	-3.047	0.031	1	-18.270	-4.042	0.001
D.lnpmaize	-5.676	0.000	1	-18.978	-4.325	0.000
D.lnpyams	-5.720	0.000	1	-25.039	-7.572	0.000
D.lnpcassava	-3.635	0.005	2	-15.316	-3.746	0.004
D.ln(X)	-3.448	0.009	2	-12.557	-3.115	0.026
D.Rice Share	-2.924	0.043	2	-17.920	-4.108	0.001
D.Maize Share	-4.574	0.000	1	-21.878	-5.331	0.000
D.Yams Share	-3.351	0.013	2	-19.026	-4.532	0.000
D.Cassava Share	-3.312	0.014	1	-20.884	-4.794	0.000

Critical values	1%	5%	10%
ADF test	-3.750	-3.000	-2.630
PP test (rho)	-17.200	-12.500	-10.200
PP test (t)	-3.750	-3.000	-2.630

Source: Author.

Note: The asterisk (*) implies we reject non-stationarity at 10% significance level.

Table A3-7. KPSS Test for Unit Roots-Levels (Ho: Stationarity) – Benin

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
lnprice	1	0.0974	0.115	
lnpmaize	2	0.0998	0.109	
lnpyams	2	0.1030	0.5400	
lnpcassava	1	0.1960	0.231	
Ln(X)	1	0.1810	0.279	
Rice Share	1	0.074	0.129	
Maize Share	1	0.1820	0.271	
Yams Share	1	0.1910	0.281	
Cassava Share	1	0.1990	0.220	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note: The asterisk (*) implies we do not reject Stationarity at 5% significance level.

Table A3-8. KPSS Test for Unit Roots- First Differenced (Ho: Stationarity) – Benin

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
D.lnRice	1	0.0965	0.211	
D.lnMaize	1	0.0384	0.093	
D.lnpyams	1	0.0695	0.133	
D.lnpcassava	2	0.0767	0.282	
D.ln(X)	2	0.0729	0.288	
D.Rice Share	2	0.0803	0.086	
D.Maize Share	1	0.0475	0.122	
D.Yams Share	2	0.0634	0.211	
D.Cassava Share	1	0.0502	0.200	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note: The asterisk (*) implies we do not reject Stationarity at 5% significance level.

Table A3-9. Unit Root Tests (H_0: Non-Stationarity/Unit Roots) – Mali

	ADF test			PP test		
Variable	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices with trend						
lnprice	-1.463	0.841	2	-4.694	-1.387	0.865
lnpmaize	-4.699	0.001	1	-19.183	-3.981	0.009
lnpmillet	-4.215	0.004	1	-17.819	-3.816	0.016
lnpsorghum	-4.354	0.003	1	-19.209	-4.123	0.006
Ln(X)	-4.284	0.003	1	-16.356	-3.561	0.033
Rice Share	-3.283	0.069	1	-13.888	-3.081	0.111
Maize Share	-3.185	0.088	1	-15.747	-3.521	0.037
Millet Share	-4.401	0.002	1	-13.011	-3.659	0.025
Sorghum Share	-1.892	0.659	1	-15.721	-3.257	0.074
Differenced Real Prices With Trend						
D.lnprice	-5.168	0.000	1	-20.632	-4.72	0.001
D.lnpmaize	-4.886	0.000	1	-23.254	-5.902	0.000
D.lnpmillet	-4.333	0.003	1	-24.272	-6.081	0.000
D.lnpsorghum	-4.505	0.002	1	-24.91	-6.41	0.000
D.ln(X)	-4.367	0.003	1	-24.044	-5.906	0.000
D.Rice Share	-3.625	0.028	1	-24.177	-5.53	0.000
D.Maize Share	-3.540	0.035	1	-22.969	-5.378	0.000
D.Millet Share	-3.630	0.027	1	-23.479	-5.366	0.000
D.Sorghum Share	-3.939	0.011	1	-24.86	-6.721	0.000

Critical values	1%	5%	10%
ADF test	-4.380	-3.600	-3.240
PP test (rho)	-22.500	-17.900	-15.600
PP test (t)	-4.380	-3.600	-3.240

Source: Author.

Note: Asterisk (*) means we reject the unit roots at 10%.

Table A3-10: Unit root tests (H_0: Non-Stationarity/unit roots) - Mali

	ADF test			PP test		
Variable	T-Stat.	p-value	lags	T-Stat.(rh0)	T-Stat. (t)	p-value
Real Prices Without Trend						
lnprice	-3.187	0.021	2	-6.424	-2.968	0.038
lnpmaize	-4.742	0.000	1	-19.363	-4.115	0.001
lnpmillet	-4.001	0.001	1	-18.071	-3.921	0.002
lnpsorghum	-4.407	0.000	1	-19.352	-4.275	0.001
Ln(X)	-3.797	0.003	1	-16.843	-3.595	0.006
Rice Share	-3.178	0.021	1	-8.790	-2.619	0.089
Maize Share	-1.622	0.472	1	-6.382	-2.068	0.258
Millet Share	-3.758	0.003	1	-13.509	-3.662	0.005
Sorghum Share	-1.208	0.670	1	-1.998	-1.020	0.746
Differenced Real Prices Without Trend						
D.lnprice	-3.708	0.004	1	-17.999	-3.949	0.002
D.lnpmaize	-4.955	0.000	1	-23.285	-5.885	0.000
D.lnpmillet	-4.422	0.000	1	-24.313	-6.104	0.000
D.lnpsorghum	-4.608	0.000	1	-24.907	-6.428	0.000
D.ln(X)	-4.344	0.000	1	-23.835	-5.760	0.000
D.Rice Share	-3.751	0.004	1	-23.852	-5.485	0.000
D.Maize Share	-3.675	0.005	1	-22.971	-5.558	0.000
D.Millet Share	-3.911	0.002	1	-22.965	-5.423	0.000
D.Sorghum Share	-3.935	0.002	1	-25.115	-6.821	0.000

Critical values	1%	5%	10%
ADF test	-3.750	-3.000	-2.630
PP test (rho)	-17.200	-12.500	-10.200
PP test (t)	-3.750	-3.000	-2.630

Source: Author.

Asterisk (*) means we reject unit roost at 10%.

Table A3-11. KPSS Test for Unit Roots-Levels (H_0: Stationarity) – Mali

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
lnprice	2	0.157	0.458	
lnpmaize	1	0.051	0.060	
lnpmillet	1	0.067	0.083	
lnpsorghum	1	0.055	0.056	
Ln(X)	1	0.083	0.127	
Rice Share	1	0.114	0.572	
Maize Share	1	0.092	0.818	
Millet Share	1	0.106	0.104	
Sorghum Share	1	0.145	0.961	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note: Asterisk (*) means we do not reject stationarity at 5%.

Table A3-12. KPSS Test for Unit Roots- First Differenced (H_0: Stationarity)-Mali

	With Trend		Without Trend	
Variable	Lag Order	Test Statistics	Test Statistics	
D.lnRice	1	0.056	0.356	
D.lnMaize	1	0.041	0.054	
D.lnMillet	1	0.043	0.059	
D.lnSorghum	1	0.044	0.059	
D.ln(X)	1	0.043	0.091	
D.Rice Share	1	0.044	0.085	
D.Maize Share	1	0.060	0.069	
D.Millet Share	1	0.083	0.131	
D.Sorghum Share	1	0.079	0.083	
Critical Values	10%= 0.119	2.5%=0.176	10%=0.347	2.5%=0.574
	5%= 0.146	1%=0.216	5%=0.463	1%=0.739

Source: Author.
Note: Asterisk (*) means we do not reject at 5%.

CHAPTER 4. HOUSEHOLD-LEVEL EVIDENCE OF CEREALS DEMAND IN URBAN AND RURAL MALI

4.1. Background and Problem Statement

The aggregate, country-level analysis of food demand based on FBS data from Chapter 3 is a good starting point for understanding major drivers of the demand for starchy staples in West Africa. However, the information it provides permits only the identification of the general priorities for consumption analysis and overall food policy attention. The limitations of the FBS are quite well known: a) its failure to disaggregate supply by income class and b) its failure to provide information on the distribution of food availability geographically within a country. As a result, an analysis thereof ignores the effects of the distribution of income and of differences in food supply across regions on food demand. Such a disaggregation is essential in bringing the food situation into clearer focus. Even more, several factors at the household-level work to determine food demand behavior, and these need to be understood in order to design effective food policies.

This chapter aims to provide micro-level evidence on food demand in Mali by means of a household-level disaggregated, multivariate analysis using household budget survey (HBS) data. An analysis of food demand disaggregated at the household level helps to identify households that are most vulnerable to inadequate food intake and their geographic location; and in particular in understanding the behavioral parameters underlying any adjustment to the economic environment. A multivariate analysis that is grounded in economic theory provides estimates of microeconomic measures of households' consumption responsiveness to changes in the amount of resources available for consumption and also allows us to test the responsiveness of demand to other arguments included in the demand function (e.g., prices). Estimation at the household level allows not only the incorporation of household consumption variables (economic and socio-demographic) into the analysis, but even more important, the interest of this type of analysis lies in the estimation of price and income elasticities of demand which: a) take into account differences in the distribution of income across households and b) capture the extent to which price differences resulting from differences in food supply conditions as well as differences in tastes and preferences across regions influence food demand. Such information is needed for a much precise description of food security problems, in designing programs that target food assistance efficiently and in evaluating the effect of various policies and other targeted programs to alleviate food insecurity.

4.2. Research Questions and Hypotheses

The main objective of this chapter is to analyze HBS data for Mali in order to estimate consumption parameters. Separate food demand estimates will be provided by place of residence (urban/rural) and by per capita income groups. Specifically, the analysis asks the following questions:

- What factors influence the demand for individual cereals and the substitution among individual cereal types?
- How does food consumption behavior differ across households of different income levels?
- How does the structure of food demand differ by place of residence (rural/urban)?

The following hypotheses will be tested:

Hypothesis 4.1: Cereals expenditure elasticities are higher for poorer than for richer households. Engel’s law also predicts that the proportion of income spent on food declines with income. We therefore expect expenditure elasticities to be higher for lower income groups.

Hypothesis 4.2: Rice demand is less responsive (inelastic) to price changes (relative to coarse grains) in urban areas than in rural areas. Due to the high opportunity cost of time and convenience in the urban area, one would expect urban households to prefer rice to coarse grains and therefore be less sensitive to changes in rice prices.

Hypothesis 4.3: The Marshallian own-price elasticities of cereals demand are more elastic (larger in absolute terms) for lower income households than higher income households. For poorer households spending a higher percentage of their income on food (Engel's law) the income effect of a change in the price of food is expected to be substantial and demand would be elastic. Meanwhile for richer households for which food represents only a negligible portion of the budget, the income effect will be insignificant and demand inelastic.

Hypothesis 4.4: The substitution effects (cross-price elasticities) of demand across different types of cereals are higher for urban than for rural households. Rural households are often also food producing households, and they usually have available to them that which they can produce – predominantly millet and sorghum (since it is too dry in many areas to produce rice and maize). Urban households on the other hand, especially those in larger cities, quite often have a full panoply of goods available in urban markets. As a result, the substitution effects are expected to be larger in the urban areas (with a wider range of products to draw from) than in the rural areas.

Hypothesis 4.5: The compensated cross-price elasticities of cereal demand will be higher for the low-income groups than for higher-income groups. For the same reason that staple food is an important share of the consumption base amongst the low-income population, low-income households are more likely to substitute across staples in the event of an increase in the price of a commodity.

The findings of this chapter make an important empirical contribution by reporting for the first time a set of estimates of food demand elasticities for urban and rural Malian households, by income groups and taking into account differences in households' socio-demographic characteristics. The remainder of this chapter is organized as follows: the conceptual framework underlying the analysis; a review of relevant literature on the determinants of household demand; the data and computation of variables used in the analysis; the methodological framework, including discussion of the theoretical background for the QUAIDS demand model and of the empirical problems encountered in the specification of the model (the problem of zero expenditure on certain commodities and the problem of expenditure endogeneity); and findings.

4.3. Conceptual Framework and Literature Review

4.3.1. Household-Level Determinants of Food Demand

Microeconomic analysis recognizes the role of key variables in determining demand. These variables are commonly referred to as demand "shifters", since changes in these variables lead to changes in demand. Common household-level demand shifters include income, taste and preferences and relative prices. Other factors such as household demographic characteristics (size, age and sex composition), place of residence and geographic location also influence household demand.

4.3.1 Income

Engel's law predicts that the proportion of income spent on food declines with income, even if actual expenditure on food rises. It is widely, if not universally, acknowledged that income elasticities for food items decline with income (Alderman, 1986). Inferior foods, those that decrease in demand when consumer income rises, have a potential for self-targeting.[32] This makes them attractive as candidates for social safety-net programs that seek to alleviate hunger amongst the poor in a period of crisis. Households of different income groups respond differently to changes in the conditions that determine demand. As a result, designing effective food policy requires demand parameters differentiated by income groups.

4.3.1.2. Prices

Consumers react to price changes by changing quantity or quality consumed. For primary products (with little quality differentiation) like cereals, it is common to find consumers making quantity adjustments and /or moving to closely related products. In theory, the total effect of a good's price change is summarized using the Slutsky decomposition–the income and the substitution effects. The income effect is the effect on demand due to a change in consumer's real purchasing power. The substitution effect represents the change in demand due to a relative price change. The Slutsky decomposition shows that the magnitude and the sign of the Marshallian (income constant) price elasticity depend on: a) the compensated or Hicksian (utility constant) elasticity, b) the share of the good in consumption, and c) the income elasticity of the good. Both b) and c) are usually larger for lower-income households than higher income households because of Engel's law and also because food staples constitute a major share in the food budget for lower income groups, who are more concerned about calories quantity than quality than are higher income groups. The balance of the movements of the substitution effect and the income effect is what makes a good normal or inferior.

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[32] A mechanism whereby those who are in need of benefit identify themselves for or gain from the assistance.

For agricultural households, the effect of food price changes goes beyond the "income effect" and the "substitution effect" discussed above. Under the perspective of an agricultural household model, consumption behavior is complicated by production decisions. While most urban households are solely food consumers, most rural households are also food producers, such that changes in food prices affect them as consumers (expenditure side) and producers (income side). An increase in the price of a food commodity could increase the demand for that commodity (contrary to the traditional demand theory) since a farmer may produce more of it and gain more income. The net effect of a price change depends on the net position of the household in the food market (net-seller or net buyer). Thus, at the household level, while net food-selling households would see an increase in income that may compensate for the rise in the price of foods they purchase (the "profit effect" described by Singh et al., 1986), the net food-buying households are likely to be adversely affected by increases in the prices of foods they purchase (unless the higher agricultural prices lead to an increase in the demand for agricultural labor, which could lead to the net buyer households earning more money as agricultural laborers).

A primary motive for estimating demand elasticities is to use them in estimating the welfare effects of food price changes. According to de Janvry and Sadoulet (2008), imputing changes in relative food prices to the household's production and consumption of food crops for the computation of welfare effects of food price changes requires a household survey that gives detailed information on the consumption structure and on the production structure.

Estimating the additional effect of a change in price for agricultural households on consumption requires: 1) capturing the change in income from a price change (profit effect) and 2) the corresponding change in total expenditures on a the set of commodities of interest (in this case cereals) as a result of the change in income. The estimation of the additional profit effect from food price changes requires information on the production technology (input and output quantities) as well cost information (input and output costs). The ELIM 2006 HBS used in this chapter does not include information on quantities or cost of inputs used or quantities of output produced for the commodities of interest in this study. Total revenue from cereals sales is reported. However, this is not disaggregated by individual cereals type. Information on the cost of production of cereals is not available. This data limitation therefore makes it impossible to model the joint production and consumption behavior of food producing and consuming households in this chapter.

4.3.1.2.1. Estimating Price Effects in Cross-Sectional Household Survey Data

Mali's cross-sectional HBS data known as the "Enquête Légère Intégrée auprès des Ménages (ELIM)-2006" is used in this chapter. All nine regions of Mali, including the district of Bamako, were covered in the survey (Koulikoro, Segou, Sikasso, Gao, Kayes, Kidal, Mopti, Tombouctou, and Bamako). Like most HBS data, no information is provided on the prices paid by individual households for most goods. The Observatoire du Marche Agricole (OMA) is the office responsible for collecting agricultural price data. Table A4-1 in Appendix presents the structure of the ELIM-2006 data. The regions surveyed are comprised of "cercles" or districts (total=48), each of which is further divided into "arrondissements" or sub-districts. The last column in Table A4-1 shows the representative markets from which the OMA collects cereal price data. At the level of the sub-districts, there is a paucity of OMA data collection sites, limiting the degree of price variation one can get at this level. Variation in prices can therefore be obtained only at the district level. For 33 of the 48 districts, OMA monitors at least one market within the district. District-level prices can be calculated by averaging the prices from all the markets for which prices are collected within each district. For the other 15 districts with no representative markets, regional-level average prices by product will be imputed.

An important question that often emerges in the analyses of household food demand behavior using cross-sectional survey data (where households indicate the actual price paid for a commodity), is whether price variation can be obtained from the surveys in order to estimate a complete system of demand and price elasticities (Koç and Alpay, 2002). As stated earlier, this study makes use of cross-sectional price data from an external source. The appropriateness of cross-sectional price variations in the estimation of reliable price elasticities of demand has been widely discussed in the literature.

Cross-sectional variations in prices could be due to various reasons such as region, price discrimination, seasonality and quality effects (Prais and Houthakker, 1955). Imputing prices from an external source makes it impossible to capture price discrimination and quality effects. However, when dealing with primary commodities, one expects relatively little quality variation. Price variations from regional and seasonal differences allow accurate estimation of price elasticities, and thus are desirable for demand analysis (Deaton, 1988; Cox and Wohlgenant, 1988). Friedman (1976) suggests that constructing a demand curve from spatial data is essentially similar to that from time-series data when conditions of supply vary considerably while conditions of demand vary little, which is possible for products (such as food) that have distinctive local markets with different supply conditions.

Generally, price variations across regions at a given point in time are often attributed to differences in supply conditions and differences in tastes and preferences. This makes it difficult to infer causality to regionally different consumption patterns even when prices are different. Deaton (1997) notes that it is often desirable to allow for the effects of regional and seasonal taste variation in the pattern of demand by entering regional and seasonal dummies into the regression, so that the price effects on demand are only identified to the degree that there are multiple observations within regions or that regional prices do not move in parallel across seasons. Dummy variables will be introduced to isolate changes in demand from differences in taste and preference from changes in demand from changes in prices.

Deaton (1988) shows that under appropriate separability conditions, one can exploit the spatial nature of data to back out true price elasticities. The idea is that within a geographic unit (say district) the prices will be the same, and controlling for district-level fixed effects allows one to back out the true price elasticities because the real price variation occurs only through the spatial dimension. Thus, even though the survey is a one shot survey, multiple observations of prices (district-level) within a region allow us to capture some temporal variability in prices, which when combined with regional dummy variables permits us to obtain estimates of price elasticities by income group.

4.3.1.3. Taste and Preferences

Food demand is also strongly influenced by changes in tastes and preferences. Taste and preferences may change over time (e.g., due to globalization), across regions and with ethnicity. In a cross-sectional setting, one can capture variations in taste and preferences across regions but not across time. The use of regional dummy variables enables us to isolate the effect on demand from differences in taste and preferences (across regions) from other effects.

4.3.1.4. Household Socio-demographic Characteristics

Socio-demographic characteristics, such as family size and composition (sex and age), inf1uence household expenditure patterns and hence are important variables in policy design and analysis. Teklu (1996) observes that an increase in household size leads to a less than proportional increase in food consumption. That is, the elasticity of demand for food with respect to size is less than unity—holding per capita income constant (there are economies of scale in consumption). Savadogo and Brandt (1988) in urban Burkina Faso showed that such economies of scale in consumption are larger for high-income groups, who had higher levels of food consumption, such that the effect of an increase in household size on food consumption is lower at the margin. Moreover, an increase in household size induces a reallocation of food budget away from food groups that are income-elastic towards income-inelastic food staples (Savadogo and Brandt; 1988). Demand patterns may also vary across age (child and adult goods) and sex within the households.

4.3.1.5. Geographic Location

Geographic regions differ in climatic and infrastructure conditions and hence in the availability of food and consumption habits (composition of the food basket). Wodon and Zaman (2010) observe that the distributional impact of rising food prices affects poor households partly based on where they live, which poses a challenge for policymakers. In the development and targeting of food safety net interventions to help households cope with the increase in food prices, policymakers therefore need to identify the hardest hit areas which: a) may not necessarily be among the poorest in the country; and b) are also not always homogenous in terms of income or other indicators of household vulnerability. Regional dummies are used to isolate geographic differences in consumption and not just those due to taste and preferences discussed above.

4.3.1.6. Place of Residence

Rural and urban consumption patterns are different due to differences in economic activity and lifestyle. Rural livelihoods are mostly dependent on agriculture, and rural areas account for much of the food consumed in Mali. Kelly et al. (2008) note that even in the import-dependent Sahelian countries, production of coarse grains persists in the rural areas such that while the urban consumers heavily rely on imported cereal for food, rural households also heavily rely on traditional coarse grains for their dietary needs and have a lower level of rice consumption. Not only do rural and urban consumers have different base levels of food consumption (at the commodity level), but also, time is an important factor that brings about differences in rural and urban consumption habits. Kennedy and Reardon (1994) found that in urban Burkina Faso the opportunity cost of women's time was a major factor in the choice of coarse grains versus-non-traditional grains. Women who worked outside the home were found to have a strong preference for rice, which took less time to cook than coarse grains.

Earlier studies of food consumption patterns in the Sahel have focused largely on urban households, based on the notion that they rely on the market for most of their consumption because of their lifestyle. Changes in relative prices of food were therefore expected to hurt these urban consumers more than rural dwellers. According to Kelly et al. (2008), a challenge in the current food crisis situation is the difficulty to assess the relative vulnerability of urban versus rural groups. They explained further that because the price hikes to date are greatest on imported cereals consumed more by urban than rural populations, there is a tendency to think of this more as an urban problem. However, to the extent that these higher prices are transmitted to domestic cereals and rural markets, or supplies of domestic cereals become tight, the vulnerability may be as great in rural areas. Thus, a comprehensive understanding of food consumption patterns requires giving consideration to both rural and urban households.

4.4. Data and Computation of Relevant Variables

The ELIM-2006 HBS data covered 4494 Malian households, urban (1594) and rural (2910), and 9 regions including the district of Bamako. Data were collected on household economic and socio-demographic characteristics and expenditures by major categories (food and non-food). Food expenditures are further divided into major food groups (cereals and non-cereals foods) and cereals expenditures are grouped by cereal crop type. Total consumption expenditures per expenditure category sums the value of consumption on a given category from all sources (includes purchases, own-production and from other modes of acquisition). Household adult equivalents (AE) are calculated by aggregating the determined AE of the respective household members. The AE for each household member is calculated using the scale: male>14 years=1.0; female>14=0.8; children=0.5 (Duncan, 1994). Total expenditure on all household expenditure categories is used as a proxy for household income. Expenditure shares are calculated as the proportion of each expenditure group in total expenditure for the aggregate group considered.

4.5. Methodological Framework

4.5.1. Commodity Aggregation and Weak Separability

The analysis assumes that consumers' preferences are weakly separable in order to simplify the modeling of consumption decisions. Without the assumption of weak separability, 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 Muelbauer, 1980). Under this assumption, the consumer's simultaneous decision-making process can be broken down into a three-stage budgeting process. In Stage I, households allocate total budget between food and non-food items. Conditional on the first stage allocations, in Stage II, households allocate food expenditure between cereals and non-cereals items. In Stage III, conditional on the second stage allocations, households allocate cereal expenditures to rice, maize, millet and sorghum. It is thus assumed that food is weakly separable from non-food commodities and that cereals are weakly separable from other food groups. The focus of this chapter is Stage III, the reason being that not only is it more interesting and useful, but also the lack of price/cost information for most non-food items and non-cereals food items makes the estimation of Stages I and II less feasible.

4.5.2. Modeling Approach

The allocation of total cereals expenditures to specific cereals types (Stage III) is modeled using the quadratic almost ideal demand system (QUAIDS) proposed by Banks et al. (1997). Unlike its predecessor, the AIDS of Deaton and Muelbauer (1980), which has budget shares that are linear functions of log total expenditure and are derived from indirect utility functions that are themselves linear in log total expenditure (Muelbauer, 1976), the QUAIDS model allows for non-linearity in the budget shares. As a complete demand system, the QUAIDS allows us to consistently account for the interdependence in the choices made by households between different cereal types. By nesting the AIDS model, the QUAIDS model maintains all the relevant properties of the former (allows for exact aggregation over households and satisfies all the axioms of choice). In addition to these advantages, the QUAIDS specification allows for more flexibility—expenditure elasticities differ with expenditure levels. This could be a significant advantage in welfare analysis. It also allows the possibility of normal goods becoming inferior or vice versa as one move along the expenditure spectrum of households (Bopape, 2006).

4.5.2.1. Model Specification Test

The choice between estimating an AIDS or a QUAIDS model rests on the shape of the Engel curves. Bopape (2006) developed a parametric quadratic expenditure specification test for whether the QUAIDS or the AIDS is appropriate for the demand analysis. The test is based on the fact that the QUAIDS model is rank 3, exactly aggregable and has a coefficient on the linear expenditure term that is independent of the prices. It involves testing for the statistical significance of prices in the coefficient on the quadratic expenditure term in the QUAIDS model. The null hypothesis of the test is that the coefficient on the quadratic expenditure term is independent of prices across all the budget share equations. This test is a Lagrangian multiplier (LM) test, and it has the advantage of allowing one to test parametrically if the quadratic expenditure is necessary without having to estimate the highly non-linear QUAIDS model. This test is carried out to decide between the QUAIDS and AIDS models.

4.5.2.2. Problems in Demand System Estimation

Zero-expenditure and expenditure endogeneity have been identified as common econometric issues that arise when cross-sectional data is used to estimate elasticities. These issues need to be addressed in order to obtain unbiased and efficient price elasticities (Chuang et al. 2005).

4.5.2.2.1. Zero-Expenditure

Zero-expenditure arises when a large number of households report zero expenditure for some commodities/aggregates for which demand is being estimated. This causes a censored dependent variable problem that leads to biased results if not dealt with. This problem presents an empirical difficulty because the random disturbances have non-zero means and are correlated with the exogenous variables (Alfonzo et al. 2006). Tables A4-2 and A4-3 in Appendix show zero expenditure in the entire sample and by cereal type and by mode of acquisition, respectively. There is a large proportion of zero expenditure, ranging from 5.1% for rice to 49.8% for maize. Dropping these households would dramatically reduce the sample size (loss in large number of degree of freedom) and still give inconsistent estimates. Given that censoring is severe in the sample, we need a censored system approach.

To address this problem, various estimation methods based on a two-step decision process initially proposed by Tobin (1958) have been utilized. Heien and Wessells (1990) introduced a two-step estimation procedure based on Heckman's (1978) work. However, Shonkwiler and Yen (S and Y) (1999) demonstrated the inconsistency of Heien and Wessels' two-step estimation procedure and they proposed an alternative approach for equation systems with limited dependent variables. This chapter uses the S and Y approach. Bopape (2006) and Alviola et al. (2010), Ecker and Quaim (2008), and Tafere et al. (2010) also use this approach for QUAIDS estimation.

4.2.5.2.2. Expenditure Endogeneity (EE)

The problem of EE[33] arises when total expenditures are determined jointly with the expenditure shares of the individual commodities that enter the demand model, making it endogenous in the expenditure share equations (Blundell and Robin, 1999). This problem may also arise whenever the household expenditure allocation process is correlated with other unobserved behavior not captured by the explanatory variables in the budget share equations, because these unobserved effects would be bundled in the error term. Estimation that ignores EE may lead to inconsistent demand parameter estimates (Bopape, 2006). This is because a key assumption of regression analysis is violated—that the mean of the disturbance term is zero and that the disturbance term is independent of the regressors so that the covariance between the disturbance term and the independent variables is zero. Bopape (2006) notes that because the problem of EE may affect the results of the LM test for model specification, it is important to address the problem before performing the test. Thus, for more reliable results, the LM test should be applied to estimated budget share equations that have been corrected for potential EE if EE is identified as a problem with the data.

The augmented regression technique of Hausman (1978) and Blundell and Robin (1999) has been widely used to deal with the problem of EE. This technique is suitable in a system of non-linear equations. Barslund (2011) applies this technique to a system of censored demand

[33] Most empirical demand analyses do not cover all products that households purchase. As a result, the practice is to assume separable preferences and estimate a set of conditional demands for the goods of interest as functions of prices and total expenditure on these goods (Pollak and Wales, 1969). However, such a practice raises questions regarding the possibility of simultaneity bias in the budget share equations of the demand model.

equations based on the AIDS. Bopape (2006) and Tafera et al. (2010) also use the same technique to deal with the issue of EE in the context of a QUAIDS model.

The augmented QUAIDS share equations are specified as follows:

$$w_{ih} = \alpha_i + \delta_{ih} lnAE_h + \theta_i M_h + \sum_{n=1}^{8} \rho_{in} RD_h + \sum_{j=1}^{k} \gamma_{ij} lnp_{jh} + \beta_i ln\left[\frac{CX_h}{a(p_h)}\right] +$$

$$\frac{\lambda_i}{b(p_h)}\left\{ln\left[\frac{CX_h}{a(p_h)}\right]\right\}^2 + u_{ih} \qquad (4-1).$$

w_{ih} is the household budget share for cereal type i. The budget shares are calculated using food expenditures. p_{ih} is the retail price of each cereal type i. CX_h is household cereal expenditure. Dummy variables will capture the effect of a household's geographic location on expenditures. RD_h, are regional dummies. M_h represents a dummy for place of residence (urban=1 and rural=0) of a household. The translog price aggregator, a(p_h), and the price aggregator function, b(p_h), are functions homogeneous of degree 1 and 0, respectively, in prices. ln a(p_h) and lnb(p_h) are specified as translog and Cobb-Douglas equations[34].

The theoretical restrictions of homogeneity, adding up and symmetry are the same as discussed in chapter 3, in addition to:

$$\sum_{i=1}^{K} \lambda_i = 0 \quad \forall i$$

[34] $\ln a(p_h) = \alpha_0 + \sum_{i=1}^{k} \alpha_i lnp_{ih} + \frac{1}{2}\sum_{i=1}^{k}\sum_{j=1}^{k} \gamma_{ij}\, lnp_{ih} lnp_{jh}\ and\ \ b(p_h) = \prod_{i=1}^{k} p_{ih}^{\beta_i}$.
For commodities i=1,…k.

To deal with the problem of EE, assume that the error terms have an orthogonal decomposition

$$u_{si} = \rho_s \tau_{si} + \varepsilon_{si} \qquad (4-2)$$

τ_{si} are the residuals from the regression of total cereal expenditure on the set of instruments and explanatory variables. ε_{si} is normally distributed. The parameter ρ_s provides a test of exogeneity of total cereal expenditure for each consumption share and should be equal to zero if the cereal expenditure is exogenous.

To deal with the problem of censoring, following the S and Y approach, consider the dichotomous variable

$$d_{ih} = 1 \ \ if \ \sigma_i z_{ih} + v_{ih} > 0 \ ; \ and \ \ d_{ih} = 0 \ otherwise \qquad (4-3)$$

Where σ_i is a vector of coefficients, z_{ih} a vector of explanatory variables and v_{ih} is the equation-specific error term, which is distributed normally (0,1).

The observed expenditure shares for the hth household are given by:

$$w_{ih}^{obs} = (w_{ih} + \ \rho_s \tau_{si}) \cdot d_{ih} \qquad (4-4)$$

Consistent parameters in equation 4-1 can be obtained by estimating

$$w_{ih}^{obs} = \Phi(\hat{\sigma}_i z_{ih})(w_{ih} + \ \rho_s \tau_{si}) + \pi_i \phi(\hat{\sigma}_i z_{ih}) + \ \xi_{ih} \qquad (4-5)$$

Where $\hat{\sigma}_i z_{ih}$ are predicted indices from the first-step probit estimation of the equation in (4-3) and Φ and ϕ are respectively the standard normal cumulative distribution (cdf) and probability density (pdf) functions. Unlike in the conventional system specification without censoring, the deterministic components on the right hand side of equation (4-5) do not add up to unity across all equations of the system, and so the error terms in the estimation form do not add up to zero (Yen et al., 2002). As a result, the usual procedure of imposing the adding-up restriction on the system and dropping one equation is not valid. Therefore, with censoring, equation (4-5) is estimated correctly when using the entire set of n equations (Yen et al., 2002).

The expressions for the elasticities following Banks et al. (1997) are simplified as follows:

$$\mu_i \equiv \frac{\partial w_{ih}^{obs}}{\partial lnCX_h} = \Phi(\hat{\sigma}_i z_{ih})\left[\beta_i + \frac{2\lambda_i}{b(p_h)}\left\{ln\left[\frac{CX_h}{a(p_h)}\right]\right\}\right] \qquad (4-6)$$

$$\mu_{ii} \equiv \frac{\partial w_{ih}^{obs}}{\partial lnp_i} = \Phi(\hat{\sigma}_i z_{ih})\left[\gamma_{ij} - \mu_i\left(\alpha_i + \sum_{l=1}^{K}\gamma_{jl}\, lnp_{lh}\right) - \frac{\lambda_i\beta_j}{b(p_h)}\left\{ln\left[\frac{CX_h}{a(p_h)}\right]\right\}^2\right] \qquad (4-7)$$

Expressing the formula for expenditure elasticities in terms of μ_i:

$$e_i = \frac{\mu_i}{w_i} + 1 \qquad (4-8)$$

Similarly, the Marshallian or uncompensated elasticities of demand can be expressed as follows:

$$e_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij} \qquad (4-9)$$

Where δ_{ij} is the Kronecker delta equating 1 if i=j and 0 otherwise. The Hicksian or compensated elasticities can be derived as thus using Slutsky equation

$$\mathrm{e_{ij}^c} = \mathrm{e_{ij}^u} + \mathrm{w_i e_i} \qquad (4-10)$$

4.6. Estimation Method

The complete estimation procedure for Stage III follows this pattern: in step one, a test for endogeneity of the total cereal expenditure is carried out using instrumental variables; in step two, a model specification test is carried out to determine the appropriateness of the AIDS versus QUAIDS model; in step 3 the system (4-3) is estimated by multivariate probit and the pdfs and cdfs are computed; in step 4 the system in 4-5 is estimated using Non-linear, Seemingly Unrelated Regression (NLSUR) in STATA. To capture differences in expenditure patterns across income groups, households will be divided into income groups and the consumption behavior for each of the groups will be analyzed separately. Households will be ranked from lowest to highest based on per capita income levels and divided into three income groups (low, middle, and high), of equal sizes by place of residence. This is a common approach in system demand estimations.

4.7. Findings

The presentation of findings begins with a descriptive summary of the data. Then further descriptive statistics of the data are presented for Stage III, and the estimated coefficients are presented and discussed. In addition, income and price elasticities of cereals demand are examined for Stage III.

4.7.1. General Descriptive Summary of the Data

The final ELIM-2006 dataset used in this chapter comprised 4454 households; 1566 of the households reside in urban areas while 2888 of the households reside in rural areas. Table 4-1 presents the distribution of the sample by place of residence and by geographic region. Table 4-2 examines the relationship between household size and place of residence. This table reveals that urban households are on average smaller (8.2 individuals) than rural households (9.6). The average household AE is 6.2 in the urban areas and 7.0 in the rural areas. Table 4-2 also shows that about 54% of rural households and about 44% of urban households have more than 8 members. Table 4-3 shows that over 50% of the entire sample has household heads with no formal education. Table 4-4 also shows that only about 7% of the households in the sample have female heads, and the average age for household heads in the sample is about 49 years. Table 4-5 shows the distribution of household head (HHH) by socio-economic group and by region. The figures illustrate that close to 50% (Kayes and Segou) and over 50 % (Koulikoro, Sikasso, Mopti, Tombouctou, and Kidal) of the household heads are independent farmers. The District of Bamako, as expected, has the smallest number of cases where household heads are independent farmers.

Table 4-1. Distribution of Data by Region and Place of Residence

Region	Urban		Rural		All
	Freq.	Percent	Freq.	Percent	Freq.
Kayes	164	10.47	422	14.61	586
Koulikoro	208	13.28	754	26.11	962
Sikasso	185	11.81	438	15.17	623
Ségou	263	16.79	630	21.81	893
Mopti	150	9.58	300	10.39	450
Tombouctou	94	6.00	258	8.93	352
Gao	78	4.98	60	2.08	138
Bamako	399	25.48	0	0.00	399
Kidal	25	1.60	26	0.90	51
Total	1,566	100	2,888	100	4,454

Source: Author's computation using ELIM-2006 data.

Table 4-2. Relationship between Household (HH) Size Group and Place of Residence

Household Size Group	Urban		Rural	
	Freq.	Percent	Freq.	Percent
1 to 3	211	13	219	8
4 to 7	655	42	1,103	38
8 to 10	372	24	698	24
10 plus	328	21	868	30.
Total	1,566	100	2,888	100
Average HH size	8.2		9.6	
Average HH AE	6.2		7.0	

Source: Author's computation using ELIM-2006 data.

Table 4-3. Level of Education of Household Head (HHH)

Level of Education	Urban	Rural
None	653	2,534
Fundamental 1 Partial	124	150
Fundamental 1 Complete	61	52
Fundamental 2 Partial	145	52
Fundamental 2 Complete	87	25
Post Fundamental	496	75
Total	1,566	2,888

Source: Author's computation using ELIM-2006 data.

Table 4-4. Distribution of Households by Sex and Age of Household Head

	By Sex of HH-Head				By Age of Household Head	
	Urban	Rural	Total		National	49.4
Male	1390	2757	4147		Urban	47.7
Female	176	131	307		Rural	50.4
Total	1566	2888	4454			

Source: Author's computation using ELIM-2006 data.

Table 4-5. Socioeconomic Group of Household Head by Region

HH-Head Socioeconomic Group	Kayes		Koulikoro		Sikasso		Segou	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Public Employee	37	6	61	6	47	8	75	8
Private Employee	34	6	52	5	24	4	49	5
Employer	2	0	19	2	16	3	17	2
Independent Agric	290	49	588	61	364	58	429	48
Independent non Agric	99	17	107	11	49	8	115	13
Other Employment	10	2	2	0	31	5	10	1
Unemployed	114	19	133	14	92	15	198	22
Total	586	100	962	100	623	100	893	100
	Mopti		Tombouctou		Gao		Bamako	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Public Employee	58	13	17	5	32	23	87	22
Private Employee	20	4	14	4	27	20	62	16
Employer	4	1	-	-	-	-	12	3
Independent Agric	247	55	244	69	45	33	22	6
Independent non Agric	58	13	47	13	19	14	138	35
Other Employment	-	-	-	-	-	-	1	0
Unemployed	63	14	30	9	15	11	77	19
Total	450	100	352	100	138	100	399	100

Table 4-5. Con’td Socioeconomic Group of Household Head by Region

HH-Head Socioeconomic Group	Kidal	
	Freq.	%
Public Employee	58	13
Private Employee	20	4
Employer	4	1
Independent Agric	247	55
Independent non Agric	58	13
Other Employment	-	-
Unemployed	63	14
Total	450	100

Source: Author’s computation using ELIM-2006 data.

Table 4-6 shows the annual average total household expenditure including the opportunity value for all own-produced items by place of residence. The average annual exchange[35] rate for 2006 was used to convert the CFA franc amounts to their United States (US) dollar equivalent. The figures illustrate that total annual expenditures per household and per capita are generally higher in the urban areas than in the rural areas. Furthermore, in the urban areas, consumption expenditures are higher in Bamako than in the other urban areas. Households were ranked from lowest to highest based on their per capita consumption expenditures and by place of residence. The households in each place of residence (urban and rural) were then divided into three income groups, with households in each income group comprising about one-third of the total sample. The urban (rural) low-income group's annual expenditures per capita are less than 220,053 (102,138) CFAF. The urban (rural) middle income group's annual expenditures per capita are between 222,193 (102,312) and 437,701 (161,506) CFAF. The urban (rural) high-income group's annual expenditures per capita exceeded 437,942 (161,691) CFAF. Table 4-7 and 4-8 also show average total consumption expenditures by income group and place of residence, per household and per adult equivalent (AE) respectively. The division by income group is done separately for the rural and urban subsamples.

[35] The average annual exchange rates were obtained from www.Oanda.com.

Table 4-6. Annual Average Total Consumption Expenditures (CFAF) by Place of Residence

		Per Household			
	Obs	Mean	SE (Mean)	Min	Max
Bamako	399	4,534,634 (8,389)	190,029 (352)	154,800 (286)	28,300,000 (52,355)
Other Urban	1,167	2,528,883 (4,678)	65,047 (120)	38,415 (71)	16,500,000 (30,525)
Rural	2,888	1,328,788 (2,458)	22,087 (41)	44,300 (82)	17,100,000 (31,635)
		Per Capita			
Bamako	399	625,351 (1,157)	27,620 (51)	65,173 (121)	3,858,600 (7,138)
Other Urban	1,167	372,098 (689)	10,159 (19)	9,604 (18)	3,316,470 (6,135)
Rural	2,888	156,675 (290)	2,463 (5)	13,363 (25)	2,036,649 (3,768)
		Per Adult Equivalent			
Bamako	399	807,749 (1,494)	693,461 (1,283)	85,009 (157)	4,753,838 (8,795)
Other Urban	1,167	488,934 (905)	441,462 (817)	16,702 (31)	4,332,896 (8,016)
Rural	2,888	212,894 (394)	176,604 (327)	20,559 (38)	2,870,332 (5,310)

Source: Author’s computation using ELIM-2006.
Note: The figures in parenthesis are the US dollar equivalent.

Table 4-7. Annual Average Total Consumption Expenditures (CFAF) Per Household by Income Group and Place of Residence

	Urban				
Income Group	Obs	Mean	SE. (Mean).	Min	Max
Low	522	1,375,659 (2,545)	41,759 (77)	38,415 (71)	8,350,000 (15,448)
Middle	522	2,624,424 (4,855)	72,556 (134)	228,500 (423)	12,400,000 (22,940)
High	522	5,119,698 (9,471)	160,300 (297)	448,600 (830)	28,300,000 (52,355)
	Rural				
Low	963	803,385 (1,486)	16,050 (30)	44,300 (82)	4,800,000 (8,880)
Middle	963	1,235,347 (2,285)	23,403 (43)	160,733 (297)	5,930,000 (10,971)
High	962	1,948,274 (3,604)	53,820 (100)	172,930 (320)	17,100,000 (31,635)

Source: Author's computation using ELIM-2006.
Note: The figures in parenthesis are the US dollar equivalent.

Table 4-8. Annual Average Total Consumption Expenditures (CFAF) Per Adult Equivalent by Income Group and Place of Residence

	Urban				
Income Group	Obs	Mean	SE. (Mean).	Min	Max
Low	522	197,931 (366)	66,336 (123)	16,702 (31)	350,447 (648)
Middle	522	423,478 (783)	91,306 (169)	228,500 (423)	727,611 (1,346)
High	522	1,089,084 (2,015)	647,004 (1,197)	464,975 (860)	4,753,838 (8,795)
	Rural				
Low	963	99,421 (184)	28,915 (53)	20,559 (38)	169,585 (314)
Middle	963	177,400 (328)	28,529 (53)	109,706 (203)	265,319 (491)
High	962	362,015 (670)	235,838 (436)	174,485 (323)	2,870,332 (5,310)

Source: Author's computation using ELIM-2006.
Note: The figures in parenthesis are the US dollar equivalent.

The households' total food expenditure includes expenditures on food purchased and the value of consumption from own production. Table 4-9 shows average annual food and non-food expenditures by place of residence in CFAF. The figures reveal that food and non-food expenditures are higher for Bamako than for other urban areas and rural areas in both per household and per adult equivalent terms. Average annual food expenditure per AE for Bamako is 212,571 CFAF, compared to 166,842 CFAF for other urban areas and 113,442 CFAF for rural areas. Table 4-10 also shows the distribution of food and non-food expenditures by income group and by place of residence. We observe an increase in food and non-food expenditure per household and per household adult equivalent from the low to the high income group within the urban and rural locations. Also, urban per AE food expenditures are higher than rural per AE food expenditures across all income groups.

Table 4-9. Average Annual Food and Non-Food Expenditure (CFAF) by Place of Residence

	Bamako (N=399)	Other Urban (N=1167)	Rural (N=2888)
	Per Household		
Food	1,243,871 (2,301)	907,997 (1,680)	705,161 (1,305)
Non-food	3,290,763 (6,088)	1,620,887 (2,999)	623,627 (1,154)
	Per Adult Equivalent		
Food	212,571 (393)	166,842 (309)	113,442 (210)
Non-food	595,178 (1,101)	322,092 (596)	99,452 (184)

Source: Author's computation using ELIM-2006.
The figures in parenthesis are the US dollar equivalent.

Table 4-10. Average Annual Food and Non-Food Expenditure (CFAF) by Place of Residence and Income Group

	Urban			Rural		
	Obs	Food	Non food	Obs	Food	Non food
		Per Household				
Low	522	723,552 (1,339)	652,107 (1,206)	963	480,024 (888)	323,361 (598)
Middle	522	1,039,077 (1,922)	1,585,347 (2,933)	963	729,176 (1,349)	506,172 (936)
High	522	1,218,093 (2,253)	3,901,605 (7,218)	962	906,493 (1,677)	1,041,782 (1,927)
		Per Adult Equivalent				
Low	522	106,852 (198)	91,079 (168)	963	60,452 (112)	38,969 (72)
Middle	522	173,598 (321)	249,881 (462)	963	108,214 (200)	69,186 (128)
High	522	255,030 (472)	834,054 (1,543)	962	171,721 (318)	190,295 (352)

Source: Author's computation using ELIM-2006.
Note: The figures in parenthesis are the US dollar equivalent.

The analysis of weighted[36] food expenditure shares reveals that the share of food in total household consumption budget is smallest for the region of Bamako (0.30). Table 4-11 shows weighted food shares by region. Table 4-12 also shows food shares by place of residence and per capita expenditure income group. The table shows that for the entire sample, the share of food in total household consumption expenditure is 0.43. The national average conceals a discrepancy between the urban and rural food shares. Considering all urban areas, the food share is just 0.35, as opposed to a share of 0.53 in the rural areas. A breakdown of food share by income groups shows that irrespective of place of residence, there is a decline in food share as we move from

[36] Using the weight of the household in the total sample.

the low-income group to the high-income group (Engel's law). However, the difference in the food share between the low- and middle-income group is in both the rural and urban areas is not as large as the difference in food share between the middle- and the high-income group.

Table 4-11. Weighted Food Expenditure Shares by Region

Region	Share
Kayes	0.50
Koulikoro	0.48
Sikasso	0.40
Ségou	0.48
Mopti	0.49
Tombouctou	0.56
Gao	0.54
Bamako	0.30
Kidal	0.44

Source: Author's computation using ELIM-2006

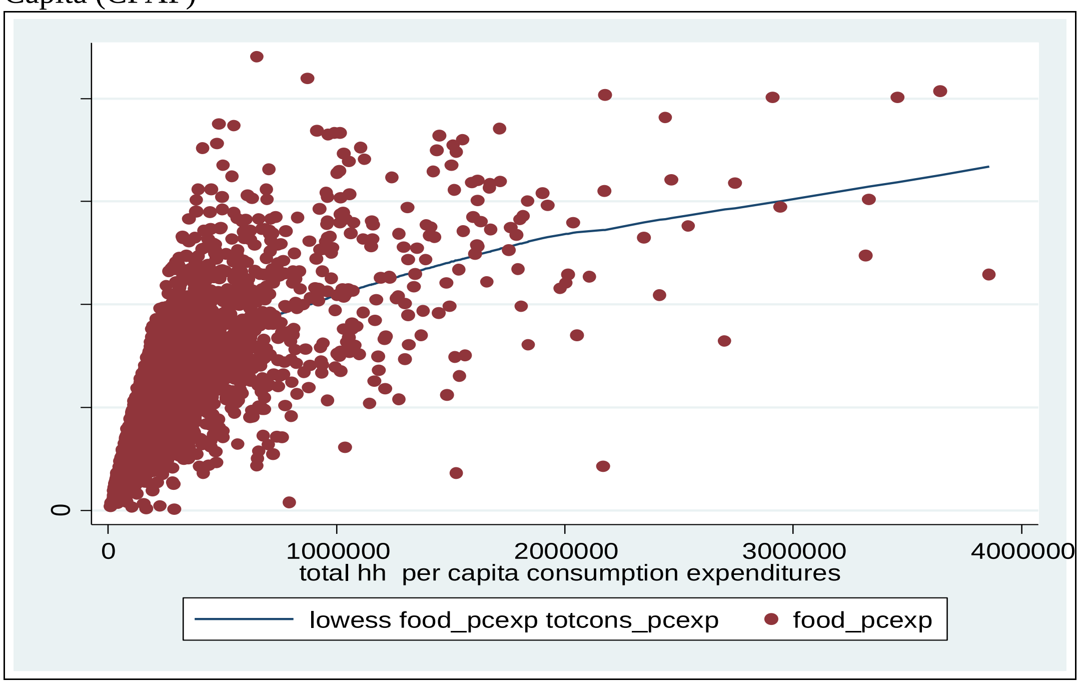
Table 4-12. Weighted Food Shares by Income Group and Place of Residence

Income Group	National	Urban	Rural
Low	0.59	0.53	0.60
Middle	0.55	0.41	0.59
High	0.34	0.26	0.47
All	0.43	0.35	0.53

Source: Author's computation using ELIM-2006.

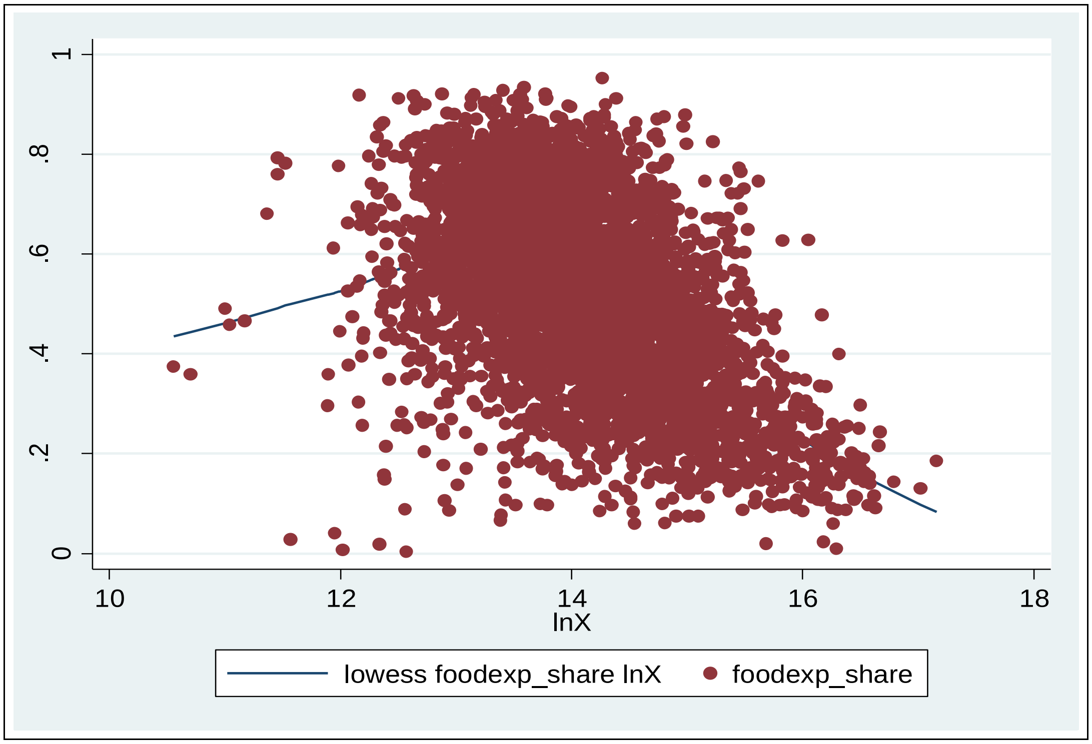
A locally weighted regression (nonparametric method based on fitting a linear model to observations in a neighborhood of a point) was carried out using the "lowess" command in STATA to examine graphically (Figure 4-1) the relationship between food expenditures per capita and total household consumption expenditure per capita. The graph illustrates that 1) food expenditure per capita increases with total consumption expenditures per capita; 2) the estimated slope of the relationship (the conditional mean) becomes flatter as total household consumption expenditure per capita increases; 3) the dispersion increases with income levels. Furthermore, a graphical examination of the relationship between food shares and total household consumption expenditure (Figure 4-2) shows: 1) an inverse relationship between food share and the log of total household consumption expenditure (Engel's law is satisfied): households with a lower total expenditure level tend, on average, to spend a higher fraction of their income on food; and 2) the dispersion is higher at low levels of total household consumption expenditure.

Figure 4-1. Food Expenditures per Capita and Total Household Consumption Expenditures per Capita (CFAF)



Source: Author.

Figure 4-2. Food Expenditure Shares and Total Household Consumption Expenditures



Source: Author.

Table 4-13 also reveals that mean expenditures on cereals per household and per AE are higher for the urban area than the rural area summing across all income groups. While in the rural area average expenditure on cereals increases from the low- to the high-income group, in the urban area average expenditure on cereals increases from the low- to the middle-income group, but declines from the middle- to the high-income group.

A breakdown of food expenditure per adult equivalent by place of residence and income group (Table 4-13) also shows that cereals expenditures per AE (CFAF/AE) increases with income level irrespective of the place of residence. However, while the average expenditures per AE on cereals are higher for the urban low (middle) income than the rural low (middle) income groups, average cereals expenditure per AE are higher for the rural high income than the urban high income. That the average expenditure on cereals per AE is higher for the rural high-income group than the urban high-income group does not imply that the rural high-income households spend more in the market on cereals than do their urban counterparts because this descriptive summary of cereals consumption includes the value of cereals from all sources (own production and purchases). Because many rural households produce some cereals for their own consumption, netting out the value of consumption from own-production could show that urban high-income households on average spend more on cereals than rural high-income households. Also, this pattern in cereals expenditure per AE by income group and place of residence also points to the fact that the value of consumption from own-production makes a difference only for the high-income group. Furthermore, given that the entire sample was first divided by place of residence, and per capita income groups were computed separately by place of residence, the high-income group in the rural area has a lower income than the high-income group in the urban area.

Table 4-14 reports the weighted share of cereals in household food expenditure by region. The figures illustrate that with the exception of Bamako, which has an average cereal share below 30%, in all other regions, cereals occupy greater than 30% of the household's food budget. Table 4-15 reports a breakdown of the cereals share by income group and place of residence. The figures illustrate that for all households combined, cereals represent about 40% of the food budget. In urban areas, however, the share is 33% while in rural areas the share is about 46%. The share of cereals in the food budget decreases from the low- to the high-income group within each place of residence. However, in both locations, the difference between the low- and middle-income groups in cereals share is quite small compared to the difference between the middle-and the high-income groups. It is acknowledged here that cereals and non-cereals are highly aggregated groups. Cereals expenditures are further disaggregated in the next sub-section of this chapter. For a breakdown of expenditure and expenditure shares in the non-cereals food group, interested readers are urged to refer to Taondyandé and Yade 2012; and Kelly et al. 2012.

Table 4-13. Average Annual Cereals and Non-Cereals Expenditure (CFAF) by Place of Residence and Income Group

	Urban		Rural	
	Per Household (CFAF)			
Income Group	Cereals	Non-Cereals	Cereals	Non-Cereals
Low	286,519 (530)	437,032 (809)	221,952 (411)	258,073 (477)
Middle	368,221 (681)	670,856 (1,241)	341,857 (632)	387,319 (717)
High	306,188 (566)	911,905 (1,687)	377,647 (699)	528,845 (978)
All Groups	320,309 (593)	673,264 (1,246)	313,797 (581)	391,365 (724)
	Per Adult Equivalent (CFAF/AE)			
	Urban		Rural	
Income Group	Cereals	Non-Cereals	Cereals	Non-Cereals
Low	42,209 (78)	64,643 (120)	27,997 (52)	32,455 (60)
Middle	59,842 (101)	113,756 (210)	49,809 (92)	58,405 (108)
High	63,021 (117)	192,009 (355)	70,574 (131)	101,147 (187)
All Groups	55,024 (102)	123,469 (228)	49,453 (91)	63,989 (118)

Source: Author’s computation using ELIM-2006.
The figures in parenthesis are the US dollar equivalent.

Table 4-14. Cereals Expenditure Shares by Region

Region	Share
Kayes	35
Koulikoro	42
Sikasso	42
Ségou	41
Mopti	47
Tombouctou	48
Gao	52
Bamako	28
Kidal	33

Source: Author's computation using ELIM-2006

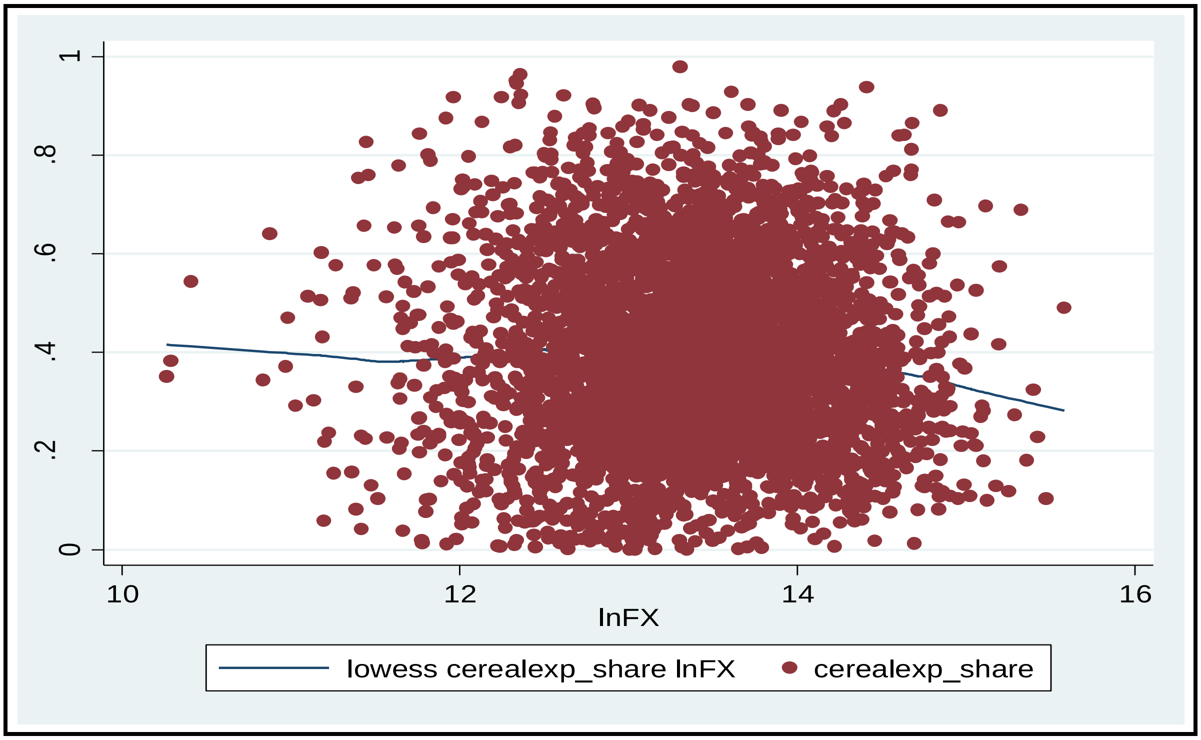
Table 4-15. Cereal Shares by Income Group and Place of Residence

Income Group	National	Urban	Rural
Low	0.46	0.40	0.47
Middle	0.45	0.35	0.48
High	0.33	0.25	0.43
All	0.40	0.33	0.46

Source: Author's computation using ELIM-2006

As seen from Figure 4-3, the share of cereals in the food budget seems to decrease as the household food budget increases. This relationship is not surprising. Cereals are major staples in Mali, and at lower income levels, households are more concerned about quantity (having a full stomach) rather than quality. It is likely that as the total food income continues to grow, households begin to think about diversifying their diets–maybe by eating higher quality and expensive foods such as meats and vegetables. The end result is that the share of cereals drops while the shares of other food groups increase.

Figure 4-3. Total Household Food Expenditure and the Share of Cereals in Food Budget



Source: Author's computation using ELIM-2006.
Note: Households with zero expenditure on all cereals were excluded.

As mentioned above, households get their food from three main sources: own-production, purchases from the market and "others" (gifts and ceremonies). The ELIM-2006 household budget survey reports consumption expenditures by mode of acquisition. However, it is not clear from the survey data whether consumption from own-production was valued at market prices or not. Furthermore, for purchased food expenditures, the data do not make a distinction between cereals consumption away from home and purchased food prepared at home. Summary statistics for individual cereals consumption will include the value of consumption from all the different sources of cereals supply.

Table 4-16 below reports average annual expenditures per adult equivalent by cereal type and place of residence. National annual average expenditures are 25,125 CFAF/AE (46 US$/AE) for rice; 14,769 CFAF/AE (27 US$/AE) for millet; 7,012 CFAF/AE (13 US$/AE) for sorghum and 4,505 CFAF/AE (8 US$/AE) for maize. A breakdown of cereals expenditures by place of residence shows that annual average rice expenditure in the urban areas is about double that of rural areas (Table 4-16) and average expenditure on rice in Bamako is larger than in other urban areas (Table 4-17). For millet, maize and sorghum, average expenditures per AE in the rural areas are much higher than those in urban areas. Up to 86% of the sample neither produces nor has any rice supplies from their own production.

Table 4-16. Average Annual Expenditures (Including Value of Own-produced Grain) per Adult Equivalent by Cereal Type and Place of Residence

Commodity	**National (N=4454)**	**Urban (N=1566)**	**Rural (N=2888)**
Rice	25,125 (46)	35,697 (66)	19,392 (36)
Millet	14,769 (27)	11,606 (21)	16,485 (30)
Sorghum	7,012 (13)	4,435 (8)	8,410 (16)
Maize	4,505 (8)	3,286 (6)	5,166 (10)

Source: Author’s computation using ELIM-2006
Note: The figures in parenthesis are the US dollar equivalent.

Table 4-17. Average Annual Expenditures (CFAF/AE) by Cereal Type and Place of Residence

	Bamako (N=399)	Other urban (N=1167)	Rural (N=2888)
Rice	38,875 (72)	34,610 (64)	19,392 (36)
Millet	11,455 (21)	11,658 (22)	16,485 (30)
Sorghum	4,800 (9)	4,310 (8)	8,410 (16)
Maize	3,172 (6)	3,324 (6)	5,166 (10)

Source: Author's computation using ELIM-2006
Note: The figures in parenthesis are the US dollar equivalent.

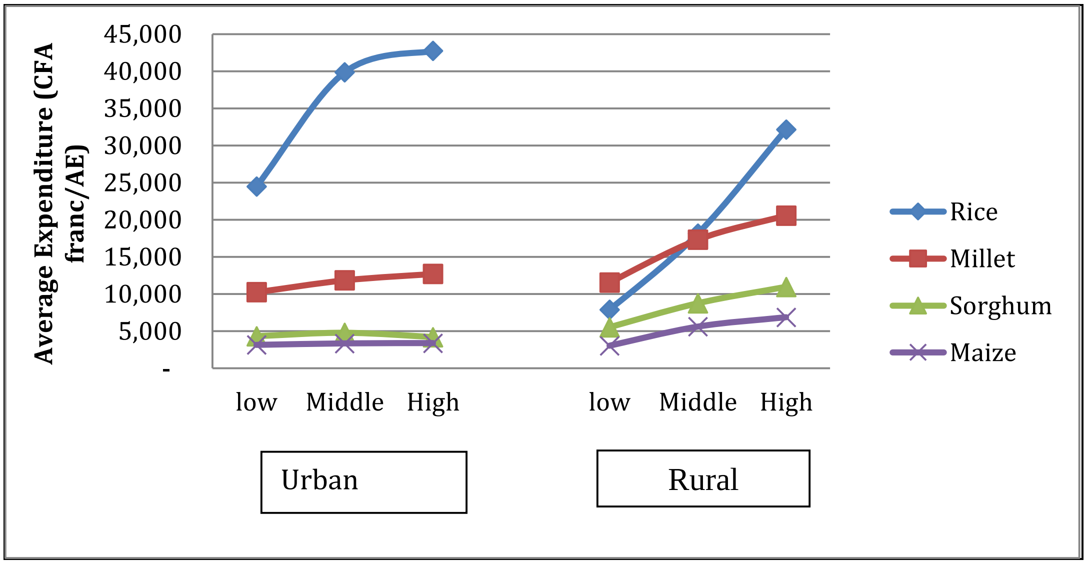
Table 4-18 shows cereals expenditures per AE by income group and place of residence. The figures reveal an increase in rice expenditure per AE as per capita income increases irrespective of the place of residence. In both the rural and urban areas, millet expenditure per AE also increases from the low to the high income group. While rice expenditures per AE are higher in the urban areas than in the rural areas across all income groups, millet, maize and sorghum expenditures per AE on average are higher in the rural areas than in the urban areas. See also Figure 4-4 for the relationship between cereals expenditures per AE, income group and place of residence. The graph reveals that sorghum appears to be an inferior good for urban households.

Table 4-18. Average Annual Expenditures (CFAF/AE) by Cereal Type, by Income Group and Place of Residence

	Rice	Millet	Sorghum	Maize
National				
Low	10,346 (19)	12,143 (22)	5,762 (11)	3,391 (6)
Middle	24,216 (45)	17,084 (32)	8,905 (16)	5,657 (10)
High	40,824 (76)	15,081 (28)	6,370 (12)	4,466 (8)
Urban				
Low	24,491 (45)	10,255 (19)	4,325 (8)	3,137 (6)
Middle	39,866 (74)	11,858 (22)	4,778 (9)	3,339 (6)
High	42,734 (79)	12,705 (24)	4,202 (8)	3,380 (6)
Rural				
Low	7,890 (15)	11,557 (21)	5,523 (10)	3,027 (6)
Middle	18,134 (34)	17,321 (32)	8,751 (16)	5,603 (10)
High	32,166 (60)	20,580 (38)	10,958 (20)	6,870 (13)

Source: Author’s computation using ELIM-2006.
Note: The figures in parenthesis are the US dollar equivalent.

Figure 4-4. Cereals Expenditures (CFA franc/AE) by Income Group and Place of Residence



Source: Author's computation using ELIM-2006.

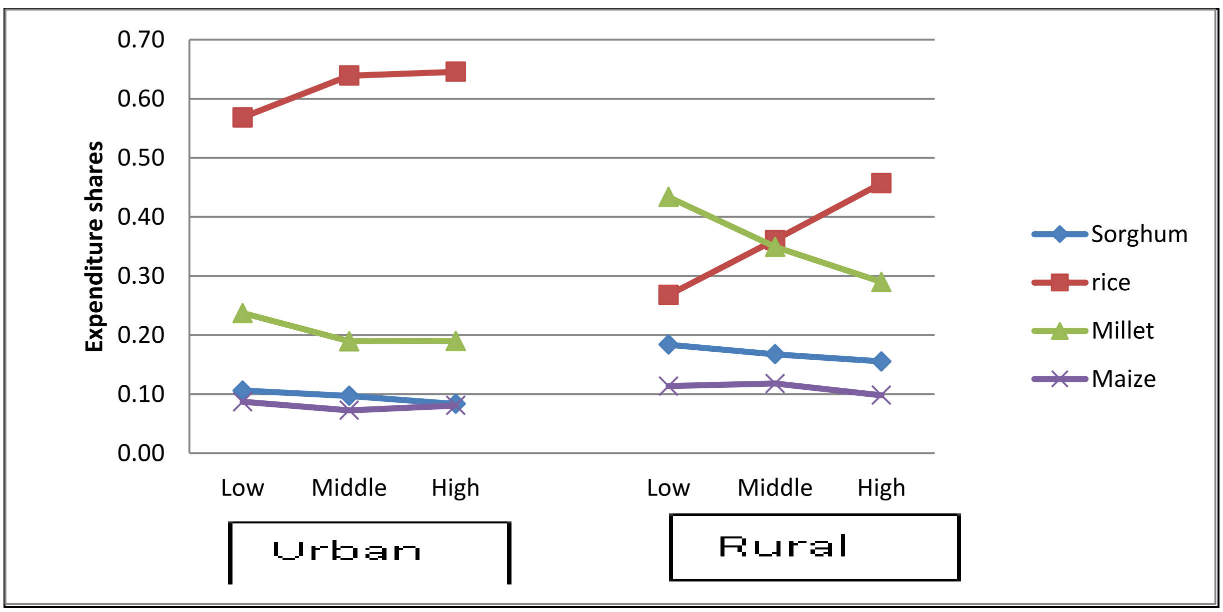
Table 4-19 presents the budget share allocated to individual cereals types by place of residence and by income group. Rice is about 46% of the cereals budget considering the entire sample. Differences in individual cereals shares are quite pronounced between the urban and the rural areas. The mean share of rice in the cereals budget is 61% for the urban areas and 38% for the rural areas. Millet is second place to rice in terms of share in the cereals budget. However, the share of millet in rural areas is higher than that in urban areas. Nationwide and by place of residence, maize occupies the smallest position in the cereals budget. An examination of shares by cereal types, by income group and place of residence (Table 4-19 and Figure 4-5) reveals a consistent expenditure class-related pattern for rice, millet and sorghum consumption in both the rural and the urban areas, whereby the share of rice increases with income level while millet and sorghum shares decrease with increases in per capita income level.

Table 4-19. Shares in Cereal Budget by Cereal Type, Place of Residence and Income Group

	Sorghum	Rice	Millet	Maize
National				
All	0.14	0.46	0.29	0.10
Urban				
Low	0.11	0.57	0.24	0.09
Middle	0.10	0.64	0.19	0.07
High	0.08	0.65	0.19	0.08
All	0.09	0.61	0.20	0.08
Rural				
Low	0.18	0.27	0.43	0.11
Middle	0.17	0.36	0.35	0.12
High	0.16	0.46	0.29	0.10
All	0.17	0.38	0.34	0.11

Source: Author's computation using ELIM-2006

Figure 4-5. Shares in Cereal Budget by Cereal Type Place of Residence and Income Group



Source: Author's computation using ELIM-2006

4.7.2. Household Cereals Demand: Econometric Results

Agricultural households are producers and consumers of food. Total output for agricultural households is usually split between the household's own-consumption and marketable surplus (comprised of marketed surplus–the portion of production that is actually marketed—in conjunction with gifts and in-kind exchanges). Several studies have been carried out to understand how agricultural households make production and consumption decisions as well as the allocation of household production to sales and home consumption. Based on different assumptions, several arguments have been put forth on the responsiveness of own-consumption and marketed surplus to market prices.

A key challenge is to estimate a complete demand system in a way consistent with the microeconomic behavior of rural Malian agricultural households that captures these households not only as food consumers, but also as food producers, operating under imperfect market situations. The agricultural household model originally proposed by Singh et al., (1986) helps to account for joint food consumption-production behavior, and the influence of influence of production decision on consumption is captured through the "profit effect". Yan and Chern (2005), in the case of rural China, observed that production as well as market situations (imperfect market in most developing countries) affect the consumption decision of an agricultural household. As a result, they conclude that the marginal value of a food product consumed is the sale price if there is a net sale for this food item; it is the purchase price if there is a net purchase; and it is the shadow price if there is no purchase or sale.

As mentioned earlier, the estimation of a complete demand model that takes into account how consumption decision is affected by production decision requires very detailed data which is not available in this case. Furthermore, giving that the ELIM-2006 data set reports the value of consumption (expenditure) on each commodity by mode of acquisition, it is very likely that consumption from own-production was valued at market prices. Comparing aggregate expenditure on cereals to the revenue from cereals sales, most households in the data set are categorized as net cereals buyers. Thus, on the one hand, one could argue that amongst rural Malian households the decision to purchase cereals as well as the amount of cereals to be purchased is made conditional on the availability of cereals from own-production.

On the other hand, it can also be argued that a household's consumption from own-production does not go through the market and hence does not respond to market prices. Given that cereals are major staples in the current context, it is hard to think of households selling supplies from their own-production that were meant for household consumption due to high market prices to buy other food items. However, households could also sell one type of cereal – e.g., rice—and buy back a cheaper cereal, such as maize.

To examine both arguments, the estimation of cereals demand was first carried out using total cereals expenditure (purchased and value of consumption from own production), and second using only purchased cereals expenditures and aggregating expenditures across purchased cereals . Although the results and discussions within this chapter focus on the first case, it makes reference to the second case (parameters reported in the Appendix).

The estimation of household-level cereals demand involved three main steps. As observed by Bopape (2006), the results of the test for model specification are influenced by endogeneity in the total expenditure variable. Hence, the logical first step is to test for endogeneity of cereals expenditure. Second, a formal test for model specification is performed to determine the appropriateness of an AIDS or QUAIDS model. Third, the appropriate model is estimated dealing with zero expenditure and expenditure endogeneity. Demand elasticities are reported by income group and by place of residence in order to understand differences in households' cereals consumption behavior and any substitution between different cereal types.

A formal test for endogeneity in total cereals expenditures is conducted using the augmented regression technique discussed earlier. The main challenge in the implementation of the technique is the choice of instrument that must fulfill the relevance and the exogeneity conditions of a good instrumental variable (IV). The relevance condition is that there must be sufficient correlation between the instrument and the potentially endogenous variable, while the exogeneity condition is that the instrument must not correlate with the error term in the demand model. The number of wives to the household head is used as an IV here. This IV is expected to be strongly correlated with total cereals expenditures in the sense that in Mali, the number of wives to the household head (HH) is a measure of wealth and wealthier households are expected to consume more cereals than households with fewer wives. The number of women in a household could also influence consumption choices. However, the inclusion of household adult equivalent as an additional explanatory variable in the demand model captures this additional effect.

While the exogeneity condition of IVs is most often assumed, the relevance condition must be tested. To formally test the relevance of the instrument, two reduced forms were estimated–one for total cereals expenditure (lnCX) and the other for the square of total cereals expenditures ($(\text{lnCX})^2$). In each reduced form, the number of wives to the HHH (nwife) and nwife-squared were used as instruments. The estimated reduced forms with nwife and nwife squared are reported in Table 4-20. The R-squared for the reduced form for lnCX is 0.210 while that from the reduced form for $(\text{lnCX})^2$ is 0.2348. Following the estimation of the reduced forms, a test for the relevance of the instruments was conducted. The test is a joint test for the statistical significance of nwife and nwife squared in each of the reduced forms. The test revealed that the number of wives to the HHH is sufficiently correlated with total cereals expenditure. In both reduced forms, we strongly reject (p-value =0.000) that nwife and nwife squared are jointly equal to zero in the equation of household's cereals expenditures.

Table 4-20. Estimated Reduced Forms for Cereals Expenditure and Cereal Expenditure Squared

Variable	lnCX		$(\ln CX)^2$	
	Coef.	Std Err.	Coef.	Std Err.
Price of rice	-0.465	0.297	-12.134	6.838
Price of millet	0.594	0.215	11.475	4.953
Price of sorghum	-0.499	0.375	-14.799	8.643
Price of maize	0.167	0.455	9.910	10.480
nwife	0.320	0.050	7.293	1.153
nwife-squared	-0.059	0.015	-1.302	0.354
HH Adult Equivalent	0.089	0.004	2.231	0.082
Urban/Rural dummy	0.101	0.031	2.401	0.721
Region dummies				
Kayes	-0.024	0.143	-0.467	3.299
Koulikoro	-0.068	0.153	-1.251	3.537
Sikasso	-0.259	0.177	-6.023	4.071
Segou	-0.365	0.164	-8.544	3.778
Mopti	0.007	0.151	0.137	3.474
Tombouctou	0.110	0.151	2.281	3.479
Gao	0.323	0.156	7.911	3.603
Bamako	0.142	0.148	3.758	3.407
Constant	12.937	1.881	171.086	43.347
R-squared		0.2101		0.2348

Source: Author's computation using ELIM-2006.

The residual-based procedure is used to test for the endogeneity of cereals expenditure in the budget share equations (see Wooldridge (2002): 118-122). The procedure for carrying out endogeneity tests involves augmenting the budget share equation for each cereal type with residuals from the reduced forms for cereals expenditure, then testing for the statistical significance of the coefficient on the residuals.   The null hypothesis is that cereals expenditure is exogenous. Blundell and Robin's (1999) approach that includes only the residuals from the reduced form for ln*CX*, using the number of wives to the HHH and its square as instruments, is applied here. Table 4-21 reports results of these Chi-square (χ^2) tests, first in the individual budget share equations, and then across all budget share equations in the demand system. In the individual budget share equations, the test results provide statistical evidence in favor of cereals expenditure exogeneity in all four budget share equations. The test was carried out on the system of equations with (restricted) and without (unrestricted) imposing demand restrictions (symmetry, and homogeneity with adding-up satisfied automatically by the data) during estimation. The null hypothesis is that cereals expenditure is exogenous across all budget share equations in the demand model in both the restricted and unrestricted system. The restricted test gives a Chi-square (χ^2) statistic of 4.78 (p= 0.1883). The conclusion is that we fail to reject cereal expenditure exogeneity at 5%. This implies that in the case of system estimation of the budget share equations, it is not necessary to control for expenditure endogeneity. With total cereals expenditure exogenous, the only necessary modification to the QUAIDS model was to deal with the issue of zero-expenditures.

Table 4-21. Results of the Test for the Endogeneity of Expenditure

Equation-by-equation tests		
Commodity	t stat	p-value
Rice	0.01	0.9753
Millet	0.83	0.3628
Maize	2.07	0.1508
Sorghum	0.01	0.9107
Equation System tests (across all budget shares): SUR		
Unrestricted	2.51	0.4730
Restricted	4.78	0.1883

Source: Author’s computation using ELIM-2006.

Bopape's (2006) test for model specification was implemented with total cereals expenditure. The translog price aggregator, a(p), is linearized with the Stone's price index for the purpose of testing. The results of the model specification test are reported in Table 4-22. The test was carried out on individual budget share equations and on the overall system (with and without demand restrictions). In each of the share equations, we reject the null hypothesis that coefficient of the price times expenditure terms are jointly equal to zero. Performing the tests on the system still produce results in favor of the quadratic almost ideal demand model. Hence, based on these test results, our preferred estimates are the results of the QUAIDS model.

Table 4-22. Tests for Nonlinearity of the Demand System Based on Statistical Significance of the Coefficient of the Price Times Expenditure-Squared Terms

Equation-by-equation tests		
Commodity	t stat	p-value
Rice	13.86	0.0000
Millet	7.66	0.0000
Maize	18.33	0.0000
Sorghum	3.94	0.0000
Equation System tests (across all budget shares): SUR		
Unrestricted	142.52	0.0000
Restricted	189.36	0.0000

Source: Author’s computation using ELIM-2006.

The final specification of the demand model is also influenced by the presence of zero-expenditure (selection bias). Rice, millet and sorghum are the mainstays of the Malian diet. Zero expenditure of these commodities could be the result of the reference period used in reporting consumption failing to capture any expenditure on some of these commodities. As shown on Table A4-1 in the Appendix, considering the total cereals expenditures (purchased plus the value of own-consumption)[37], 5.1% of the total sample reported zero expenditure on rice, 45.2% reported zero expenditure on sorghum, 18.9% reported zero expenditure on millet and 49.8% reported zero expenditure on maize. Therefore, to check if any fundamental difference exists between the decisions to purchase these cereals and how much of each to purchase, the QUAIDS model for cereals demand is estimated dealing with zero-expenditure (censored).

The general procedure in the estimation of the censored QUAIDS model in the absence of any expenditure endogeneity is as follows: we estimate the household's decision to consume a specific cereal type (Equation 4-3) by using a maximum likelihood probit regression to obtain household-specific probit estimates $\widehat{\sigma}_h z_{ih}$. The univariate standard normal probability density (pdf) and the cumulative distribution (cdf) to use in the QUAIDS model are later calculated for each cereal type and each household. Given the initial values of the price index a(p) and the predicted values (pdfs and cdfs) from the probit regressions, the cross-equation nature of the restrictions, and the non-linear structure of the QUAIDS model, Poi's (2008) "demand-system estimation: update, Non-Linear Seemingly Unrelated regression (NLSUR) model" written in STATA, augmented with the pdf and cdf from the first stage probit regression to account for zero expenditure and household demographics, is used to estimate the demand system in equation 4-5 (dropping the term $\rho_s \tau_{si}$ since we rejected expenditure endogeneity).

[37] Disaggregating zero expenditures by mode of acquisition, it is observed that 27% of the households purchased sorghum in the reference period, 80% had positive purchases for rice, 51% purchased millet and 19% purchased maize in the reference period. For rice for instance, the percentage zero expenditure drops from 20% (considering only purchased cereals expenditures) to 5.1% (considering total cereals expenditures (purchased plus value of own consumption) in the reference period. Thus, some households may not have purchased rice but they consumed rice from their own production.

4.7.2.1. Expenditure Elasticities by Place of Residence

Table A4-4 reports the estimated parameters from a censored QUAIDS regression by place of residence using total cereals expenditures. Table A4-5 also reports the estimated elasticities and their standard errors by place of residence using total cereals expenditures. Estimates of expenditure elasticities for the urban and rural areas (considering all per capita income groups within a place of residence) are reported in Table 4-23 below. All expenditure elasticities are positive and statistically significant at a 1% level for all four cereals types in the rural and urban subsamples, indicating that these commodities are normal goods.

Considering the urban subsample, rice and maize are expenditure inelastic, while millet and sorghum are expenditure elastic. The high expenditure elasticity for millet and sorghum in the urban area is intriguing because these are not only staple foods, but also, as pointed out by past studies, coarse grains are generally less preferred in the urban areas for various reasons such as the high opportunity cost of the time required for their processing/preparation. Moreover, the ELIM-2006 dataset does not distinguish between consumption away from home or the form (processed or unprocessed) in which these coarse grains are consumed. In the rural area, in addition to millet and sorghum (as in the urban area), maize is also expenditure elastic–indicating a more than proportionate increase in expenditure from an increase in total cereals budget.

Comparing the urban and the rural subsamples, the expenditure elasticity for rice is higher amongst the urban households than the rural households. The higher rice expenditure elasticity in the urban area (0.964) than in the rural areas (0.728) indicates that urban households are more likely to spend any additional income on rice than are rural households. This, in spite of the already greater rice consumption shares in urban areas compared to rural areas as revealed by the descriptive statistics of the data; theaverage rice consumption level and share amongst urban households are quite high (about double those of rural areas). The estimated urban rice expenditure elasticity is higher than what Camara (2004) estimated as rice income elasticity (0.796) for Bamako households only and much larger than what Rogers and Lowdermilk (1991) obtained as rice income elasticity (0.562) for urban Mali (the cities of Kayes, Sikasso, Segou, Tombouctou, Gao, Bamako, Mopti, and Koulikoro). The growing positive expenditure elasticity of rice over time supports Camara's comment that rice is becoming less of a necessity for urban households over time. Thus, for rice and sorghum, we observe higher expenditure elasticities in the urban areas than in the rural areas, while millet and maize expenditure elasticities are higher in the rural areas than in the urban areas. Estimated parameters by place of residence using only purchased cereals expenditures are also reported in Table A4-8 and A4-9 in Appendix[38].

4.7.2.2. Expenditure Elasticities by Income Group within Place of Residence

Expenditure elasticities are further examined by income-group per place of residence to determine if there are income-group related differences within a specific location (Table 4-23). Tables A4-6 and A4-7 also show the full matrix of estimated parameters and elasticities by income group within place of residence, using total cereals expenditures (purchased plus the value of own-consumption). In the urban and rural areas and across all income groups, all the expenditure elasticities are statistically significant at 1%[39] and positive as expected for

[38] The test for endogeneity using only purchased cereals expenditure revealed that purchased cereals expenditure was endogenous. Hence, the estimation of cereals demand using purchased cereals expenditure was carried out after correcting for endogeneity in purchased cereals expenditure using the approach outlined earlier.

[39] Except for the low-income urban households, where millet expenditure elasticity is positive but statistically significant at a 10% level of significance.

necessities. In both rural and urban subsamples, no clear pattern is observed from the low to the middle and to the high income groups. Thus, for clarity, comparison will be made mostly between the low-income and the high-income groups.

Table 4-23. Cereals Expenditure Elasticities by Place of Residence and Income Group

	Rice	Millet	Maize	Sorghum
Urban				
All	0.964*	1.038*	0.668*	1.502*
By Income Group				
Low	1.248*	0.758***	0.702*	0.673*
Middle	0.880*	1.079*	1.070*	1.454*
High	1.239*	0.415*	1.032*	1.247*
Rural				
	Rice	Millet	Maize	Sorghum
All	0.728*	1.200*	1.099*	1.109*
By Income Group				
Low	0.654*	1.248*	1.030*	1.054*
Middle	1.006*	0.980*	0.867*	1.069*
High	1.001*	1.025*	1.014*	0.974*

Source: Author.
Note: * means significant at a 1% level and ** means significant at 5% and *** means significant at 10%.

In the urban area, rice expenditure elasticity decreases slightly from the low- to the high-income urban group, millet expenditure elasticity drops from the low- to the high-income group, and maize and sorghum elasticities increase from the low- to the high-income urban groups. The noticeable decline in millet expenditure elasticity from the urban low- to the urban high-income groups indicates that as households get richer in the urban area, they are less likely to spend any additional income on millet. The increase in sorghum expenditure elasticity between the urban low- (0.673) and the urban high-income (1.247) illustrates that the sorghum expenditure elasticity observed in the urban area aggregating across all income groups (1.501) is largely driven by the behavior of the urban middle- and high-income groups. Hence, in terms of expenditure elasticities, in the urban area, we observe a high preference for rice and sorghum at higher per capita income levels while the preference for millet seems to decrease with income level. The high expenditure of elasticity of sorghum as income increases calls for attention and warrants further investigation into the type or form in which sorghum is consumed in the urban area. There is a need to differentiate demand for sorghum of different quality (processed and unprocessed) and by place of consumption (for example, home and away from home).

Rural households also reveal high expenditure elasticities across all income groups for all the different cereals when total cereals expenditures are used. The responsiveness of rice to changes in income increases from the low- to the high-income households. Millet, sorghum and to a lesser extent maize expenditure elasticities tend to decline from the rural low- to the high-income rural group.

Overall, using total cereals expenditures, the hypothesis that poorer households have higher expenditure elasticities is true for millet, sorghum and to a lesser extent maize in the rural areas and millet in the urban areas. From the summary statistics (Table 4-19), we observe a clear pattern of decline in sorghum and millet budget shares from the low- to the high-income groups and a marked increase in the rice budget share from the rural low- to high-income households. Expenditure elasticities by income group and place of residence estimated using only purchased cereals expenditures are also reported in Tables A4-10 and A4-11.

4.7.2.3. Own-Price Responses by Place of Residence

Table 4-24 reports uncompensated and compensated own-price elasticities of cereals demand by place of residence using total cereals expenditures (purchased plus value of own-consumption).

Table A4-5 in Appendix also reports the standard errors of the estimated elasticities. All uncompensated and compensated own-price elasticities are not only statistically significant at a 5% level, but are also negative in both the urban and the rural sub-samples, thus supporting a downward sloping demand curve.

Considering the urban area (without disaggregating by income group), all uncompensated own-price elasticities are close to unity, indicating high sensitivity to own price changes. The own-price elasticity for rice obtained here for the urban area (-0.955) are about 3 times that reported by Camara (2004) using data for Bamako households only (-0.338). However, Rogers and Lowdermilk (1991) using urban Malian data found the own-price elasticity of demand for rice to be -0.683. Given that the urban sample used by Rogers and Lowdermilk (1991) is quite comparable to that used in this study (in terms of geographical coverage), it can be noted that the sensitivity of rice demand to changes in its own-price in the urban areas appears to have increased over two decades. When the substitution effects are considered, all the cereals became less elastic, as the urban compensated own-price elasticities get smaller in magnitude than uncompensated own-price elasticities, as expected for normal goods. Considering total cereals expenditures, millet demand is the least sensitive to changes in its own price in the urban area. Thus, the hypothesis that rice is the least responsive to changes in its own price in the urban area due to the high opportunity cost of time and demand for convenience by urban time-poor consumers is rejected. Notwithstanding, compared to maize and sorghum, rice demand is less responsive to changes in its own price.

Still using total cereals expenditures and without disaggregating by income group, in the rural area, all statistically significant uncompensated own-price elasticities are negative as expected. Rice is the least sensitive to changes in its own price in the rural area. The estimated elasticities using only purchased cereals expenditures are shown in Tables A4-8 and A4-9 in Appendix.

Table 4-24. Cereals Own-Price Elasticities - By Place of Residence and Income Group

	Rice	Millet	Maize	Sorghum
URBAN				
	Uncompensated			
All	-0.955*	-0.904*	-1.046*	-1.156*
Low	-0.997*	-0.243	-0.996*	-1.014*
Middle	-0.915*	-1.035*	-1.026*	-0.948*
High	-1.065*	-0.514*	-0.946*	-0.658*
	Compensated			
All	-0.341*	-0.714*	-0.986*	-1.021*
Low	-0.277*	-0.089	-0.914*	-0.944*
Middle	-0.318*	-0.860*	-0.945*	-0.828
High	-0.241*	-0.439*	-0.870*	-0.557**
RURAL				
	Uncompensated			
All	-0.938*	-1.135*	-1.024*	-0.994*
Low	-0.781*	-1.010*	-1.041*	-0.894*
Middle	-0.973*	-0.963*	-0.940*	-0.945
High	-0.991*	-0.993*	-0.996*	-0.988*
	Compensated			
All	-0.660*	-0.723*	-0.896*	-0.819*
Low	-0.585*	-0.513*	-0.907*	-0.713*
Middle	-0.607*	-0.622*	-0.834*	-0.768*
High	-0.516*	-0.696*	-0.897*	-0.853*

Source: Author.
Note: * = significant at 1%, ** =significant at 5% and *** = significant at 10%.

4.7.2.4. Own-Price Responses by Income Group within Place of Residence

Using total cereals expenditures and differentiating by urban-income groups, all the uncompensated own-price responses (except millet in the low-income group) and compensated own-price responses (except millet in the low-income and sorghum in the middle-income) are statistically significant and have the expected negative sign (Table 4-24 above).

In terms of uncompensated elasticities, millet and sorghum are the least own-price sensitive amongst the urban high income group; rice is the least own-price sensitive amongst the middle-income urban group; and rice and maize are the least own-price sensitive amongst the low-income urban group. Comparing the estimates for the low- and high-income urban groups, we observe that the hypothesis that the own-price elasticities of cereals demand are more elastic (larger in absolute terms) for lower income households than higher income households is validated only for maize and sorghum. Rice own-price elasticities are higher for high-income urban households than the low-income urban households. In the rural areas, in terms of uncompensated own-price elasticities, low-income households are more sensitive to a change in the price of millet and maize than high-income households.

4.7.2.5. Cross Price Elasticities by Place of Residence

The compensated cross-price elasticities by place of residence (aggregated across all income groups) and using total cereals expenditures are reported in Table 4-25. In the urban area, all the cross-price effects are positive and statistically significant, implying a relationship of substitution amongst the different cereals types. The high and positive cross-price elasticities of millet (0.563) and sorghum (0.627) demand with respect to a change in price of rice supports previous findings, e.g., Camara (2004), that urban households would run towards purchasing more sorghum and millet in the face of high rice prices. In contrast, Rogers and Lowdermilk (1991) found that changing rice prices did not have a statistically significant impact on millet-sorghum purchases. The authors attributed their result to the fact that rice and millet-sorghum occupied different functions in urban households' diets, resulting in a tendency amongst households to consume rice at mid-day while millet and sorghum were consumed in the morning and evening. The difference with the Rogers-Lowdermilk findings may also reflect a shift in consumption habits where rice is increasingly eaten in the evenings as well. Therefore, for the range of prices observed in 2006, the price of rice appears to have a significant effect on the consumption of coarse grains in the urban area. In the rural area, with the exception of the relationship between rice and sorghum, all other compensated cross price effects are positive and statistically significant, indicating a relationship of substitution between the different cereals.

Table 4-25. Compensated Cross-Price Elasticities - By Place of Residence

Urban				
	Rice	Millet	Maize	Sorghum
lnprice	-0.341*	0.563*	0.446*	0.627*
lnpmillet	0.168*	-0.714*	0.206*	0.218*
lnpmaize	0.084*	0.081*	-0.986*	0.276*
lnpsorghum	0.068*	0.137*	0.186*	-1.021*
Rural				
	Rice	Millet	Maize	Sorghum
lnprice	-0.660*	0.491*	0.609*	0.133
lnpmillet	0.420*	-0.723*	0.116*	0.543*
lnpmaize	0.095*	0.109*	-0.896	0.148*
lnpsorghum	0.003	0.291*	0.208*	-0.819*

Source: Author. Author
* means significant at a 1%; ** significance at 5%, and *** means significant at 10%.

Comparing cross-price effects between the urban and the rural areas when total cereals expenditures are used, we observe that in both the urban and rural areas, millet and maize are substitutes for rice. However, millet is a stronger substitute for rice than maize in the urban area, while maize is a stronger substitute for rice than millet in the rural area. Sorghum substitutes rice only in the urban area. The stronger substitution of millet and sorghum for rice in the urban area could reflect the greater availability of processing services (small mills) for coarse grains in urban areas than in rural areas. Urban households, especially those in larger cities, also quite often have a full panoply of goods available in the markets. This availability of a wider range of products to draw from could also explain the larger substitution effects amongst urban households. Estimated cross-price elasticities using only purchased cereals expenditures are also reported in Tables A4-8 and A4-9 in Appendix.

4.7.2.6. Cross Price Elasticities by Place of Residence and Income Group

4.7.2.6.1. Urban Cross Price Effects by Income Group

Table 4-26 shows compensated cross-price elasticities in the urban areas by income group using total cereals expenditures. Amongst the low-income group, maize and sorghum are substitutes for rice with elasticities of substitution of 0.567 and 0.460 respectively. In the middle-income group, millet, maize and sorghum are substitutes for rice, with elasticities of substitution of 0.674, 0.580 and 0.437 respectively. Amongst high-income urban households, the relationship between a change in the price of rice and the demand for millet and sorghum is not statistically significant. Maize is a substitute for rice amongst the high-income urban group, with a high cross price elasticity of 1.299.

Comparing across urban income groups, we observe that: (i) the degree of substitution of rice for millet is almost similar in the low- and high-income groups; (ii) substitution of rice for sorghum is stronger in the low-income than the high-income group; (iii) substitution of rice for maize is of almost similar magnitude across all income groups; (iv) substitution of maize for rice increases from the low- to the high-income group; (v) substitution of maize for sorghum drops from the low- to the high-income group; and (vi) the degree of substitution of sorghum for rice drops from the low- to the middle-income group. Tables A4-10 and A4-11 in Appendix report estimated parameters by urban income groups using only purchased cereals expenditures.

Table 4-26. Urban Compensated Cross-Price Elasticities by Income Group

	Low-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.277*	0.192	0.567*	0.460*
lnpmillet	0.129**	-0.089	0.145	-0.304
lnpmaize	0.098*	0.124***	-0.914*	0.300*
lnpsorghum	0.130*	-0.077	0.215**	-0.944*
	Middle-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.318*	0.674*	0.580*	0.437*
lnpmillet	0.146*	-0.860*	0.191*	0.356*
lnpmaize	0.096*	0.063*	-0.945*	0.000*
lnpsorghum	0.067*	0.128*	0.111*	-0.828*
	High-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.241*	0.305	1.299*	0.167
lnpmillet	0.128*	-0.439*	0.570***	0.089
lnpmaize	-0.097**	0.651*	-0.870*	-0.005
lnpsorghum	0.089*	-0.034	0.245	-0.557**

Source: Author.
Note: * means significant at a 1%; ** significance at 5%, and *** means significant at 10%.

4.7.2.6.2. Rural Cross Price Effects by Income Group

Table 4-27 shows the compensated cross-price elasticities across income groups in the rural areas using total cereals expenditures. All compensated cross-price elasticities are statistically significant, and a relationship of substitution exists between the different cereals in the low-income and high-income rural group. Also in the middle-income rural group, a relationship of substitution characterizes all statistically significant cross-price effects. Comparing across rural income groups, we notice that the sensitivity of rice demand to changes in the price of millet, maize and sorghum increases from the low- to the middle-income rural group but drops from the middle- to the high-income rural group. Also noticeable is the increase in the sensitivity of millet, maize and sorghum demand to changes in the price of rice as per capita income increases. This means that richer rural households are more likely to substitute coarse grains for rice when the price of rice increases. The compensated cross-price elasticities across income groups in the rural areas estimated using only purchased cereals expenditures are reported in Tables A4-10 and A4-11 in Appendix.

Table 4-27. Rural Compensated Cross-Price Elasticities by Income Group

	Low-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.585*	0.215*	0.326*	0.369*
lnpmillet	0.291*	-0.513*	0.469*	0.298*
lnpmaize	0.058*	0.202*	-0.907*	0.103*
lnpsorghum	0.148*	0.176*	0.117*	-0.713*
	Middle-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.607*	0.347*	0.338*	0.369*
lnpmillet	0.335*	-0.622*	0.363*	0.367*
lnpmaize	0.119*	0.122*	-0.834*	0.064
lnpsorghum	0.167*	0.171*	0.048	-0.768*
	High-Income			
	Rice	Millet	Maize	Sorghum
lnprice	-0.516*	0.457*	0.451*	0.495*
lnpmillet	0.286*	-0.696*	0.308*	0.266*
lnpmaize	0.096*	0.104*	-0.897*	0.092*
lnpsorghum	0.141*	0.136*	0.136*	-0.853*

Source: Author.
Note: * means significant at a 1%; ** significance at 5%, and *** means significant at 10%.

4.8. Chapter Summary

The goal of this chapter was to provide micro-level evidence on food consumption in Mali using household budget survey data of 2006. Specifically, the analysis sought to determine the factors that influence the demand for individual cereals and the substitution among them; and to provide separate cereals demand estimates by income groups and by place of residence.

A censored QUAIDS model is estimated to understand the factors influencing the demand for individual cereal types (rice, millet, maize and sorghum). The model is estimated (a) using total cereals expenditures (the sum of purchased cereals and the value of consumption from own-production), and (b) using only purchased cereals expenditures. The estimated parameters under scenario (b) are reported in the appendix.

Positive expenditure elasticities were found for all four cereals type, irrespective of place of residence. Using total cereals expenditure, rice and sorghum expenditure elasticities were found to be higher in the urban area than in the rural areas, while millet and maize expenditure elasticities are higher in the rural areas than in the urban areas. Comparing rice expenditure elasticity estimated for the urban area in this study to that reported by previous studies in Mali (e.g., Camara, 2004), we observe a positive trend over time and find support for Camara's assertion that rice is becoming less of a necessity for urban households over time. The high expenditure elasticity of sorghum in the urban area calls for further investigations into the quality of sorghum that is consumed, since it is often argued that coarse grains (such as sorghum) are more time consuming and less convenient for urban time poor consumers.

The analysis of expenditure elasticities by income-group and place of residence also reveals some income group-related pattern for rice and millet and to a lesser extent sorghum in the urban area. Using total cereals expenditures, we observe in the urban area a high preference for rice and sorghum at higher per capita income levels while the preference for millet seems to decrease with income level. The high expenditure elasticity of sorghum as income increases indicates a need to differentiate sorghum demand by quality (processed and unprocessed) and by place of consumption (for example, home and away from home). While the expenditure elasticity for millet decreases with increases income amongst urban households, amongst rural households, millet, sorghum and to a lesser extent maize expenditure elasticities tend to decline from the rural low- to the high-income households. This suggests declining preference for coarse grains as rural households get richer.

Uncompensated and compensated own-price elasticities by place of residence support a downward-sloping demand curve for all cereals. Considering total cereals expenditures and without disaggregating by income groups, the hypothesis that rice is the least responsive to changes in its own price in the urban area due to the high opportunity cost of time and demand for convenience by urban-poor consumers is rejected. Millet is the least sensitive to changes in its own price in the urban areas. Rice is the least sensitive to changes in its own price in the rural area.

The analysis of own-price elasticities by income group and place of residence using total cereals expenditures reveal that amongst urban households, only maize and sorghum support the hypothesis that the own-price elasticities of cereals demand are more elastic (larger in absolute terms) for lower income households than higher income households. High-income urban households were found to have higher own-price elasticities for rice than the low-income urban households. In the rural areas, low-income households were more sensitive to a change in the price of millet and maize than high-income households.

The analysis also reveals that a relationship of substitution characterizes most statistically significant cross-price effects. Using total cereals expenditures and aggregating all income groups, in the urban areas we observe high and positive cross-price elasticities of millet and sorghum demand with respect to a change in the price of rice. This finding supports previous findings (e.g., Camara, 2004), that urban households would run towards purchasing more sorghum and millet in the face of high rice prices. Compensated cross-price elasticities in the rural areas also indicate a relationship of substitution between the different cereals.

Furthermore, comparing the urban and the rural areas in terms of the magnitude of cross-price effects, we observe a stronger substitution of millet and sorghum for rice amongst urban households. This could reflect the greater availability of processing services (small mills) for coarse grains in urban areas, as well as the fact that urban markets, especially in larger cities, also quite often make a wider range of products available to consumers.

Compensated cross-price elasticities by income group in the urban area using total cereals expenditures reveal that amongst urban households, while the degree of substitution of rice for millet is almost similar in the low- and high-income groups, the degree of substitution of rice for sorghum is stronger in the low-income than the high-income group. The substitution of maize for rice increases from the low- to the high-income group, while the substitution of maize for sorghum drops from the low- to the high-income group.

Comparing across rural income groups and using total cereals expenditures, we notice an increase in the sensitivity of millet, maize and sorghum demand to changes in the price of rice as per capita income increases. This means that richer rural households are more likely to substitute coarse grains for rice when the price of rice increases.

The preceding analysis reveals high substitution between rice and coarse grains in both the rural and the urban areas and across income groups. This finding implies some scope for dealing with price spikes for one cereal by increasing the availability of substitutes—a possibility that the earlier findings of low cross-elasticities seemed to discount.

APPENDIX

Table A4-1. Structure of ELIM-2006 data

Region	Cercle	Arrondissement	Market with available prices
1. KAYES	1. Kayes	Kayes central Ambidedi Aourou Diamou Sadiola Same Segala Kayes	Kayes Centre KayesN'Dy Kayes Plateau
	2. Bafoulabé	Bafoulabe central	
		Bamafele	
		Diakon	
		Goundara	
		Koundian	
		Mahina	
		Bafoulabe central	
		Bamafele	
		Diakon	
		Goundara	
	3. Diéma	Diema central	Diéma
		Bema	
		Diangountecamar	
		Dioumara	
		Lakamane	
	4. Kéniéba	Kenieba central	
		Faraba	
	5. Kita	Kita central	
		Djidian	
		Kokofata	
		Sebekoro	Badinko
		Sefeto	
		Sirakoro	
		Toukoto	
		Kita	Kita
	6. Nioro	Nioro central	
		Gavinane	
		Simbi	
		Troungoumbe	
		Nioro	Nioro
	7. Yélimané	Yelimane central	
		Kirane	

Table A4-1. (cont'd)

Region	Cercle	Arrondissement	Market with available prices
		Tambacara	
2. KOULIKORO	8. Koulikoro	Koulikoro central	
		Koula-koulikoro	
		Niamina	
		Sirakorola	Sirakorola
		Tougouni	
		Commune Koulikoro	Koulikoro Ba Koulikoro Gare
	9. Banamba	Banamba central	
		Boron	
		Toubacoura	
		Toukoroba	
	10. Dioila	Dioila central	Dioïla
		Banco	
		Beleko	
		Fana	Fana
		Massigui	
		Mena	
	11. Kangaba	Kangaba central	
		Narena	
	12. Kati	Kati central	
		Baguineda	
		Kalabancoro	
		Kourouba	
		Neguela	
		Ouelessebougou	
		Sanankoroba	
		Siby	
		Kati	
	13. Kolokani	Kolokani central	
		Djidieni	
		Massantola	
		Nonssombougou	
	14. Nara	Nara central	Nara
		Balle	
		Dilly	
		Fallou	

Table A4-1. (cont'd)

Region	Cercle	Arrondissement	Market with available prices
3. SIKASSO	15. Sikasso	Sikasso central	Sikasso Centre
		Blendio	
		Danderesso	
		Dogoni	
		Kignan	
		Klela	
		Niena	
		N'kourala	
		Commune sikasso	SikassoMédine
	16. Bougouni	Bougouni central	Bougouni
		Dogo-bougouni	
		Faragouaran	
		Garalo	
		Koumantou	Koumantou
		Manankoro	
		Sanso	
		Zantiebougou	
		Commune bougouni	
	17. Kadiolo	Kadiolo central	Loulouni -in cercle but not in this arrondissement
		Fourou	
	18. Kolondiéba	Kolondieba central	
		Fakola	
		Kadiona	
		Kebila	
	19. Koutiala	Konsseguela	Koutiala
		Molobala	
		M'pessoba	M'Pèssoba
		Commune koutiala	Zangasso (in cercle but not exactly in this arrondissement
	20. Yanfolila	Yanfolila central	
		Doussoudiana	
		Kangare	
		Siekorole	
	21. Yorosso	Yorosso central	
		Kouri	Koury

Table A4-1. (cont'd)

Region	Cercle	Arrondissement	Market with available prices
4. SÉGOU	22. Ségou	Segou central	Ségou Centre
		Sinzana	
		Dioro	Dioro
		Doura	
		Katiena	
		Markala	
		Sansanding	Fatiné-in this cercle
		Ségou	Ségou Château
	23. Baraoueli	Baroueli central	
		Sanando	
		Tamani	Shiango
	24. Bla	Bla central	Bla
		Diaramana	
		Falo	Dougouolo (in this cercle but in this arrondissement
		Touna	Touna
		Yangasso	
	25. Macina	Macina central	Macina
		Kologotomo	
		Monipe	Monimpébougou
		Sarro	
		Saye	
	26. Niono	Niono central	Niono
		Nampala	Dogofri-in this cercle but not exactly in this arrondissement
		Sokolo	Sokolo
			Diakawèrè in Cercle but not in arrondissement-inMariko-Niono
	27. San	San central	
		Dieli	
		Kassorola	
		Kimparana	
		Sourountouna	
		Sy	
		San	
	28. Tominian	Tominian central	
		Fangasso	
		Koula	
		Mafoune	
		Tamissa	

Table A4-1. (cont'd)

Region	Cercle	Arrondissement	Market with available prices
5. MOPTI	27. Mopti	Mopti central	Mopti Digue
		Dialloube	
		Fatoma	
		Konna	
		Korientze	
		Ouromodi	
		Mopti	
	28. Bandiaga	Bandiagara central	Bandiagara
		Kani-gogouna	
		Kendie	
		Sangha	
	29. Bankass	Dialassagou	Diallassagou
		Segue	Bankass in Cercle but not in arrond- in arrond of Bankass
		Sokoura	Koulogon in Cercle but not in arrondissement
	30. Djénné	Djenne central	Djenne
		Konio	
		Kouakourou	
		Mougnan	
		Sofara	MoptiGuangal
	31. Douentza	Douentza central	
		Hombori	
	32. Koro	Koro central	
		Diankabou	
		Dinangourou	
		Dioungani	
		Koporokeniena	
		Madougou	
	33. Ténenkou	Tenenkou central	
		Dioura	
		Sossobe	
		Toguerecoumbe	
	34. Youvarou	Youvarou central	

Table A4-1. (cont'd)

Region	Cercle	Arrondissement	Market with available prices
6. TOMBOUCTOU	37. Tombouctou	Tombouctou central	Tombouctou
		Aglal	
		Boureminaly	
		Commune tombouct	
	38. Diré	Diré central	Diré
		Sareymou	
	39. Goundam	Goundam central	
		Bintagoundou	
		Douekis	
		Tonka	Tonka
	40. Gourmar	Gourma-rharous	
		Gossi	
	41. Niafunké	Niafunke central	
		Lere	Léré
		Sarafere	
		Soumpi	
7. GAO	42. Gao	Gao central	
		Haoussafoulane	
		Gao	Gao
	43. Ansongo	Ansongo central	Ansongo
		Tessit	
	44. Bourem	Bourem central	
		Bamba	
		Temera	
	45. Ménaka	Menaka central	
8. KIDAL	46. Kidal	Annefis	
		Kidal	Kidal
	47. Téssalit	Tessalit central	
		Aguel-hoc	
9. BAMAKO DISTRICT	48. Bamako	Commune i	Fadjiguila
		Commune ii	Niarela, Medine
		Commune iii	Dibida,
		Commune iv	Lafiabougou
		Commune v	Badalabougou, Djikoroni
		Commune vi	Faladié, Magnambougou, Sogoniko, Niamakoro
			Ouolofobougou

Source: Author.

Table A4-2. Number of Zero Expenditures by Place of Residence-Considering Expenditure on All Modes of Acquisition

Cereal type	Place of Residence	Zero Expenditure	Positive Expenditure	Percent non Expenditure
Sorghum	Urban	910	656	45.3
	Rural	1101	1787	54.7
	Total	2011	2443	45.2
Rice	Urban	53	1513	23.6
	Rural	172	2716	76.4
	Total	225	4229	5.1
Millet	Urban	388	1178	46.0
	Rural	455	2433	54.0
	Total	843	3611	18.9
Maize	Urban	942	624	42.4
	Rural	1277	1611	57.6
	Total	2219	2235	49.8

Source: Author.

Table A4-3. Zero-Expenditure by Mode of Acquisition

Cereal Type	Zero Home-Produced	Positive Home-Produced	Percentage zero Home-Produced	Zero purchase	Positive purchase	Percentage Positive purchase
Sorghum	3270	1184	73%	3249	1205	27%
Rice	3837	617	86%	901	3553	80%
Millet	3163	1291	71%	2201	2253	51%
Maize	3166	1288	71%	3600	854	19%

Source: Author.

Table A4-4. Estimated Parameters of the Censored QUAIDS Model for Cereals Demand by Place of Residence – Total Cereals Expenditure

	Urban			Rural		
	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Constants						
α_1	0.622	0.028	0.000	0.874	0.069	0.000
α_2	0.229	0.045	0.000	-0.047	0.100	0.637
α_3	0.293	0.089	0.001	-0.287	0.077	0.000
α_4	-0.606	0.151	0.000	-0.189	0.101	0.060
Expenditure						
β_1	-0.051	0.011	0.000	-0.206	0.017	0.000
β_2	0.034	0.012	0.007	0.148	0.028	0.000
β_3	-0.088	0.009	0.000	0.054	0.011	0.000
β_4	0.110	0.028	0.000	0.021	0.025	0.407
Prices						
γ_{11}	0.014	0.005	0.011	-0.118	0.029	0.000
γ_{12}	-0.012	0.006	0.057	0.107	0.034	0.001
γ_{13}	-0.016	0.005	0.003	0.053	0.014	0.000
γ_{14}	-0.005	0.009	0.599	-0.039	0.024	0.106
γ_{22}	-0.012	0.006	0.057	0.107	0.034	0.001
γ_{23}	0.024	0.008	0.005	-0.076	0.035	0.031
γ_{24}	0.001	0.006	0.815	-0.049	0.019	0.010
γ_{33}	0.007	0.010	0.497	0.036	0.025	0.145
γ_{34}	-0.016	0.005	0.003	0.053	0.014	0.000
γ_{44}	0.001	0.006	0.815	-0.049	0.019	0.010

Note: Rice=1, millet=2, maize= 3 and sorghum=4. $\gamma_{ij=}$ Equation i and commodity j.

Table A4-4 (cont'd)

	Urban			Rural		
Expenditure Squared						
λ_1	0.009	0.001	0.000	0.020	0.001	0.000
λ_2	-0.008	0.001	0.000	-0.014	0.002	0.000
λ_3	0.005	0.001	0.000	-0.007	0.001	0.000
λ_4	-0.004	0.002	0.014	0.002	0.002	0.471
PDFs						
Rice	0.338	0.039	0.000	0.567	0.043	0.000
Millet	0.283	0.024	0.000	0.155	0.042	0.000
Maize	0.165	0.081	0.041	0.290	0.040	0.000
Sorghum	0.546	0.077	0.000	0.490	0.045	0.000
HH Adult Equivalent						
Rice	0.004	0.001	0.000	0.002	0.001	0.002
Millet	-0.005	0.001	0.000	-0.003	0.001	0.000
Maize	0.001	0.001	0.210	-0.002	0.000	0.000
Sorghum	0.001	0.001	0.460	0.001	0.000	0.010

Source: Author.
Note: Rice=1, millet=2, maize= 3 and sorghum=4. $\gamma_{ij=}$ Equation i and commodity j.

Table A4-5. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Place of Residence - Total Cereals Expenditures

		Urban			Rural		
		Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Expenditure Elasticities							
	Rice	0.964	0.016	0.000	0.728	0.031	0.000
	Millet	1.038	0.047	0.000	1.200	0.044	0.000
	Maize	0.668	0.033	0.000	1.099	0.034	0.000
	Sorghum	1.502	0.118	0.000	1.109	0.060	0.000
Uncompensated Elasticities							
Rice equation	Rice	-0.955	0.009	0.000	-0.938	0.029	0.000
	Millet	-0.010	0.011	0.370	0.192	0.050	0.000
	Maize	-0.005	0.008	0.571	0.018	0.021	0.388
	Sorghum	-0.041	0.014	0.004	-0.172	0.037	0.000
Millet Equation	Rice	-0.077	0.025	0.002	0.028	0.036	0.429
	Millet	-0.904	0.037	0.000	-1.135	0.059	0.000
	Maize	-0.022	0.023	0.330	-0.046	0.030	0.124
	Sorghum	0.072	0.042	0.086	0.138	0.048	0.004
Maize Equation	Rice	0.008	0.018	0.646	0.112	0.038	0.003
	Millet	0.045	0.024	0.064	-0.174	0.074	0.019
	Maize	-1.046	0.030	0.000	-1.024	0.037	0.000
	Sorghum	0.113	0.048	0.018	0.031	0.060	0.603
Sorghum Equation	rice	-0.155	0.041	0.000	-0.189	0.053	0.000
	Millet	-0.034	0.049	0.489	0.120	0.087	0.167
	Maize	0.158	0.046	0.001	0.021	0.046	0.641
	Sorghum	-1.156	0.087	0.000	-0.994	0.073	0.000

Table A4-5 (cont'd)

		Urban			Rural		
		Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Compensated Price Elasticities							
Rice equation	Rice	-0.341	0.008	0.000	-0.660	0.034	0.000
	Millet	0.168	0.007	0.000	0.420	0.038	0.000
	Maize	0.084	0.004	0.000	0.095	0.014	0.000
	Sorghum	0.068	0.007	0.000	0.003	0.026	0.911
Millet Equation	Rice	0.563	0.034	0.000	0.491	0.050	0.000
	Millet	-0.714	0.035	0.000	-0.723	0.048	0.000
	Maize	0.081	0.013	0.000	0.109	0.020	0.000
	Sorghum	0.137	0.026	0.000	0.291	0.040	0.000
Maize Equation	Rice	0.446	0.051	0.000	0.609	0.071	0.000
	Millet	0.206	0.044	0.000	0.116	0.105	0.269
	Maize	-0.986	0.032	0.000	-0.896	0.036	0.000
	Sorghum	0.186	0.052	0.000	0.208	0.068	0.002
Sorghum Equation	Rice	0.627	0.090	0.000	0.133	0.096	0.166
	Millet	0.218	0.079	0.006	0.543	0.103	0.000
	Maize	0.276	0.051	0.000	0.148	0.039	0.000
	Sorghum	-1.021	0.078	0.000	-0.819	0.078	0.000

Source: Author.

Table A4-6. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Urban Income Group—Total Cereals Expenditures

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Expenditure Elasticities							
	Rice	1.248	0.124	0.880	0.012	1.239	0.050
	Millet	0.758	0.416	1.079	0.027	0.415	0.125
	Maize	0.702	0.037	1.070	0.029	1.032	0.288
	Sorghum	0.673	0.174	1.454	0.043	1.247	0.198
Uncompensated Price Elasticities							
Rice Equation	Rice	-0.997	0.072	-0.915	0.009	-1.065	0.054
	Millet	-0.157	0.088	0.003	0.006	-0.122	0.052
	Maize	-0.108	0.102	0.073	0.020	-0.443	0.123
	Sorghum	0.000	0.030	-0.012	0.007	-0.027	0.065
Millet Equation	Rice	-0.196	0.144	-0.045	0.028	0.023	0.137
	Millet	-0.243	0.342	-1.035	0.027	-0.514	0.162
	Maize	0.066	0.190	-0.034	0.028	1.146	0.281
	Sorghum	-0.259	0.161	0.059	0.037	-0.123	0.210
Maize Equation	Rice	0.071	0.059	-0.060	0.022	0.258	0.163
	Millet	0.002	0.068	0.009	0.027	0.208	0.197
	Maize	-0.996	0.068	-1.026	0.047	-0.946	0.338
	Sorghum	0.130	0.077	0.018	0.028	0.158	0.257
Sorghum Equation	Rice	0.034	0.088	-0.274	0.041	-0.286	0.260
	Millet	-0.265	0.174	0.077	0.050	-0.075	0.290
	Maize	0.242	0.085	-0.133	0.025	-0.098	0.337
	Sorghum	-1.014	0.122	-0.948	0.054	-0.658	0.244

Table A4-6. (cont'd)

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Compensated Price Elasticities							
Rice Equation	Rice	-0.277	0.060	-0.318	0.005	-0.241	0.052
	Millet	0.129	0.054	0.146	0.004	0.128	0.036
	Maize	0.098	0.031	0.096	0.007	-0.097	0.049
	Sorghum	0.130	0.022	0.067	0.004	0.089	0.027
Millet Equation	Rice	0.192	0.227	0.674	0.026	0.305	0.187
	Millet	-0.089	0.295	-0.860	0.027	-0.439	0.150
	Maize	0.124	0.064	0.063	0.014	0.651	0.145
	Sorghum	-0.077	0.123	0.128	0.025	-0.034	0.118
Maize Equation	Rice	0.567	0.126	0.580	0.042	1.299	0.471
	Millet	0.145	0.122	0.191	0.050	0.570	0.328
	Maize	-0.914	0.070	-0.945	0.048	-0.870	0.334
	Sorghum	0.215	0.085	0.111	0.034	0.245	0.263
Sorghum Equation	Rice	0.460	0.147	0.437	0.079	0.167	0.670
	Millet	-0.304	0.279	0.356	0.077	0.089	0.497
	Maize	0.300	0.091	0.000	0.019	-0.005	0.321
	Sorghum	-0.944	0.130	-0.828	0.056	-0.557	0.248

Source: Author.

Table A4-7. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Rural Income Group–Total Cereals Expenditures

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Expenditure Elasticities							
	Rice	0.654	0.021	1.006	0.032	1.001	0.004
	Millet	1.248	0.017	0.980	0.016	1.025	0.004
	Maize	1.030	0.018	0.867	0.026	1.014	0.006
	Sorghum	1.054	0.025	1.069	0.060	0.974	0.007
Uncompensated Price Elasticities							
Rice Equation	Rice	-0.781	0.017	-0.973	0.011	-0.991	0.003
	Millet	0.035	0.019	-0.017	0.038	-0.004	0.004
	Maize	-0.046	0.020	-0.006	0.011	-0.004	0.003
	Sorghum	0.052	0.027	0.000	0.024	0.003	0.003
Millet Equation	Rice	-0.145	0.014	-0.009	0.025	-0.024	0.005
	Millet	-1.010	0.028	-0.963	0.048	-0.993	0.005
	Maize	0.060	0.018	0.003	0.034	0.006	0.005
	Sorghum	-0.051	0.034	0.011	0.062	-0.008	0.004
Maize Equation	Rice	0.009	0.016	0.014	0.027	-0.017	0.007
	Millet	0.039	0.024	0.042	0.068	0.010	0.009
	Maize	-1.041	0.023	-0.940	0.049	-0.996	0.007
	Sorghum	-0.053	0.029	-0.088	0.098	-0.004	0.007
Sorghum Equation	Rice	0.035	0.035	-0.013	0.050	0.020	0.005
	Millet	-0.091	0.056	-0.004	0.093	-0.011	0.006
	Maize	-0.039	0.025	-0.072	0.085	-0.003	0.005
	Sorghum	-0.894	0.068	-0.945	0.160	-0.988	0.006

Table A4-7. (cont'd)

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Compensated Price Elasticities							
Rice Equation	Rice	-0.585	0.013	-0.607	0.015	-0.516	0.003
	Millet	0.291	0.020	0.335	0.025	0.286	0.003
	Maize	0.058	0.012	0.119	0.007	0.096	0.002
	Sorghum	0.148	0.018	0.167	0.019	0.141	0.002
Millet Equation	Rice	0.215	0.015	0.347	0.029	0.457	0.006
	Millet	-0.513	0.028	-0.622	0.046	-0.696	0.005
	Maize	0.202	0.013	0.122	0.024	0.104	0.003
	Sorghum	0.176	0.025	0.171	0.047	0.136	0.003
Maize Equation	Rice	0.326	0.025	0.338	0.041	0.451	0.012
	Millet	0.469	0.037	0.363	0.100	0.308	0.013
	Maize	-0.907	0.022	-0.834	0.050	-0.897	0.007
	Sorghum	0.117	0.034	0.048	0.105	0.136	0.008
Sorghum Equation	Rice	0.369	0.047	0.369	0.059	0.495	0.008
	Millet	0.298	0.078	0.367	0.134	0.266	0.008
	Maize	0.103	0.023	0.064	0.083	0.092	0.005
	Sorghum	-0.713	0.067	-0.768	0.155	-0.853	0.006

Source: Author.

Table A4-8. Estimated Parameters of the Censored QUAIDS Model for Cereals Demand by Place of Residence–Only Purchased Cereals Expenditure

	Urban			Rural		
	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Constants						
α_1	1.230	0.133	0.000	-0.579	0.157	0.000
α_2	0.854	0.244	0.000	-0.042	0.100	0.673
α_3	1.200	0.234	0.000	-0.018	0.253	0.944
α_4	-3.465	0.436	0.000	1.506	0.218	0.000
Expenditure						
β_1	-0.139	0.020	0.000	0.102	0.011	0.000
β_2	-0.112	0.043	0.010	0.029	0.014	0.038
β_3	-0.210	0.035	0.000	-0.062	0.029	0.030
β_4	0.514	0.071	0.000	-0.232	0.028	0.000
Prices						
γ_{11}	-0.122	0.036	0.001	-0.029	0.017	0.088
γ_{12}	-0.065	0.052	0.216	-0.034	0.008	0.000
γ_{13}	-0.189	0.033	0.000	-0.025	0.018	0.176
γ_{14}	0.477	0.099	0.000	0.152	0.029	0.000
γ_{22}	-0.146	0.071	0.039	0.033	0.011	0.002
γ_{23}	-0.183	0.084	0.029	0.003	0.018	0.884
γ_{24}	0.336	0.219	0.126	-0.005	0.025	0.837
γ_{33}	-0.252	0.101	0.013	-0.004	0.035	0.920
γ_{34}	0.747	0.243	0.002	0.017	0.040	0.670
γ_{44}	-2.121	0.590	0.000	-0.225	0.066	0.001
Expenditure Squared						
λ_1	0.006	0.001	0.000	-0.001	0.000	0.000
λ_2	0.007	0.002	0.000	0.001	0.000	0.140
λ_3	0.008	0.001	0.000	0.005	0.001	0.000
λ_4	-0.017	0.003	0.000	0.004	0.001	0.000
PDFs						
Rice	0.001	0.003	0.627	0.000	0.001	0.652
Millet	0.000	0.003	0.983	0.000	0.001	0.504
Maize	0.001	0.004	0.858	-0.001	0.002	0.751
Sorghum	-0.002	0.007	0.780	-0.002	0.001	0.021

Rice=1, millet=2, maize= 3 and sorghum=4. $\gamma_{23=}$ Equation i and commodity j. The regional dummy excluded in the estimation was Ségou (the reference region)

Table A4-8. (cont'd)

	Urban			Rural		
	Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
HH Adult Equivalent						
Rice	0.007	0.000	0.000	-0.012	0.002	0.000
Millet	-0.010	0.001	0.000	-0.006	0.001	0.000
Maize	0.005	0.003	0.073	0.007	0.004	0.109
Sorghum	-0.015	0.002	0.000	0.011	0.002	0.000
Regional Dummies						
Kayes						
Rice	0.014	0.012	0.232	0.791	0.083	0.000
Millet	-0.074	0.020	0.000	-0.422	0.059	0.000
Maize	0.063	0.060	0.297	-0.165	0.093	0.077
Sorghum	0.338	0.043	0.000	0.019	0.049	0.694
Koulikoro						
Rice	-0.025	0.018	0.177	0.566	0.067	0.000
Millet	-0.160	0.027	0.000	-0.121	0.031	0.000
Maize	0.013	0.069	0.853	-0.250	0.073	0.001
Sorghum	0.785	0.067	0.000	-0.070	0.029	0.017
Sikasso						
Rice	-0.169	0.033	0.000	0.656	0.077	0.000
Millet	-0.183	0.047	0.000	-0.820	0.092	0.000
Maize	0.184	0.127	0.147	0.414	0.113	0.000
Sorghum	0.184	0.056	0.001	0.233	0.074	0.002
Mopti						
Rice	-0.042	0.013	0.001	0.190	0.025	0.000
Millet	0.074	0.020	0.000	0.184	0.012	0.000
Maize	-0.089	0.037	0.016	-0.500	0.059	0.000
Sorghum	0.014	0.015	0.319	-0.022	0.042	0.603
Tombouctou						
Rice	0.057	0.018	0.002	-0.199	0.030	0.000
Millet	0.002	0.020	0.919	0.107	0.017	0.000
Maize	-0.041	0.167	0.808	-0.115	0.048	0.017
Sorghum	-0.657	0.074	0.000	0.133	0.059	0.023

Rice=1, millet=2, maize= 3 and sorghum=4. $\gamma_{23=}$ Equation i and commodity j. The regional dummy excluded in the estimation was Ségou (the reference region)

Table A4-8. (cont'd)

	Urban			Rural		
Gao						
Rice	-0.008	0.019	0.667	-0.465	0.089	0.000
Millet	0.028	0.028	0.317	0.038	0.054	0.479
Maize	-0.089	0.191	0.641	0.136	0.097	0.160
Sorghum	-0.010	0.033	0.752	-0.044	0.044	0.320
Bamako						
Rice	-0.027	0.011	0.013			
Millet	-0.063	0.017	0.000			
Maize	0.016	0.060	0.787			
Sorghum	0.504	0.049	0.000			
tau						
Rice	0.848	0.086	0.000	3.226	0.199	0.000
Millet	0.292	0.025	0.000	0.065	0.041	0.114
Maize	-0.036	0.126	0.775	0.195	0.145	0.178
Sorghum	1.496	0.131	0.000	-0.256	0.072	0.000

Rice=1, millet=2, maize= 3 and sorghum=4. $\gamma_{23=}$ Equation i and commodity j. The regional dummy excluded in the estimation was Ségou (the reference region)
tau - are the residuals from the reduced form regression of total cereal expenditure on the set of instruments and explanatory variables

Table A4-9. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Place of Residence—Only Purchased Cereals Expenditures

		Urban			Rural		
		Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Expenditure Elasticities							
	Rice	0.874	0.017	0.000	1.141	0.018	0.000
	Millet	0.826	0.108	0.000	1.060	0.024	0.000
	Maize	0.393	0.113	0.001	0.893	0.087	0.000
	Sorghum	2.817	0.228	0.000	0.401	0.074	0.000
Uncompensated Elasticities							
Rice equation	Rice	-0.898	0.016	0.000	-1.004	0.010	0.000
	Millet	0.032	0.018	0.086	-0.041	0.012	0.001
	Maize	0.047	0.042	0.261	-0.030	0.015	0.045
	Sorghum	-0.314	0.055	0.000	0.058	0.021	0.006
Millet Equation	Rice	0.208	0.057	0.000	-0.056	0.014	0.000
	Millet	-1.286	0.097	0.000	-0.937	0.019	0.000
	Maize	-0.110	0.094	0.239	0.009	0.025	0.738
	Sorghum	-0.373	0.081	0.000	-0.046	0.034	0.179
Maize Equation	Rice	-0.171	0.079	0.030	-0.123	0.062	0.049
	Millet	-0.442	0.177	0.012	-0.001	0.065	0.989
	Maize	-1.271	0.180	0.000	-0.995	0.126	0.000
	Sorghum	0.903	0.451	0.045	0.153	0.133	0.250
Sorghum Equation	rice	0.462	0.211	0.028	0.378	0.062	0.000
	Millet	0.691	0.498	0.165	-0.037	0.063	0.557
	Maize	1.406	0.481	0.003	0.054	0.070	0.441
	Sorghum	-4.658	1.184	0.000	-1.389	0.129	0.000

Table A4-9. (cont'd)

		Urban			Rural		
		Coef.	Std. Err.	P>|z|	Coef.	Std. Err.	P>|z|
Compensated Price Elasticities							
Rice equation	Rice	-0.307	0.011	0.000	-0.344	0.012	0.000
	Millet	0.176	0.014	0.000	0.302	0.008	0.000
	Maize	0.078	0.014	0.000	0.043	0.003	0.000
	Sorghum	-0.058	0.023	0.011	0.126	0.007	0.000
Millet Equation	Rice	0.858	0.113	0.000	0.518	0.021	0.000
	Millet	-1.140	0.107	0.000	-0.634	0.018	0.000
	Maize	0.005	0.047	0.907	0.047	0.007	0.000
	Sorghum	-0.150	0.045	0.001	0.075	0.020	0.000
Maize Equation	Rice	-0.241	0.269	0.370	-0.211	0.341	0.535
	Millet	-0.841	0.378	0.026	0.252	0.213	0.238
	Maize	-1.243	0.185	0.000	-0.957	0.126	0.000
	Sorghum	1.089	0.522	0.037	0.370	0.255	0.146
Sorghum Equation	Rice	3.073	0.609	0.000	1.425	0.176	0.000
	Millet	1.709	0.910	0.060	0.045	0.114	0.691
	Maize	1.399	0.422	0.001	0.045	0.035	0.197
	Sorghum	-4.443	1.169	0.000	-1.352	0.135	0.000

Source: Author.

Table A4-10. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Urban Income Group—Only Purchased Cereals Expenditures

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Expenditure Elasticities							
	Rice	0.991	0.006	1.096	0.017	1.075	0.014
	Millet	1.239	0.132	1.203	0.050	0.905	0.035
	Maize	1.003	0.088	0.643	0.073	1.716	0.210
	Sorghum	1.901	0.229	-0.151	0.231	0.719	0.091
Uncompensated Price Elasticities							
Rice Equation	Rice	-0.928	0.018	-1.281	0.102	-1.079	0.019
	Millet	0.034	0.013	0.330	0.112	0.017	0.014
	Maize	-0.023	0.010	0.264	0.126	-0.048	0.035
	Sorghum	-0.069	0.021	-0.260	0.111	0.084	0.021
Millet Equation	Rice	-0.051	0.078	0.773	0.331	0.156	0.044
	Millet	-1.221	0.069	-1.719	0.323	-1.029	0.030
	Maize	-0.013	0.046	-0.854	0.347	0.414	0.078
	Sorghum	0.212	0.083	0.623	0.356	-0.269	0.056
Maize Equation	Rice	-0.055	0.031	0.341	0.312	0.438	0.071
	Millet	-0.071	0.051	-1.410	0.465	0.202	0.082
	Maize	-0.967	0.051	-0.455	0.385	-0.926	0.368
	Sorghum	0.050	0.093	0.502	0.399	-0.482	0.188
Sorghum Equation	Rice	-0.438	0.101	-0.128	0.322	0.180	0.071
	Millet	0.053	0.127	0.931	0.529	-0.229	0.054
	Maize	0.161	0.094	-0.750	0.381	-0.334	0.136
	Sorghum	-2.013	0.396	-1.967	0.689	-0.777	0.120

Table A4-10. (cont'd)

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Uncompensated Price Elasticities							
Rice Equation	Rice	-0.261	0.016	-0.535	0.105	-0.354	0.016
	Millet	0.200	0.009	0.427	0.081	0.205	0.010
	Maize	0.066	0.003	0.174	0.045	0.055	0.013
	Sorghum	0.050	0.007	-0.037	0.052	0.118	0.009
Millet Equation	Rice	0.754	0.055	1.879	0.453	0.820	0.048
	Millet	-0.998	0.059	-1.514	0.323	-0.867	0.031
	Maize	0.084	0.028	-0.334	0.172	0.286	0.041
	Sorghum	0.202	0.042	0.494	0.229	-0.077	0.032
Maize Equation	Rice	0.486	0.085	1.387	0.873	2.244	0.206
	Millet	0.025	0.102	-2.754	0.945	0.681	0.142
	Maize	-0.894	0.052	-0.409	0.384	-0.808	0.382
	Sorghum	0.132	0.102	0.706	0.521	-0.354	0.181
Sorghum Equation	Rice	-0.034	0.201	-0.376	0.816	0.926	0.154
	Millet	0.444	0.269	1.421	0.789	-0.290	0.108
	Maize	0.278	0.088	-0.585	0.299	-0.280	0.137
	Sorghum	-1.873	0.379	-1.979	0.702	-0.721	0.115

Source: Author.

Table A4-11. Estimated Elasticities of the Censored QUAIDS Model for Cereals Demand by Rural Income Group—Only Purchased Cereals Expenditures

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Expenditure Elasticities							
	Rice	0.994	0.001	1.054	0.032	0.919	0.026
	Millet	0.955	0.010	1.199	0.073	1.015	0.209
	Maize	1.071	0.015	0.095	0.418	2.151	0.316
	Sorghum	1.108	0.032	0.777	0.369	2.462	0.489
Uncompensated Price Elasticities							
Rice Equation	Rice	-1.002	0.002	-0.926	0.035	-0.963	0.115
	Millet	-0.005	0.002	-0.095	0.061	0.217	0.105
	Maize	0.002	0.001	-0.117	0.058	-0.295	0.147
	Sorghum	0.002	0.002	0.197	0.096	0.161	0.188
Millet Equation	Rice	0.012	0.003	-0.143	0.061	0.309	0.123
	Millet	-1.004	0.006	-1.008	0.082	-1.535	0.206
	Maize	-0.010	0.008	0.217	0.154	0.116	0.290
	Sorghum	0.017	0.008	-0.078	0.159	-0.117	0.364
Maize Equation	Rice	-0.004	0.001	-0.180	0.110	-0.614	0.415
	Millet	-0.013	0.014	0.462	0.460	0.236	0.820
	Maize	-0.985	0.014	-1.635	0.708	-2.713	1.368
	Sorghum	0.009	0.021	0.059	0.247	-1.254	0.718
Sorghum Equation	Rice	-0.016	0.005	0.398	0.168	0.391	0.460
	Millet	0.030	0.014	-0.110	0.316	-0.177	0.577
	Maize	0.009	0.020	0.029	0.200	-0.359	0.549
	Sorghum	-1.057	0.025	-1.310	0.315	-2.459	0.732

Table A4-11. (cont'd)

		Low-Income		Middle-Income		High-Income	
		Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Uncompensated Price Elasticities							
Rice Equation	Rice	-0.429	0.002	-0.324	0.038	-0.425	0.107
	Millet	0.274	0.001	0.258	0.036	0.403	0.074
	Maize	0.052	0.000	0.020	0.009	-0.025	0.031
	Sorghum	0.092	0.000	0.159	0.030	0.148	0.073
Millet Equation	Rice	0.575	0.003	0.438	0.095	1.055	0.260
	Millet	-0.738	0.007	-0.652	0.085	-1.251	0.192
	Maize	0.047	0.002	0.103	0.042	0.079	0.091
	Sorghum	0.097	0.003	0.073	0.084	0.028	0.219
Maize Equation	Rice	0.581	0.012	-1.089	0.714	-1.621	1.916
	Millet	0.244	0.061	1.731	1.598	1.343	2.562
	Maize	-0.929	0.014	-1.631	0.720	-2.624	1.364
	Sorghum	0.116	0.040	0.121	0.473	-2.070	1.302
Sorghum Equation	Rice	0.572	0.010	1.765	0.533	2.450	1.246
	Millet	0.371	0.036	0.020	0.532	0.384	0.978
	Maize	0.062	0.010	0.044	0.113	-0.096	0.294
	Sorghum	-0.955	0.023	-1.236	0.345	-2.228	0.712

Source: Author.

CHAPTER 5. WELFARE EFFECTS OF CEREAL PRICE SHOCKS IN MALI

5.1. Problem Statement

Rice, millet, maize and sorghum are primary staple foods in Mali. Increases in cereals prices are likely to have substantial negative impacts on the poor (see Ivanic and Martin, 2008; Joseph and Wodon, 2008; Wodon and Zaman, 2010). Limited empirical evidence on aggregate as well as micro-level demand parameters differentiated by important household characteristics (e.g., household place of residence) in Mali places a limit on policy makers' ability to make informed food policy decisions. If policymakers are to intervene to help those most adversely impacted by food price changes, then policymakers need to identify those who have been most harmed and the magnitude of that harm (Friedman and Levinsohn, 2002). Effective design of targeted actions therefore requires knowledge of the distribution of the effects of changes in income as well as other factors that determine food demand across different segments of the population.

5.2. Research Objectives

The goal of this chapter is to estimate the welfare effects of cereals price shocks, allowing for second-order demand responses (substitution in demand) to cereal price changes. The study is focused on the relative differences in the welfare effect of cereals price shocks across income distribution and place of residence, with the goal to determine households that are most likely affected by cereals price changes. Specifically, the analysis seeks to:

- Link observed cereals price changes to changes in household welfare using the household cereals demand parameters estimated in chapter 4 (that take into account differences in household socio-economic and demographic characteristics, geographic location, and place of residence) to compute a welfare measure for a cereal price change. The welfare measure used in this study is a proportional compensating variation (CV) adapted from de Janvry, et al. (2008) and that allows for substitutions in consumption.

- Distinguish the welfare effects of cereals price changes by place of residence and household per capita expenditure group.

5.3. Literature Review

A vast literature exists on the welfare implications of food price increases. The welfare effects of changes in food prices on households can be traced through three principal channels: by affecting the affordability of an important component of the consumption basket; by affecting the returns from farming, insofar as the household is directly engaged in this activity; and by affecting the demand for labor in agriculture and thus the wage income of household members who work for agricultural producers (Aksoy and Hoekman, 2010). A fourth pathway is described in Lele and Mellor (1972) and includes the effect of food prices on real wages and hence the impact on the demand for labor in non-agricultural activities. Deaton (1989) observed that, as many households in developing countries are both producers and consumers, the net impact of price changes is determined by which effect is greater: whether the household is a net consumer/buyer or a net producer/seller.

There has been a general consensus in the literature that first-order approximations which focus only on the direct effects on consumption of a good resulting from a change in its price may not be enough in evaluating the welfare consequences of food price changes. For instance Mghenyi et al. (2011) argue that first-order approximation approaches may be restrictive for evaluating the welfare effect of a large discrete price change because supply and demand responses to a major price change may be substantial. When the price of a food item increases, consumers can switch to cheaper/more affordable items or producers can respond to the increase by expanding supply or reallocating inputs to capture the increase in price.

While most urban households rely on the market for almost all of their food needs, most rural households, in contrast, are both food producers and consumers. Thus, in urban areas while changes in food prices directly affect the affordability of the food for which the price has increased, in the rural areas a food price increase hurts them as consumers on one hand, but on the other hand, it has the potential of raising the incomes of food-producing households and even that of non-food producing households through multiplier effects. Ideally, one would need to account for second-order effects that examine not only substitution effects in consumption but also the effects on production of food price increases, as well as the dynamic aspect (multiplier effects— e.g., wage effects) of the food price changes (Nouve and Wodon,2008; Porto, 2005;and Porto, 2010).

Notwithstanding, the specific approach used in examining the welfare impacts of food price changes has been influenced by data availability and whether the interest is in measuring short, medium or long-term effects; or static as opposed to dynamic effects. Using household budget survey data for Mali, Joseph and Wodon (2008) provide an assessment of the short-term impact on poverty of the increase in the price of cereals. Specifically, they examine, using statistical analysis and non-parametric methods, both the impact on food producers (who benefit from an increase in prices) and food consumers (who lose out when the price increases), with a focus on poor producers and consumers. They provide estimates of the impact on poverty of higher food prices based on a number of assumptions. First, they assume that the cost of an increase in food prices for a household translates into an equivalent reduction of its consumption in real terms–they do not take into account the price elasticity of demand which may lead to substitution effects and thereby help offset part of the negative effect of higher prices for certain food items. Second, they assume an increase for producers in the value of their net sales of food translates into an increase of their consumption of equivalent size. Third, they assume that changes in prices do not affect households when food is home-produced and consumed. To assess impacts, they compare poverty measures obtained after the increase in prices to baseline poverty measures. This implicitly means that they do not take into account the potential spill-over effects of the increase in food prices for the food items included in the analysis on the prices for items not included.

Nouve and Wodon (2008) took a step further in the work done by Joseph and Wodon (2008) and in a dynamic general equilibrium framework estimate the broader medium-term impact of higher rice prices in Mali on poverty. They compare a base scenario (business as usual) to six different scenarios that combine rice price changes and policy responses (import tax cuts on rice and measures to increase productivity of domestic rice production). They find that considering either an 80%[40] or a 110%[41] increase in international rice prices from the level in 2006, a 15%[42] an increase in productivity will have a larger impact than a 100% reduction in taxes.   The current study uses the same household survey data as Joseph and Wodon. However, unlike Joseph and Wodon (2008), the study considers own-price and cross-price demand effects in examining the welfare effects of cereals price changes. The data set covers 1566 urban households and 2888 rural households in Mali taken from the 2006 ELIM, as described in Chapter 4. The presence of rural households (the majority of whom are food producers and

[40] This is the level of the increase actually observed in CFAF in 2008.
[41] This is the level of the increase in US dollar terms.
[42] An arbitrary level of productivity gains chosen for illustrative purposes.

consumers) warrants taking into consideration the effects of cereal price increases on cereals demand and supply. The estimation of household supply response to food price changes, however, requires detailed production information (e.g., production quantities/value and shares by crop and by household, supply elasticities, etc.) which are not available in the ELIM-2006 data file. While it would be appropriate to estimate the overall welfare changes (i.e., including producer welfare), due to data limitations on the supply side, welfare estimation in this chapter is limited only to the consumption response (direct and substitution effects). Producer supply response and wage effects are not taken into consideration. Consequently, the estimated impact is considered the upper-limit of the effect of cereal price shocks on welfare.

5.4. Methodological Approach and Data

To evaluate the partial equilibrium welfare effect of cereals price changes from an initial price level, the analysis measures a proportional compensating variation of a price change which takes into account demand responses to a change in price. The formula for the second-order approximation is adapted from de Janvry and Sadoulet (2008) and also used by Friedman and Levinsohn (2002). Starting from a household's indirect utility function, which reflects the household's consumption components, a second-order Taylor expansion to the indirect utility function is used to derive a welfare measure that accounts for demand responses. The idea is that using a set of reference prices, we can compute how well-off or worse-off households are as a result of the price changes, moving from their initial utility level to the new utility level in response to the changes in cereals prices. The CV is the difference between the minimum expenditure required to achieve the original utility level (2006) at the new prices, and the initial total expenditure–i.e., the amount of money the household would need to be given at the new set of (higher) prices in order to attain the initial level of utility (2006). Approximated using a second-order Taylor expansion of the minimum expenditure function, the CV is written as:

$$CV \approx \sum_{i=1} w_i^d \, dlnp_i + 0.5 \left[\sum_{i=1} \sum_{j=1} w_i^d e_{ij}^d (dlnp_i)(dlnp_j) \right] \qquad (5-1)$$

Estimates of the compensated own (e_{ii}^d) and cross-price elasticities (e_{ij}^d) of demand for rice, maize, millet and sorghum by place of residence and income group are all available from chapter 4. The share of each cereal type in the household's food budget in the initial period – 2006 (w_i^d) is directly calculated from the survey data. $dlnp_i$ approximates the proportionate change in the price of commodity *i*. The first-order effect is captured by the first term in equation 5-1, and it implicitly assumes zero demand elasticities (i.e., household consumption behavior remains unaltered with price changes). The second-order effect depends on the compensated price elasticities. From equation 5-1 it is clear that the second-order effects depend on the magnitude of the price change as well as the relative importance of the product in purchases in the household's budget. Ideally, household-specific estimates are required for the computation of household specific proportional welfare effects from price changes. To account for consumption responses, we estimate first and second-order impacts using the budget shares and the compensated demand elasticities.

Table 5-1. Average Consumer Price Changes Compared to 2006 (%)

Period	Rice	Millet	Maize	Sorghum	Average
2008	21	9	17	10	14
2009	21	21	28	21	23
2010	16	15	20	14	16
2011	23	19	30	23	24

Source: Author's computation using price data from OMA-Mali.

The welfare measure is computed jointly for rice, millet, sorghum and maize because these are the cereals for which average consumption is highest. The welfare measure is computed by comparing cereals prices observed in 2006 (the year in which the HBS was collected-reference prices) to prices observed in each of the years 2008, 2009, 2010 and 2011[43]. Price data at the administrative unit level for 2006 to 2011 were obtained from Mali's Observatoire du Marche Agricole (OMA). Given the constructed nature of the observed price changes, variations in prices within a given year are mainly due to differences in geographic region. However, the year-to-year variations in prices are due to factors other than geographic location–e.g., supply conditions. Price changes were computed at the district or "cercle" as the natural logarithm of the ratio of the price in year t+1 to the price in year t, i.e., $dlnP_i = ln(p_{it+1}/P_{it})$. Table 5-1 summarizes the average price changes for all locations covered by ELIM-2006. Average price rose rapidly for all cereals over time but maize price changes were more dramatic compared to the other cereals. The estimated increase in the price of rice in 2008 is in line with Nouve and Wodon's estimate of an increase in the average price of rice (covers both imported and locally produced rice) of 21 percent in 2008 against the base scenario (2006).

[43] Comparing 2007 to 2006, price changes were 0% for rice, -11% for millet, -7% for maize and -5% for sorghum.

5.5. Findings

The welfare effects of cereal price changes observed from 2008 to 2011 were estimated by place of residence and per capita income group to illustrate variations across different segments of the population. Table 5-2 presents the welfare measure as a share of total household cereals expenditure in 2006 by place of residence. The table reports both the first-order and the full effect (first plus second-order effects) considering all four cereals (rice, millet, sorghum and maize) and the substitution responses among them.

Table 5-2. Compensating Variation of Cereals Price Changes by Place of Residence
(% of Total Cereals Expenditures)

	Urban		Rural	
	First-order	Full Effect	First-order	Full Effect
2008	18.0	17.7	15.8	15.5
2009	22.2	22.0	22.9	22.7
2010	16.7	16.6	16.5	16.2
2011	23.0	22.8	23.7	23.4

Source: Author.

The figures reported in Table 5-2 illustrate that the first-order approximation of the impact of price changes which implicitly assumes that households are unable to change their consumption patterns when prices change (equivalent to assuming that all elasticities are zero), captures almost all of the impact of price changes on welfare. It has been argued that ignoring consumption responses (substitution effects in consumption) in welfare analysis (the second-order approximation) may lead to significant biases and inappropriate inferences (Friedman and Levinsohn, 2002). However, as seen from the table above, there is not much difference between the first-order and the fuller impacts of cereals price changes considering the urban and rural sub-samples. This reflects the fact that during this period all cereals prices were rising sharply, limiting the scope for substitution to “cheaper” cereals. Across all the years, the first-order impact was larger than the full impact by less than 1%. Thus, consistent with a priori expectations, the first-order effect overstates, albeit marginally, the welfare losses for urban and rural households.

Furthermore, on examining differences in the full effect between the rural and the urban sample, we notice that in 2008 and 2010, the full effect was higher in the urban than the rural areas, while in 2009 and 2011 the rural full effects were larger than the urban full effects. Looking at Table 5-2, we observe that the changes vary year to year and track remarkably the unweighted average of price changes of all cereals from year to year as reported in Table 5-1. Although the figures displayed in Table 5-2 do not reveal much difference between the urban and the rural population in the percentage compensation based on total household cereals expenditures in 2006, the actual magnitude of the welfare losses from cereals price changes by place of residence are quite substantial and different by place of residence. As seen from Table 4-13, average annual expenditure on cereals per household in 2006 is 320,306 CFAF (593 US $) in the urban area and 313,797 CFAF (581 US $) in the rural area. Also, as revealed by the data, average annual total consumption expenditure (proxy for income) is 3,039,927 CFAF (5,624 US $) per household in the urban area and 1,328,788 CFAF (2,458 US $) in the rural area. Thus, cereals account for an average of 10.5% of urban and 23.6% of rural total household consumption expenditures. Based on these figures, the actual magnitude of the welfare loss from cereals price changes (effect on total cereals expenditure and effect on total household consumption expenditure) are computed and reported in Table 5-3. In 2008 for instance, considering the full welfare impact, on average urban households had to be compensated by 17.7% (56,719 CFAF=105 US $) while rural households had to be compensated by 15.5% (48,697 CFAF = 90 US $) of their total cereals expenditures in 2006. This is equivalent to saying that the observed price changes in 2008 would result in a compensation of urban households of about 1.9% and rural households of about 3.7% of their 2006 total household consumption expenditures (proxy for income). The figures in Table 5-3, therefore, show the adverse effect of the higher prices on Malian population–essentially, everyone got approximately a 2-6% income reduction because of the higher cereals prices. The welfare loss from higher cereals prices was greater in the rural area than the urban area without considering the possibility of producer supply response in the rural areas. However, because many other prices (e.g., of other foods and of energy) also increased sharply during this period, the impact of what became known in Mali as the "crisis of the high cost of living" was greater than that indicated by just the cereal price increases.

Table 5-3. Magnitude of Welfare Loss Implied by Cereals Price Changes by Place of Residence

	Urban			Rural		
Year	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006
2008	17.7	56,719 (105)	1.9%	15.5	48,697 (90)	3.7%
2009	22.0	70,506 (131)	2.3%	22.7	71,132 (132)	5.4%
2010	16.6	53,037 (98)	1.7%	16.2	50,798 (94)	3.8%
2011	22.8	72,999 (135)	2.4%	23.4	73,523 (136)	5.5%

Source: Author. Note: The figures in parenthesis are US dollar equivalents.

Table 5-4 shows first-order and the full effect by place of residence and per capita income group considering all cereals and substitution amongst them. The welfare measure of cereals price changes (in a similar manner to the expenditure shares shown in Table 4-19) do not show much difference across per capita income groups within a given place of residence in terms of percentage in total cereals expenditures in 2006. However, in absolute terms the impacts differ widely.

Table 5-4. Compensating Variation of Cereals Price Changes by Place of Residence and Income Group (% of Total Cereals Expenditures)

	Urban		Rural	
	First-order	Full Effect	First-order	Full Effect
	Low-Income Group			
2008	18.1	17.8	15.2	15.0
2009	22.8	22.6	23.6	23.4
2010	16.3	16.2	16.8	16.7
2011	22.9	22.7	23.5	23.3
	Middle-Income Group			
2008	18.2	18.0	15.7	15.4
2009	22.0	21.9	23.0	22.7
2010	16.8	16.7	16.6	16.3
2011	23.1	22.8	24.0	23.6
	High-Income Group			
2008	17.8	17.5	16.5	16.2
2009	21.7	21.8	22.0	21.7
2010	17.0	17.0	16.0	15.6
2011	23.2	23.1	23.7	23.3

Source: Author's computation.

Based on the average annual household total consumption expenditures (proxy for income) by place of residence and per capita income group as shown in Table 4-7, and the average annual household expenditures on cereals by place of residence and income group as shown in Table 4-13, the estimated welfare losses from higher cereals prices by place of residence and income group are as shown in Table 5-5.

In the urban population, the absolute values of the welfare losses based on average expenditures on cereals in 2006 increases from the low- to the middle-income group but declines from the middle- to the high-income group. However, the percentage of household income of the welfare loss is lowest for the high-income group and largest for the low-income group. In 2008 for instance, urban low-income households had to be compensated by about 3.7% of their average 2006 total household consumption expenditures; urban middle-income households had to be compensated by about 2.5% of their average 2006 total household consumption expenditures; while urban high-income households had to be compensated by about 1.0% of their average 2006 total household consumption expenditures (Table 5-5).

In the rural population, the absolute value of the welfare loss based on average household cereals expenditures in 2006 increased from the low- to the high-income households. However, like in the urban group, the loss in percentage terms based on total household expenditures generally declined from the low- to the high-income group. In 2009 for instance, the percentage compensation based on average total household consumption expenditures in 2006 was 6.5% for rural low-income households; 6.3% for rural middle-income households, and 4.2% for the rural high-income households. Thus, in both the rural and the urban locations, the welfare loss from observed price changes in the period 2008 to 2011 (as a proportion to total household consumption expenditures) was greater for poorer households than richer households. Also, one might argue that the capacity of a poor family to absorb an X% reduction in income is lower than that of a rich household.

Table 5-5. Magnitude of Welfare Loss Implied by Cereals Price Changes by Place of Residence and per Capita Income Group

	Urban			Rural		
Year	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006
	Low-Income			Low-Income		
2008	17.8	51,000 (95)	3.7%	15.0	33,293 (62)	4.1%
2009	22.6	64,753 (120)	4.7%	23.4	51,937 (96)	6.5%
2010	16.2	46,416 (86)	3.4%	16.7	37,066 (69)	4.6%
2011	22.7	65,040 (121)	4.7%	23.3	51,715 (96)	6.4%
	Middle- Income			Middle- Income		
2008	18.0	66,280 (123)	2.5%	15.4	52,646 (98)	4.3%
2009	21.9	80,640 (150)	3.1%	22.7	77,602 (144)	6.3%
2010	16.7	61,493 (114)	2.3%	16.3	55,723 (103)	4.5%
2011	22.8	83,954 (156)	3.2%	23.6	80,678 (150)	6.5%
	High-Income			High-Income		
2008	17.5	53,583 (99)	1.0%	16.2	61,179 (114)	3.1%
2009	21.8	66,749 (124)	1.3%	21.7	81,949 (152)	4.2%
2010	17.0	52,052 (97)	1.0%	15.6	58,913 (109)	3.0%
2011	23.1	70,729 (125)	1.4%	23.3	87,992 (163)	4.5%

Source: Author.
Note: The figures in parenthesis are US dollar equivalents.

To check the validity of the estimated welfare impact by income group and place of residence, given that: a) rice is the most important share in the cereals budget for both the rural and urban households; and also b) that the largest difference in budget share between the rural and the urban place of residence are noticeable in the case of rice, the full effect of rice price changes were also computed (i.e., taking into account the share of rice and the response of rice and the other cereals to changes in rice prices). Table 5-6 reports the first-order or immediate response to changes in rice prices as well as the full effect of rice price changes, by place of residence.

Table 5-6. Compensating Variation Implied by Rice Price Changes by Place of Residence (%)

	Urban		Rural	
	First-order	Full-Effect	First-order	Full Effect
2008	13.8	13.5	7.2	6.8
2009	14.1	13.9	7.1	6.8
2010	11.0	10.8	5.0	4.9
2011	15.3	15.2	8.0	7.7

Source: Author's calculations.

As shown in Table 5-6, urban and rural households suffered welfare losses from higher rice prices in the period 2008-2011. The first-order effect marginally overstates the welfare losses for urban households. The results reveal some heterogeneity in the impact of higher rice prices by place of residence. In terms of percentage compensation based on average expenditures on cereals in 2006, the burden of higher rice prices fell more on urban households than rural households. On average, urban (rural) households require a compensation of about 13.5% (6.8%) in 2008, 13.9% (6.8%) in 2009, 10.8% (4.9%) in 2010 and 15.2% (7.7%) in 2011 of their 2006 cereals budget for the higher rice prices they faced in 2008, 2009, 2010 and 2011 respectively. Thus, the results indicate that the relative impact of higher rice prices is more adverse for urban households than for rural households. This is not surprising because of the much larger share of rice in the urban food budget.

Examining the magnitude of the welfare loss by place of residence, we observe that the actual value of the compensation required to bring the households to their 2006 cereals expenditure level is higher in absolute terms for urban households than rural households (Table 5-7). However, because average total household consumption expenditures and average total household cereals expenditures in 2006 are much higher for urban households than rural households, the percentage of the compensation based on the average total household consumption expenditures in 2006 is slightly lower for the urban than for rural areas. Hence, although the actual amount of the compensation is higher for urban households than rural households, the percentage reduction in total household expenditure (proxy for income) is greater for rural households than urban households.

Table 5-7. Magnitude of Welfare Loss Implied by Rice Price Changes by Place of Residence

	Urban			Rural		
Year	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006
2008	13.5	43,242 (80)	1.4%	6.8	21,338 (40)	1.6%
2009	13.9	44,523 (83)	1.5%	6.8	21,338 (40)	1.6%
2010	10.8	34,593 (64)	1.1%	4.9	15,376 (29)	1.2%
2011	15.2	48,687 (90)	1.6%	7.7	24,162 (45)	1.8%

Source: Author.
Note: The figures in parenthesis are US dollar equivalents.

Examining the distributional impacts of rice price changes by income groups and place of residence (Table 5-8), we observe some differences across income groups within the same location. Generally, across all income groups, the full welfare effects of rice price changes are higher in the urban area than in the rural area across all years. However, regarding the absolute magnitude of the welfare losses to households by place of residence and per capita income groups, we observe that in the urban area the absolute amount of the required compensation increases from the low- to the middle-income group but declines from the middle-income group to the high-income group (Table 5-9). The percentage reduction in total household consumption expenditures also declined from the low-income urban group to the high-income urban group, implying a negative relationship between per capita income group and percentage reduction in total household consumption expenditures as a result of a change in the price of rice.

Table 5-8. Welfare Effects of Rice Price Increases by Place of Residence and Income Group (%)

	Urban		**Rural**	
	First-order	Full Effect	First-order	Full Effect
	Low Income			
2008	12.2	12.0	5.5	5.3
2009	12.1	12.1	5.4	5.3
2010	9.0	8.9	3.6	3.5
2011	12.8	12.8	5.9	5.9
	Middle-Income			
2008	14.5	14.2	6.9	6.6
2009	14.8	14.6	6.7	6.6
2010	11.5	11.4	4.7	4.3
2011	16.2	16.1	7.5	7.4
	High-Income			
2008	14.6	14.3	9.3	8.9
2009	15.3	14.9	9.2	8.8
2010	12.3	12.3	6.8	6.4
2011	17.0	16.6	10.4	10.2

Source: Author.

Table 5-9. Magnitude of Welfare Loss Implied by Rice Price Changes by Place of Residence and per Capita Income Group

	Urban			Rural		
Year	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006	CV (Full impact) in %	Value of compensation based on 2006 average cereals expenditure (CFAF)	Percent of average total household consumption expenditure in 2006
	Low-Income			Low-Income		
2008	12.0	34,382 (64)	2.5%	5.3	11,763 (22)	1.5%
2009	12.1	34,669 (64)	2.5%	5.3	11,763 (22)	1.5%
2010	8.9	25,500 (47)	1.9%	3.5	7,768 (14)	1.0%
2011	12.8	36,674 (68)	2.7%	5.9	13,095 (24)	1.6%
	Middle- Income			Middle- Income		
2008	14.2	52,287 (97)	2.0%	6.6	22,563 (42)	1.8%
2009	14.6	53,760 (100)	2.0%	6.6	22,563 (42)	1.8%
2010	11.4	41,977 (78)	1.6%	4.3	14,700 (27)	1.2%
2011	16.1	59,284 (110)	2.3%	7.4	25,297 (47)	2.0%
	High-Income			High-Income		
2008	14.3	43,785 (81)	0.9%	8.9	33,611 (62)	1.7%
2009	14.9	45,622 (85)	0.9%	8.8	33,233 (62)	1.7%
2010	12.3	37,661 (70)	0.7%	6.4	24,169 (45)	1.2%
2011	16.6	50,827 (94)	1.0%	10.2	38,520 (71)	2.0%

Source: Author.
Note: The figures in parenthesis are US dollar equivalents.

Within the rural place of residence, we observe an increase in the percentage compensation based on average total cereals expenditures in 2006 (full effect) required from rice price changes as we move from the low- to the high-income groups. Additionally, we observe that the actual magnitude of the compensation based on average expenditure on cereals in 2006 increases from the low- to the high-income rural population groups (Table 5-9).

In 2011 for instance, low-income rural households would need compensation of 13,095 CFAF (24 US $) to leave them indifferent to the price changes, the middle-income rural needed compensation of 25,297 CFAF (47 US $), while the high-income rural population needed compensation of 38,520 CFAF (71 US $). In terms of the percentage of the compensation in total household consumption expenditures, the welfare losses were almost of the same magnitude in the middle- and high-income rural population but lower in the low-income rural households. Thus, the high- and middle-income rural households would have had to be compensated by a slightly higher percentage of their total income following a change in the price of rice compared to the low-income households to leave their welfare unaffected by the price hikes. The explanation for this pattern is the increasing rice expenditure (Table 4-18) and expenditure shares (Table 4-19) as rural households get richer.

Overall, we observe that all households are adversely affected by cereals price changes. However, considering all four cereals and the substitution between them, there are not many differences in the estimated full effects by place of residence and per capita income group in terms of relative shares of the cereals budget. Although the actual value of the welfare loss as a percentage of total household cereals expenditure in 2006 is higher amongst urban households than rural household, the magnitude of the welfare loss based on the percentage of average total household consumption expenditures were higher for rural households than urban households.

The analysis by place of residence shows that the adverse effect of the higher cereals prices on Malian population ranged from a 1.7 to 5.5% income reduction, without considering the possibility of producer supply response. Examining welfare losses by place of residence and per capita income groups reveals that in the urban population the percentage reduction in total household expenditure is lowest for the high-income group and largest for the low-income group. In the rural population, the welfare loss in terms of percentage reduction in total household expenditures in most cases declined from the low- to the high-income group.

Because of its importance in the Malian food basket in terms of consumption shares, rice was isolated for the welfare impact evaluation to see whether there are any variations in welfare effect by place of residence. The full effect of rice price changes revealed that rice accounts for a substantial part of the overall welfare effect implied by higher cereals prices. Estimates of the full effect of rice price changes taking into account rice consumption share and the response of rice and other cereals to changes in rice prices show some heterogeneity in the impact of higher rice prices by place of residence. In terms of percentage in the 2006 average total household cereals budget, the burden of higher rice prices fell more on urban households than rural households. This result was not surprising giving that the share of rice in cereals budget was about 20% larger in the urban location than in the rural location. Examining the magnitude of the welfare loss from higher rice prices by place of residence reveals that although the actual amount of the compensation is higher for urban households than rural households, rural households would have to be compensated by a greater percentage of the average of their 2006 total household consumption expenditures than urban households.

Still considering the welfare effects of rice price changes only, we observe a general increase in the full effect across per capita income groups within a particular place of residence in terms of relative shares in the cereals budget. The distributional impacts of higher rice prices by income group and place of residence reveal a decline in the percentage income reduction from the low- to the high-income urban group. In the rural population, the reductions in total household expenditures emanating from higher rice prices are quite similar in the middle- and high-income group, but smaller in the low-income rural group. The increasing in welfare loss (in terms of percentage in total household expenditures) from a change in the price of rice from the rural low- to the rural high-income group reflects increasing rice expenditure and rice expenditure shares with growth in rural per capita income.

CHAPTER 6. SUMMARY OF MAJOR FINDINGS AND IMPLICATIONS FOR THE FOOD SECURITY POLICIES IN MALI

6.1. Summary of Major Findings and Policy Implications

The goal of this study was to examine trends and determinants of food consumption patterns in West Africa and draw some implications for the design of food security policies. Knowledge of food demand parameters and of how consumption patterns have changed over time is critical for informed food policy making. However, in WA, information on food demand parameters is limited, thus restricting policymakers' ability to make sound food policy decisions. One ultimate goal of the analysis of food consumption patterns is to improve the efficiency of government interventions by providing policymakers, for example, with suggestions for the design of food security policies compatible with targeting people based on the nature and extent of food insecurity.

As defined by FAO (2006), "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". Food security is a broad concept which cuts across many dimensions. The four main dimensions of food security extracted from this definition are: sufficient quantities available for consumption, sustained access to food by each individual (adequate resources to obtain appropriate foods for a nutritious diet), effective utilization, and stable food supply (FAO, 2006). Simply put, people are food insecure when they do not "eat right" due to a lack of either physical or monetary access to food. Diaz-Bonilla et al. (2000) also observe that while food availability and access are preconditions for adequate utilization, they do not determine unequivocally the more substantive issue of malnutrition and nutrition security at the individual level. Furthermore, from an economist's point of view, access to food depends on income, prices, and distance to local food markets.

Chapter 2 in this study explores physical food sufficiency, measured through aggregate-level food supply indicators. Specifically, the chapter analyzes aggregate-level trends in per capita food availability in the ECOWAS countries of West Africa using a descriptive approach and per capita food availability data from FAO's FBS covering the period 1980-2009. With respect to the aggregate-level trend in per capita daily energy availability (DEA), the analysis reveals: 1) an overall pattern of shift towards greater calorie availability in the region; 2) a remarkably positive growth in per capita DEA over time amongst the countries that have experienced strong economic performance, like Ghana and Nigeria; and 3) less favorable trends in per capita DEA in countries that have experienced civil disruption, like Liberia, Sierra Leone and Cote d'Ivoire. Per capita DEA has been widely used in the literature as one of the main determinants of national food availability (Smith and Haddad, 2000). As a national average, DEA is sometimes viewed as an imperfect indicator of the state of individual food security. However, empirical evidence, such as that provided by Smith and Haddad (2000), suggest that there is a strong correlation between this per capita DEA and more individual-based indicators of food security (e.g., anthropometric indicators of children's nutritional status). In particular, Smith and Haddad (2000) show that national caloric availability was responsible for more than a quarter of reductions in child malnutrition in developing countries over the period 1970-95. Consequently, based on the observed trend in per capita DEA in the current study, one can say that there have been some improvements in the state of food security over the last three decades.

The analysis of the trend in the composition of food supply over time provides evidence of a diversification in the composition of food supply. Starchy roots and tubers are emerging as important contributors to the diets. In the Sahel for instance, we observe growth in percentage terms in starchy R&T availability per capita. However, this has been from a small base. The growth in the supply of starchy R&T has been greatest along the humid coast of WA. In some Coastal Non-Sahelian countries (Nigeria, Ghana, and Sierra Leone) there has been a big cassava revolution. The apparent per capita consumption of cassava grew in Senegal; that of sweet potatoes grew in Mali; and that of yams also showed huge increases in some Coastal Non-Sahelian countries (e.g., Ghana and Nigeria). The supply of Irish potatoes grew in some countries (e.g., Cape Verde and Senegal), while that of maize showed a striking growth in the Sahel (Burkina Faso, Mali and Senegal). Apparent per capita rice consumption increased for most countries in the study period. In Cape Verde for instance, there has been a replacement of maize with rice as the dominant type of cereal. These findings therefore present a scope to encourage ongoing diversification of staple food sources to give consumers more opportunity for substitution and choice.

Not only have there been greater per capita availability of food and a diversification in the composition of the diet, but also the quality of food available has improved over time in terms of major macronutrient composition. Daily protein supply per capita has grown for most countries since the early 2000s. This study goes beyond examining the average per capita levels of total protein availability to disaggregate per capita protein availability by source. Protein quality varies by source, and animal proteins are generally of higher quality (essential amino acids) than protein from plant sources. Diaz-Bonilla et al. (2000) suggest that the availability of animal proteins is more directly correlated with measures of nutritional security than is the availability of total proteins. Animal protein supply has been increasing for some countries in the region. The growth in the supply of animal protein reflects greater purchasing power (effective demand). In countries that have experienced rapid economic growth over time like Ghana and Cape Verde, the growth in the supply of animal protein has been remarkable. Countries with modest economic growth, such as Mali, have also shown modest growth in the consumption of animal protein over time. Decomposing animal protein by specific source, it is observed that growth in the apparent per capita consumption of poultry meat has been quite large for most countries in the region, although fish remains the dominant source of animal protein for most coastal countries.

Furthermore, while plant protein dominates as the major source of protein for most countries in the region, some of these countries (e.g., Niger, Sierra Leone, Nigeria and Cape Verde) derive an important share of vegetable protein from pulses, which are also a source of high-quality protein. The positive growth in protein supply from pulses as well as in the share of pulses in daily vegetable protein supply supports the emergence of pulses as *poor people's meat* in the region. This finding provides a scope to encourage and promote agricultural practices like crop rotation or intercropping of cereals with high protein grain legumes. Such agronomic practices will not only enhance soil fertility in an era of rising prices of inorganic fertilizers and climate change, but will also present an alternative to expensive animal protein, particularly for low-income households. Growth in the consumption of high quality plant protein would result in improvement in the nutritional status of poor households who cannot afford the expensive animal protein. Apparent per capita daily fat supply increased for most countries in the study period. There has therefore been some diet upgrading as the consumption of important macronutrients such as fats and protein have increased in the last three decades.

The analysis of aggregate-level determinants of starchy staples demand (Chapter 3) after correcting for the unit roots properties of the data does not support any statistical association between the urban population share and cereals consumption behavior in Senegal, but points to a statistically significant negative relationship between millet and urban population share in Mali. Evidence on the role of per capita income in influencing cereals consumption at the aggregate level reveals a statistically significant relationship between per capita cereals budget and rice and millet expenditure shares in the dynamic demand specification in Mali. The analysis also reveals no evidence in support of a statistical association between per capita income and starchy staples consumption in Senegal.

The Hicksian cross-price elasticities from the error-corrected demand model provide evidence of a relationship of substitution in the short-run and long-run between rice and sorghum as hypothesized for Mali and Senegal. Furthermore for Mali, maize is found to be a substitute for rice and sorghum. In Benin, we observe\ a relationship of substitution between maize and yams in the short-run–both are used to make “fufu”, a basic carbohydrate main dish eaten with sauce. An implication of these statistically significant relationships of substitution is that they offer a scope to encourage ongoing diversification of starchy staples consumption, thereby giving consumers more opportunities for substitution and choices.

Micro-level analysis in Chapter 4 gives us a closer look into the situation of food security at the household level. Using Mali’s 2006 HBS data, households’ economic access to food (measured by the household’s food expenditures) is examined alongside other factors at the household level to understand household food consumption behavior. Effective design of targeted actions requires knowledge of the distribution of the effects of changes in income as well as factors other than income that determine food demand — e.g., food prices and place of residence. To understand differences in cereals consumption by per capita income group, the rural and urban subsamples were each divided separately in thirds and households were assigned to high, medium, and low-income groups for each type of residence, and demand parameters were estimated for each group. The demand for cereals is specified as a QUAIDS model which takes care of common problems in household demand estimation such as zero-expenditure and endogeneity in total cereals expenditure.

The analysis in Chapter 4 reveals high expenditure elasticities for starchy staples. In particular, in the urban area, rice expenditure elasticity seems to have increased over time while the expenditure elasticity of sorghum is very high. With past findings that coarse grains are generally less preferred in the urban areas for various reasons such as the high opportunity cost of the time required for their preparation, the high sorghum expenditure elasticity warrants an investigation of consumer preferences for sorghum with different quality attributes. In the rural area, rice and millet are also high in expenditure elasticity. The high expenditure elasticities even for staples suggest strong future growth in demand and hence pressure on prices if supply is not increased. Therefore, the need to focus on driving down unit costs throughout the food system.

Expenditure elasticities disaggregated by income-group and place of residence also reveal rice demand to increase in expenditure elasticity from the low- to the high-income urban groups. Millet and sorghum, on the other hand, become less preferred as urban households get richer, and the high expenditure elasticity obtained when all urban households are combined appears to be largely driven by the behavior of low-income urban households. In the rural areas, all four cereals increase in expenditure elasticity as households get richer.

The findings of this study also provide scope to encourage ongoing diversification of staple food sources to give consumers more opportunity for substitution and choice. Sorghum demand was found to be the most responsive to own-price changes in the urban area. Also, disaggregating by income group, the demand for sorghum is most sensitive amongst the high income urban group. If the high own-price elasticity of sorghum estimated represents urban Malian consumer behavior correctly, efforts geared towards expanding sorghum production and driving down the unit cost of production could encourage the consumption of sorghum

Furthermore, the analysis reveals that for the range of prices observed in 2006, the price of rice appears to have a significant effect on the consumption of coarse grains in the urban area, whereby sorghum and millet are substitutes for rice. Thus, in the event of high rice prices, the consumption of traditional coarse grains in the urban areas can be encouraged by promoting the production of coarse grains (increased availability), and also by encouraging private sector involvement in the processing of these coarse grains to reduce preparation time. Further research can be carried out to investigate consumers' preference for cereals with different quality attributes. Disaggregated across income groups and place of residence, the compensated cross-price elasticities point mostly to a relationship of substitution between the different cereals. This reveals not only a scope for dealing with price spikes for one cereal by increasing the availability of substitutes—a possibility that the earlier findings of low cross-price elasticities seemed to discount, but also a scope for price transmission across cereals across cereals. Thus, there is need for a cereals policy rather than just, for example, a rice policy.

The welfare analysis of cereals price shocks in Mali over the period 2008-2011, taking into account the first order-response and the substitution responses, reveals not very large substitution effect for the reason that all cereals prices rose together. Estimates of the full impact reveal that all households are adversely affected by cereals price changes and the adverse effect of the higher cereals prices on Malian population ranged from a 2 to 6% income reduction, without considering the possibility of producer supply response. Disaggregating across income groups, the analysis reveals that in both the urban and rural population, low-income households are hardest hit by cereals price increases–i.e., the percentage reduction in total household expenditure is lowest for the high-income group and largest for the low-income group. The decreasing expenditure elasticity of sorghum and millet as per capita income increase (discussed above), particularly in the urban area, and the willingness to substitute one cereal type for another implies that expanding the availability of these cereals could help reduce some of the welfare losses from cereals price shocks. The welfare losses from the recent price hikes imply a need to address supply (including marketing and processing) issues due to concerns about welfare and food security, as well as the likely impacts on economic growth of a likely reduced consumer spending on non-food items.

6.2. Limitations of the Study

Despite the limitations outlined throughout the study, we can say that the key objectives of the study have been met in their essence. Yet, this study could be improved in many respects. Ideally, the analysis of household level food demand in a developing economy like that of Mali that has the rural population producing most of the food consumed in the country should go beyond measuring just consumption responses to measuring producer supply response to food price changes as well. Under the perspective of an agricultural household model, consumption behavior is complicated by production decisions. While most urban households are solely food consumers, most rural households are also food producers, such that changes in food prices affect them as consumers and producers. Furthermore, an increase in the price of a food commodity could increase the demand for that commodity (contrary to traditional demand theory) since a farmer may produce more of it and gain more income. Consequently, the net welfare effect of a price change depends on whether the household is a net-seller or net buyer of food. Net food-selling households may see an increase in income that may compensate for the rise in the price of foods they purchase, while the net food-buying households are likely to be adversely affected by increases in the prices of foods they purchase. Unfortunately, as a result of data limitations, the analyses of cereals demand and the welfare effect of cereals price shocks in this study fails to account for the production or additional profit effect for food producing households that could accompany rising food prices. To carry out such analysis, one would need data on production by cereal type, production shares by cereal types, as well as input and output prices.

Consumption patterns are determined by a combination of three factors: level of income, the preferences of households, and market prices. Preferences are in turn affected by the composition of the household, its members' knowledge and education, habits and cultural norms, biological factors that affect hunger, etc. (Ruel et al. 2005). Two key assumptions of standard household demand models are that household resources are pooled and that the household has a single set of preferences. In the modeling of household cereals consumption behavior, the current study does not take into account differences in preferences within a household and in the intra-household allocation of resources and especially food. While it is recognized here that there are significant gender dimensions to the challenge of ensuring food security, in the absence of sex-disaggregated data it is hard to investigate any gender differences in the allocation of household production and consumption resources, and also in the availability and utilization of food within a household, making it even harder to understand any gender differences in the welfare effects of food price increases.

BIBLIOGRAPHY

BIBLIOGRAPHY

Aksoy, M.A. and Hoekman, B. 2010. Food Prices and Rural Poverty. Centre for Economic Policy Research and the World Bank, Introduction and Overview. Accessed at http://siteresources.worldbank.org/INTRANETTRADE/Resources/Pubs/Food_Prices_Rural_Poverty.pdf 3, 6, 7, 25

Alderman, H. 1986.*The Effect of Food Price and Income Changes on the Acquisition of Food by Low-Income Households*. Washington DC: International Food Policy Research Institute, 1986.

Alfonzo, L. and Peterson, H. H. 2006. "Estimating food demand in Paraguay from household Survey data". *Agricultural Economics*, 34: 243–257.

Alpay, S. and Koc, A.2002. Household Demand in Turkey: an Application of Almost Ideal Demand System with Spatial Cost Index. *Economic Research Forum* Volume 226 of Working paper.

Alviola, P. A., IV, Capps, O., Jr. and Wu, X. 2010. Micro-Demand Systems Analysis of Non-Alcoholic in the United States. An Application of Econometric Techniques Dealing with Censoring. Agricultural and Applied Economics Association>2010 Annual Meeting, July 25-27, 2010, Denver, Colorado. URL: http://purl.umn.edu/60462

Asche F. and Wessels C.R. 1997. *On Price Indices in the Almost Ideal Demand System*. American Journal of Agricultural Economics 79:1182–1185.

Balcombe, K.G., and Davis, J.R., 1996. An Application of Cointegration Theory in the Estimation of the Almost Ideal Demand System for Food Consumption in Bulgaria. *Agric. Econ*. 15, 47–60.

Banks, J., R. Blundell and A. Lewbel. 1997. "Quadratic Engel Curves and Consumer Demand." *Review of Economics and Statistics* 79 (1997): 527-539.

Barslund, N. 2011."Censored Demand System Estimation with Endogenous Expenditures in Clustered samples: an application to food demand in urban Mozambique," LICOS Discussion Papers 28011, LICOS - Centre for Institutions and Economic Performance, K.U.Leuven. File URL: http://www.econ.kuleuven.be/licos/DP/DP2011/DP280.pdf

Blundell, R. and M. Robin. 1999. "Estimation in Large and Disaggregated Demand Systems: An Estimator for Conditionally Linear Systems." *Journal of Applied Econometrics* 14 (1999): 209-232.

Blundell R, Pashardes P, Weber G. 1993. “What Do We Learn About Consumer Demand Patterns from Micro Data?” *American Economic Review* 83(1993): 570-597.

Bopape, Lesiba Elias.2006. The Influence of Demand Model Selection on Household Welfare Estimates: An Application to South African Food Expenditures. Ph.D. Dissertation, 2006. Michigan State University.

Camara, O. 2004. The Impact of Seasonal Changes in Real Incomes and Relative Prices on Households’ Consumption Patterns in Bamako, Mali. Ph.D. Dissertation. Michigan State University.

Chalfant, J. 1987. A Globally Flexible, Almost Ideal Demand System. *Journal of Business and Economic Statistics.* 5(2): 233 – 242.

Chuang, C. Dong, D. Schmidt, T. M., Kaiser, H. M. and Gould B. W. 2005, Estimation of Price Elasticities from Cross-Sectional Data. *Agribusiness*, Vol. 21 (4) 565–584 (2005)

Cox, T. L, and Wohlgenant, A.K. 1988. Prices and Quality effects in Cross-sectional Demand Analysis. *American Journal of Agricultural Economics*, 68, 908–919.

Deaton, A. 1988. Quality, Quantity, and Spatial Variation of Price *The American Economic Review*, Vol. 78, No. 3 (Jun., 1988), pp. 418-430

Deaton, A. 1989. “Rice Prices and Income Distribution in Thailand: a Non-Parametric Analysis”, *Economic Journal* 99 (Conference volume):1-37.

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

Deaton, A. and J. Muellbauer.1980. *An Almost Ideal Demand System*. *American Economics Review* 70 (1980): 312-326.

de Janvry, A. and Sadoulet, E. 2008. Methodological Note: Estimating the Effects of the Food Price Surge on the Welfare of the Poor. URL: http://are.berkeley.edu/~esadoulet/papers/FoodPriceMethodologyDec08.pdf

Delgado, C. 1989. “Why is Rice and Wheat Consumption Increasing in West Africa?” Paper Presented to the European Seminar of Agricultural Economists, Montpellier.

Delgado, C.L., and C.P.J Miller. 1985. Changing food patterns in West Africa: Implications for Policy Research. *Food Policy* 10, 55–62.

Delgado, C and T. Reardon. 1992. Cereal Consumption Shifts and Policy Changes in Developing Countries: General Trends and Case Studies from the West African Semi-Arid Tropics.

In 1991 International Sorghum and Millet CRSP Conference Proceedings. INTSORMIL Publication 92-1, May 1992, ed. T. Schilling and D. Stoner. Lincoln, NB: INTSORMIL.

Diagana, B., F. Akindès, K. Savadogo, T. Reardon, J. M. Staatz, 1999. Effects of the CFA Franc Devaluation on Urban Food Consumption in West Africa: Overview and Cross-Country Comparisons. *Food Policy*, Vol. 24:5 (465-478). (Special Feature Papers: The Effects of the Franc CFA Devaluation on Urban Household Food Consumption in West Africa: Case Studies and Policy Implications. Guest editor, T. Reardon.)

Diallo, B., N. Dembélé and J. Staatz 2010 Transmission des Fluctuations des Prix Alimentaires Mondiaux en Afrique de l'Ouest. Research Results N° 2010-01. September 2010.Available at: http://www.aec.msu.edu/fs2/srai/presao_recherche_resultat_1.pdf

Diaz-Bonilla, E., M. Thomas, S. Robinson and A. Cattaneo. 2000. "Food Security and Trade Negotiations in the World Trade Organization: A Cluster Analysis of Country Groups". Trade and Macroeconomics Discussion Paper 59, Washington D.C: International Food Policy Research Institute.

Dickey, D. and W. Fuller. 1981. Likelihood Ratio Tests for Autoregressive Time-series with a Unit Root. *Econometrica* 49 (1981): 1057 - 1072.

Diewert, W. E. 1974: *Applications of Duality Theory," in Frontiers of Quantitative Economics*. Ed. by M. D. Intriligator and D. A. Kendrick, Amsterdam, Netherlands: North-Holland, vol. 2, 106–171.

Ecker, E., and Qaim, M., 2008. Income and price elasticities of food demand and nutrient Consumption in Malawi, Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, FL, July 27-29, 2008.

FAO. 2000. *The State of Food Insecurity in the World 2000*. Rome: FAO. Available at: http://www.fao.org/docrep/x8200e/x8200e04.htm

FAO. 2006. *The State of Food Insecurity in the World 2006. Eradicating World Hunger–Taking Stock Ten Years after the World Food Summit*. Available at: ftp://ftp.fao.org/docrep/fao/009/a0750e/a0750e00.pdf

FAOSTAT. Statistics Data on FAO Website. Accessed 15 August, 2011. http://faostat.fao.org/faostat/collections?subset=agriculture

Farnsworth, C. Helen. 1961. Defects, Uses, and Abuses of National Consumption Data. *Food Research Institute Studies* II.3: 179-201.

Friedman, M. 1976. *Price Theory*. New York: Aldine Publishing Co.

Friedman, J. and Levinsohn, J.A. 2002, "The Distributional Impact of Indonesia's Financial Crisis on Household Welfare: A 'Rapid Response' Methodology", *World Bank Economic Review*, vol. 16, no. 3, pp. 397-423.

Gossen, F. 2002. Potato Marketing in Rwanda. Prepared for United States Agency for International Development/Rwanda. http://pdf.usaid.gov/pdf_docs/pnacx568.pdf

Hausman, J.A., 1978. Specification tests in econometrics". *Econometrica* 46, pp. 931-959.

Heckman, J. 1978. Dummy endogenous variables in a simultaneous equation system. *Econometrica,* 46: 931-959.

Heien, D. and Wessells, C. 1990. Demand Systems Estimation with Microdata: a Censored Regression Approach. *Journal of Business and Economic Statistics*, 8(3): 365-371.

Ivanic, M. and W. Martin. 2008. "Implications of higher global food prices for poverty in low-Income countries." Policy Research Working Paper 4594.The World Bank, Washington, DC. Available at SSRN: http://ssrn.com/abstract=1149097

Joseph, George and Wodon, Quentin, 2008."Assessing the potential impact on poverty of Rising Cereals Prices: the Case of Mali," Policy Research Working Paper Series 4744, The World Bank. Downloadable at http://ideas.repec.org/s/wbk/wbrwps.html

Karagiannis, G., S. Katranidis, and K. Velentzas 2000: "An Error Correction Almost Ideal Demand System for Meat in Greece," *Agricultural Economics*, 22, 29–35.

Kelly, V., N. Dembele, J. Staatz. 2008. Potential Food Security Impacts of Rising Commodity Prices in the Sahel: 2008-2009: A special report by the Famine Early Warning Systems Network. Washington, D.C.: FEWS NET

Kelly, V. N., Murekezi, A., Me-Nsope, N.M., Perakis, A. and Mather, D. 2012. *Cereal Market Dynamics: The Malian Experience from the 1990s to Present*. MSU International Development Working Paper (IDWP) No. 128. December 2012. Available at: http://aec.msu.edu/fs2/papers/idwp.htm

Kennedy, E and T. Reardon. 1994. Shift to Non-traditional Grains in the Diets of East and West Africa: Role of Women's Opportunity Cost of Time. *Food Policy* 19 (1) 45-56

Kwiatkowski D., P. C. B. Phillips, P. Schmidt, and Y. Shin. 1992. Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure Are We that Economic Time-series Have a Unit Root? *Journal of Econometrics* 54 (1992): 159 - 178.

Lele, U. M. and Mellor, J. W. 1972. Jobs, Poverty and the "Green Revolution". *International Affairs* (Royal Institute of International Affairs 1944) Vol. 48, No. 1, pp. 20-32

Lopriore, C. and E. Muehlhoff. 2003. Food Security and Nutrition Trends in West Africa - Challenges and the Way Forward. Presented at the 2nd International Workshop Food-based Approaches for a Healthy Nutrition, 23-28 November, 2003. Ouagadougou, Burkina Faso. Available at: http://www.mpl.ird.fr/fn2ouaga/P2IW_Part%201.pdf

Me-Nsope, N. M. and Staatz, J. M. 2013. Trends and Determinants of Food Consumption Patterns in West Africa. Michigan State University. *International Development Working Paper*. February 2013.

Mghenyi, E., Myers, R. J. and Jayne, T.S. 2011. The Effects of a Large Discrete Maize Price Increase on the Distribution of Household Welfare and Poverty in Rural Kenya. *Agricultural Economics*, 42: 343–356. doi: 10.1111/j.1574-0862.2010.00518.x

Minot, N. 2010. Transmission of World Food Price Changes to African Markets and its Effect on Household Welfare" Paper to be presented at the COMESA policy seminar "Food price Variability: Causes, consequences, and policy options". On 25-26 January 2010 in Maputo, Mozambique under the COMESA-MSU-IFPRI African Agricultural Markets Project (AAMP)
Available at: citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.193.5743...

Moschini, G. 1995: Units of Measurement and the Stone Index in Demand System Estimation. *American Journal of Agricultural Economics*, 77, 63–68.

Muellbauer, J. 1976. Community Preferences and the Representative Consumer. Econometrica, Vol. 44, No. 5. (Sep., 1976), pp. 979-999.

Nishida, C., R. Uauy, S. Kumanyika, and P. Shetty. 2004. The Joint WHO/FAO Expert Consultation on Diet, Nutrition, and the Prevention of Chronic Diseases: Process, Product, and Policy Implications. *Public Health Nutrition* 7.1A: 245–50.

Nouve, Kofi, and Quentin Wodon 2008. "Impact of Rising Rice Prices and Policy Response in Mali: Simulations with Dynamic CGE Model." Mimeo, World Bank, Washington, DC.

Nweke, F.I., D.S.C. Spencer, and J.K. Lynam. 2002. *The Cassava Transformation: Africa's Best Kept Secret*. East Lansing: Michigan State University Press.

Nzuma, J.M. and Sarker, R. 2008. An Error Corrected Almost Ideal Demand System for Major Cereals in Kenya. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, Florida, and July 27-29, 2008.

Phillips, P. and P. Perron.1988. Testing for a Unit Root in Time-series Regression. *Biometrika* 75: 335 - 346.

Poi, B. P. 2008. "Demand System Estimation: Update," *The Stata Journal*, 2 (4), 554-556.

Pollak, R. A. and Wales T. J. 1987. Pooling International Consumption Data. *The Review of Economics and Statistics*, Vol. 69, No. 1 (Feb., 1987), pp. 90-99

Porto Guido G. 2005, "Informal Export Barriers and Poverty", *Journal of International Economics*, 66, 447–70.

Porto, G. G., 2010. Food Prices and Rural Poverty. Centre for Economic Policy Research and The World Bank, Ch. Food Prices: Household Responses and Spillover, pp. 167–184. URL http://siteresources.worldbank.org/INTRANETTRADE/ Resources/Pubs/Food_Prices_Rural_Poverty.pdf 3, 6, 7, 25

Prais, S., and Houthakker, H. 1955. *The Analysis of Family Budgets*. Cambridge University Press, Cambridge, 2nd ed. 1972 edn.

Reardon, T., T. Thiombiano and C. Delgado. 1988. "Substitution of Imported for Traditional Cereals in Household Food Consumption in Ouagadougou, Burkina Faso". IFPRI Research Report.

Regmi, A. 2001. *Changing Structure of Global Food Consumption and Trade*. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, Agriculture and Trade Report. WRS-01-1.

Regmi, A. and J. Dyck. 2001. Effects of Urbanization on Global Food Demand in Changing Structure of Global Food Consumption and Trade, Regmi, A. (ed). Agricultural and Trade Report, WRS-01-1, US Department of Agriculture, Economic Research Service: 27-34

Rogers, B. L. and M. Lowdermilk. 1991. "Price policy and food consumption in urban Mali". *Food Policy* 16 (6), 461-473.

Ruel, M. T., Minot, M., Smith, L. 2005. Patterns and Determinants of Fruits and Vegetables Consumption in Sub-Saharan Africa. Background paper for the Joint FAO/WHO Workshop on Fruits and Vegetables for Health. 1-3 September, 2004, Kobe, Japan

Sadoulet, E., and de Janvry, A. 1995. *Quantitative Development Policy Analysis*. Baltimore, Johns Hopkins University Press.

Satterthwaite, D., McGranahan, G., and Tacoli, C. 2010. Urbanization and its Implications for Food and Farming. *Phil. Trans. R. Soc.* B 2010 365, doi: 10.1098/rstb.2010.0136, published 16 August 2010. http://rstb.royalsocietypublishing.org/citmgr?gca=royptb;365/1554/2809

Savadogo, K. and Brandt, J.A. 1988. Household Food Demand in Burkina Faso: Implications for Food policy. *Agricultural Economics*.Volume 2, Issue 4, December, Pages 345–364

Shonkwiler, J.S., and S.T. Yen. 1999. "Two-Step Estimation of a Censored System of Equations." *American Journal of Agricultural Economics* 81(4) (November):972-982.

Singh, I., L. Squire, and J. Strauss. 1986. *Agricultural Household Models: Extensions, Applications, and Policy*. Baltimore: Johns Hopkins University Press.

Smith, L. C. and L. Haddad. 2000. "Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis". *IFPRI Research Report* 111. Washington D.C.: International Food Policy Research

Staatz, J. M., N. N. Dembélé, V. Kelly and R. Adjao. 2008. Agricultural Globalization in Reverse: The Impact of the Food Crisis in West Africa. Background paper for the Geneva Trade and Development Forum Crans-Montana, Switzerland September 17-20, 2008 URL:http://www.aec.msu.edu/fs2/srai/Agricultural_Globalization_in_Reverse_MSU_Crans-Montana_paper_final.pdf.

Tafere, K., Seyoum, A., and Tamiru, S., with Tefera, N., Paulos, Z., 2010. Food Demand Elasticities in Ethiopia: Estimates Using Household Income Consumption Expenditure (HICE) Survey Data; ESSP2 Discussion Paper 011

Taondyandé, M. and M. Yade. 2012. Etude sur la Consommation Alimentaire en Afrique de l'Ouest. AGWA Background Paper. Ibadan, Nigeria: ReSAKSS West Africa.

Teklu, T. 1996. "Food Demand Studies in Sub-Saharan Africa: a survey of empirical evidence. *Food Policy* 21 (6), 479-496

Timmer, C. P., W. D. Falcon, and S. R. Pearson. 1983. *Food Policy Analysis*. Baltimore: Johns Hopkins University Press for the World Bank.

Wang, D. and Tomek, W.G. 2004. Commodity Prices and Unit Root Tests. Paper presented at the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management St. Louis, Missouri, April 19-20, 2004

Wodon, Q. T. and H. Zaman. 2010. Higher Food Prices in Sub-Saharan Africa: Poverty Impact and Policy Responses. *The World Bank Research Observer*, Vol. 25, No. 1, pp. 157-176. Available at SSRN: http://ssrn.com/abstract=1565973 or doi: lkp018

Wooldridge, J.M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

World Bank. 2013. World Bank Urban Population Ratios from the United Nations World Urbanization Prospects. Accessed in January, 2013 at: http://data.worldbank.org/indicator/SP.URB.TOTL/countries

Yen, S.T., K. Kan, and S. J. Su. 2002. "Household Demand for Fats and Oils: Two-step Estimation of a Censored Demand System." *Applied Economics* 34(14):1799-1806.