MEASURING FOOD SECURITY USING HOUSEHOLD EXPENDITURE SURVEYS: A COMPARISON OF QUANTITY AND QUALITY INDICATORS FOR GHANA, MALAWI, AND UGANDA.

by

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STATEMENT BY AUTHOR

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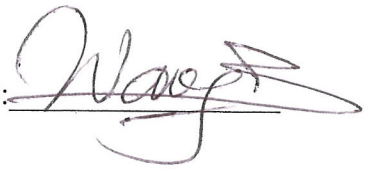
SIGNED: 

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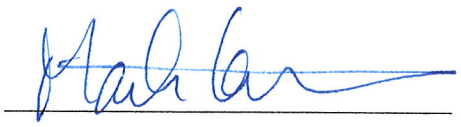

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DEDICATION

To my mom and dad, Elhadji Tahirou Wane and Aissata Abdoul Ba.

To my grandparents, Elhadji Abdoul Wahab Ba and Hadia Coumba N. Kane

To my uncle Ba Mohamed Lamine dit Mamadou

To my uncle and friend Abdoul Sy

To Elijah A. Wane

To my extended family members and friends.

To all households suffering from hunger.

TABLE OF CONTENTS

TABLE OF CONTENTS- continued

LISTE OF FIGURES

LISTE OF TABLES

ABSTRACT

Food security exists when " all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life"(FAO 1996, p.1083). Achieving Sustainable food security in Sub-Saharan Africa (SSA) could be quite a challenge to the ultimate objective of a "hunger free" World. Food security is certainly one of the most complex and multi-dimensional issues of our times in the region, and it is an important measure of development. The general topic of this thesis is the measurement of food security. The general question this thesis asks is: if we include both diet quantity *and* diet quality in a set of food security indicators, what difference does it make for targeting food-insecure populations and the types of policies needed to reduce food insecurity?

Specifically, this thesis investigates two indicators of food security using data from national Household Expenditure Surveys (HESs) conducted in three Sub-Saharan Africa countries in the late 1990s: Ghana, Malawi and Uganda. The two indicators are: household calorie availability, a measure of the quantity of food people eat, and diet diversity, a measure of the quality of that food. Two questions are explored: (1) Do the indicators tell us different things about who in a population is food insecure and the prevalence of food insecurity? And (2) Do they have different determinants? To answer the first question, correlation analysis and contingency tables are employed. To answer the second, community fixed-effects regression analysis (Ordinary Least Squares and Two-stage Least Squares) is employed.

CHAPTER 1

INTRODUCTION

"We, the Heads of State and Government,... reaffirm the right of everyone to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger."

Rome Declaration on World Food Security, 1996

Food security exists when " all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life"(FAO 1996, p.1083). Sustainable food security is one of the world's most important sociological, political, economic and scientific challenges of the new millennium. Its achievement in Sub-Saharan Africa (SSA) could be quite a challenge to the ultimate objective of a "hunger free" World. Food security is certainly one of the most complex and multi-dimensional issues of our times in the region, and it is an important measure of development. The achievement of stable and sufficient food supply and supporting the capacity of households to gain access to food are critical first steps toward the reduction of food insecurity and malnutrition, and also the beginning of any development strategy consideration by governments. "Food access is ensured when households and all individuals within them have adequate resources to obtain appropriate foods for a nutritious diet. Access depends upon income availability

to the household, on the distribution of income within the household and on the price of food" (USAID 1995).

The African continent is considered to have the most severe food insecurity problems compared to its counterparts of Asia and Latin America (FAO 2002; USAID 2002). Many countries in the region are not even able to meet the food needs of their populations at the aggregate, national level, much less ensure that sufficient food reaches all people (Smith et al. 1999). The FAO in a recent report released called for more food pledges and accelerated emergency food deliveries to 25 countries, including Malawi and Uganda whose food supplies appear to be irregular and unstable. Sixteen countries in Sub-Saharan Africa face exceptional food emergencies. In these countries an estimated 28 million people are at risk of severe food shortage with 18 million of these in eastern Africa (FAO, 2001).

Poor diet quality is a major problem in Sub-Saharan Africa. Micronutrient deficiency estimates of the three main forms of micronutrient malnutrition (iron deficiency, vitamin A deficiency, and iodine deficiency) are alarming in this part of the world. The estimated number of preschool children affected by the three listed deficiency problems are respectively 34.1 million, 36 million, and 30.1 million (Mason 2000). Sifri and Darnton-Hill estimated that in 2002 over 85 million people living on the African continent are iodine deficient. Overall 206 million people in SSA have anemia (a pathological deficiency in the oxygen-carrying component of the blood), 52 million are vitamin A deficient, and 181 are iodine deficient (FAO 1997).

The result of food insecurity is malnutrition among the most vulnerable people, especially young children[1]. Out of some 30 million infants born each year in developing countries with impaired growth due to poor nutrition, 26 % are from Sub-Saharan African countries. In addition, 8.2 million more children were underweight in 2000 compared to 1990 (ACC/SCN 2000).

Underlying the limited access to food, households in many SSA countries are poor (incapacity to meet all their needs, characterized by low income). The statistics show that SSA has the highest poverty rate in the world just slightly lower than South Asia (Ravallion and Chen 1997). Furthermore, between 1987 and 1993, the percentage of population spending less than $1 a day rose from 38.5 % to 39.1 %.

The general topic of this thesis is the measurement of food security. Most measures used by development practitioners and researchers have been indicators of diet quantity or insufficiency. Diet quality, an equally important aspect of food security, has received less attention. Research should also be directed toward this second aspect of food security. "A poor diet would contain few animal products, fruits and vegetables, and consist primarily of staples such as cereals, legumes or other plants" (Allen et al., 1991). Such poor diet quality is associated with low intake of several vitamins and minerals and poor mineral bioavailability.

The general question this thesis asks is: if we include both diet quantity *and* diet quality in a set of food security indicators, what difference does it make for targeting food-insecure populations and the types of policies needed to reduce food insecurity?

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[1] Child malnutrition not only reflects food consumption but also care for children and their mothers, and

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This thesis is structured as follows. Chapter 2 presents the concepts and reviews some of the recent literature on household food security. Chapter 3 presents some background information on Ghana, Malawi, and Uganda. Chapter 4 discusses the data sets and the sample selection, the measures of food security indicators and finally the different statistical methods used in this thesis. Chapter 5 presents the empirical results and finally chapter 6 summarizes the key results of the study and concludes with some policy implications.

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health environment quality (Smith and Haddad 2000).

CHAPTER 2

CONCEPTS AND LITERATURE REVIEW

This chapter is divided into three sections. Section 1 presents the core concepts and definitions of food security. Section 2 examines the measures and indicators of food security. Section 3 examines the relationship between diet quantity and diet quality.

2.1 DEFINITION OF FOOD SECURITY

Before getting into the examination of some indicators of food security, it is crucial to define the concept for a better understanding. There is not one definition of food security that incorporates all of its dimensions. Many definitions have been presented with very different characteristics and labels. Some 200 definitions and 450 indicators are mentioned in the literature (Maxwell and Frakenberger 1992). In 1973 the United Nations defined food security narrowly as "Availability at all times of adequate world supplies of basic food-stuffs..., to sustain a steady expansion of food consumption ... and to offset fluctuations in production and prices" (UN 1975). Hopkins defines food security as: "food security stands as a fundamental need, basic to all human needs and the organization of social life. Access to necessary nutrients is fundamental, not only to life per se, but also to stable and enduring social order" (Hopkins 1986, p.4). For Maxwell, food security is defined by the following: "A country and people are food secure when their food system operates in such a way as

to remove the fear that there will not be enough to eat. In particular, food security will be achieved when the poor and vulnerable, particularly women and children and those living in marginal areas, have secure access to the food they want" (Maxwell 1991, p.10). Staatz (1990, p1311-1317) added: " The ability... to assure, on a long term basis, that the food system provided the total population access to timely, reliable and nutritionally adequate supply of food". Food security has also been defined as whether the household has enough calories available to meet caloric requirements of household members, using an adult equivalent unit measure (MPF/UEM/IFPRI 1998).

Maxwell and Frankenberger (1992) present four characteristics of food security: sufficiency, access, security, and time. Sufficiency is about whether each household is provided with the minimal level of food consumption. Access focuses on the question whether individuals and households (and more generally nations) are able to acquire sufficient food. Security is strictly linked with the notion of vulnerability. It focuses more on risk.

Since the beginning of 90's there has been an increase in literature on household food security indicators. Maxwell and Frankenberger (1992) list 25 broadly defined indicators. With so many definitions and indicators to choose from, the question is how must one approach the food security problem? What tools and measures must be used to identify the food insecure section of the population, assess the gravity of their food shortfall, characterize the nature of their insecurity, and allow decision makers to implement some policies that would make the world "hunger free"?

The definition adopted in this paper is the one adopted by the FAO at the World Food Summit in 1996. Food security exists when "all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996, p.1083). This definition incorporates a fundamental dimension of food security: access. Access is about whether the household members collectively and individually are able to acquire sufficient food. It refers to the ability of households to obtain food, whether it is derived from home production, commercial purchases, or in kind transfers. It may be considered as roughly equivalent to "real household income" or "effective demand," with respect to the cost of some prescribed food basket. Security of food access, however, implies the consideration of both current and future sources of production and income. Thus physical and human assets are also important components of food access. Differential access within households is also important, but often difficult to measure. Access depends upon income available to the household, on the distribution of income within the household and on the price of food (United Nations 1975).

It is obvious that definitions of food security have in the past focused on the food supply and access sides. Somehow an important aspect of food security, diet quality, has been left out. The definition adopted for this study places strong emphasis on diet quality, specifying that food security is achieved when people have access to "nutritious food to meet their dietary needs..."

2.2 MEASURES AND INDICATORS OF FOOD SECURITY

A better understanding of the food security problem is dependent on selection of appropriate measures and indicators of food security. These elements would indeed capture the "food security" problem and guide the decision-makers to resolve it. Maxwell and Frankenberger (1992) present two types of indicators: process indicators and outcome indicators. The first have to do with food supply and food access and the second ones, outcome indicators, are a proxy for food consumption. While supply indicators can provide some very insightful information about regional trends in food availability, they also are very much limited by their highly aggregated character. Maxwell and Frankenberger indicate that indicators reflecting food supply also provide information on the likelihood of a shock or a disastrous event that will adversely affect household food security. An example of such an indicator is rainfall. Alternatively indirect outcome indicators such as anthropometric measures are being used more and more in the literature because the related data is very easy to collect. There are also indicators that reflect food access, for example, food entitlement and effective demand of households.

Following is a presentation of some measures and indicators that have been used recently in the literature. We start with the measure individual food intake. It is a measure of the amount of calories or nutrients consumed by an individual in a given time period, usually 24 hours. Two methods are used to derive this measure: observational and recall approach. In the observational approach, an enumerator resides in the household all

day long and measures the amount of food served to each person. In the recall method, an enumerator interviews each member of the household regarding the food they consumed in the previous 24-hour period. Individual food intake is calculated by converting the quantities of food into nutrient (calorie and micronutrient) content using factors that convert quantities into nutrients. This measure has two significant advantages. If implemented, it provides the most accurate measure of individual nutrient intake and it allows determining whether food security status differs among individuals within the household (Hoddinott 2001).

Another example of a food security measure used in the literature is an index of household coping strategies. These strategies include behavioral and emotional adjustments that an individual or a household makes in order to alleviate a stressful situation. In this case, the method helps in understanding how the household responds to food shortages. Dietary change (e.g. eating less preferred but less expensive food), increasing short-term food access (wild food), decreasing numbers of people to feed (short-term migration), and rationing strategies (skipping eating for whole days) are examples of categories of coping strategies according to location and culture (CARE International 2001). Two types of coping strategies are risk-minimizing and loss-management strategies. They both involve a low commitment of domestic resources, enabling speedy recovery once the crisis has eased (Maxwell and Frankenberger, 1992). The data are generated by asking the person responsible for food in the household to answer a series of questions on whether the household has enough food. This method has three interesting advantages. It is easy to implement, it captures the notion of adequacy

and vulnerability, and finally the questions asked are easy to understand and reply to, both by respondents and by analysts and project designers (Hoddinott 2001).

Household calorie availability is thought to be a valid and reliable measure of access to food in its quantitative dimension (Smith 2003). It represents the food acquired from three distinct sources: (1) food purchased, including food purchased and consumed away from home; (2) food given to a household member as a gift or a payment for work; and (3) food consumed that is home produced. When compared with requirements, it allows determination of whether a household is able to meet its needs for a major macronutrient: energy. Household calorie availability does not address the issue of risk and vulnerability.

Ruel (2002) demonstrated that diet quality appears to have no official definition in the literature she reviewed. Definitions vary widely, according to the type of measurement tools used. The overall perception is that diet quality reflects "nutrient adequacy". Nutrient adequacy itself refers to a diet that meets requirements for energy and all essential nutrients. She added that the recent concern in developed countries and in countries in transition regarding overnutrition and excess intake of certain nutrients and foods has led to a global shift in the definition of dietary quality to include both concepts of nutrient deficiency and overnutrition. A commonly used measure of diet quality is diet diversity, defined as the number of different foods or food groups consumed over a given reference period. Having a diverse diet enhances the chances of achieving an adequate diet, lessens the risks of developing a deficiency or excess of any nutrient, ensures an appropriate balance of micronutrients as well as energy from fat, and

reduces the likelihood of exposure to excessive amounts of contaminants. Ruel concluded that diet diversity is not synonymous to dietary quality and therefore the two terms should not be used interchangeably. Confusion in the use of these terms may originate from the nutrition and health benefits that have been attributed to dietary diversity and that are related to the concept of dietary quality (Ruel 2002). A typical poor quality diet would contain few animal products, fruits and vegetables, and consist primarily of staples such as cereals, legumes or other plants (Allen et al., 1991). Poor quality diets are associated with low intakes of several vitamins and minerals and poor mineral bioavailability. Also, morbidity is likely to cause depletion of several nutrients simultaneously, through anorexia or malabsorption.

Allen et al., (1992) demonstrate strong associations between dietary quality and growth of preschool-children. The existence of simultaneous deficiencies made it difficult to detect associations between the intake of a single nutrient and growth. For example, in Mexican preschool-children there was no significant relationship between size at 30 months (weight, length or weight-for-length) and each child's average intake of energy, protein, or other nutrients during the previous 12 months. Stronger positive associations were found between the intake of specific foods and linear growth. The usual diet of taller children contained more animal products (especially milk and meat), and fewer maize tortillas than that of shorter children. These relationships persisted when socioeconomic status was controlled in analyses. Weight was less strongly related to the intake of specific foods.

How to measure diet diversity? There are two approaches. One approach used by Kant (Ruel 2002) directly counts the number of food groups consumed. It is a simple arithmetic sum, the sum of the number of different food groups consumed. Within this approach some suggest 8 groups and others the 12 groups used by the Food and Agriculture Organization (FAO). Alternatively the other approach suggests counting each food item separately.

2.3 EMPIRICAL ASSOCIATION BETWEEN DIET QUALITY AND DIET QUANTITY

Some studies have tried to show that there is a relationship between diet quantity and diet quality. Hoddinott and Yohannes (2002), for example, assess whether household dietary diversity could be used as an indicator of household food security where the "gold standard" measure of food security employed is household calorie availability. They use correlation coefficient method to show the level of association between different categories of food insecurity indicators. This is an important question because it is far less costly to collect data on dietary diversity. Ten data sets were used to perform the analysis. The countries were India, Philippines, Mozambique, Mexico, Bangladesh, Egypt, Mali, Malawi, Ghana, and Kenya. The correlation analysis results showed that, on average a 1 percent increase in dietary diversity is associated with a 0.7 percent increase in total per capita caloric availability, a 0.5 percent increase in household per capita daily caloric availability from staples, and a 1.4 percent increase in household per capita daily caloric availability from nonstaples. They concluded that dietary diversity

would appear to show promise as a means of measuring food security and monitoring changes and impact, particularly when resources available for such measurement are scarce. Respondents find the questions relatively straightforward, nonintrusive, and not especially burdensome to answer and it take very little time to answer the questions.

However, Hoddinott and Yohannes' research leaves some open questions. An elasticity of 0.7 doesn't guarantee automatically the possibility of these indicators to be substituted one another. Based on all samples, the magnitude of the association between dietary diversity and household per capita caloric availability increases with the mean level of caloric availability. The authors found quite low associations between dietary diversity and household per capita caloric availability for some countries in their sample (e.g., India, Philippines, Mozambique and Mexico).

CHAPTER 3

BACKGROUND CHARACTERISTICS OF MALAWI-UGANDA-GHANA

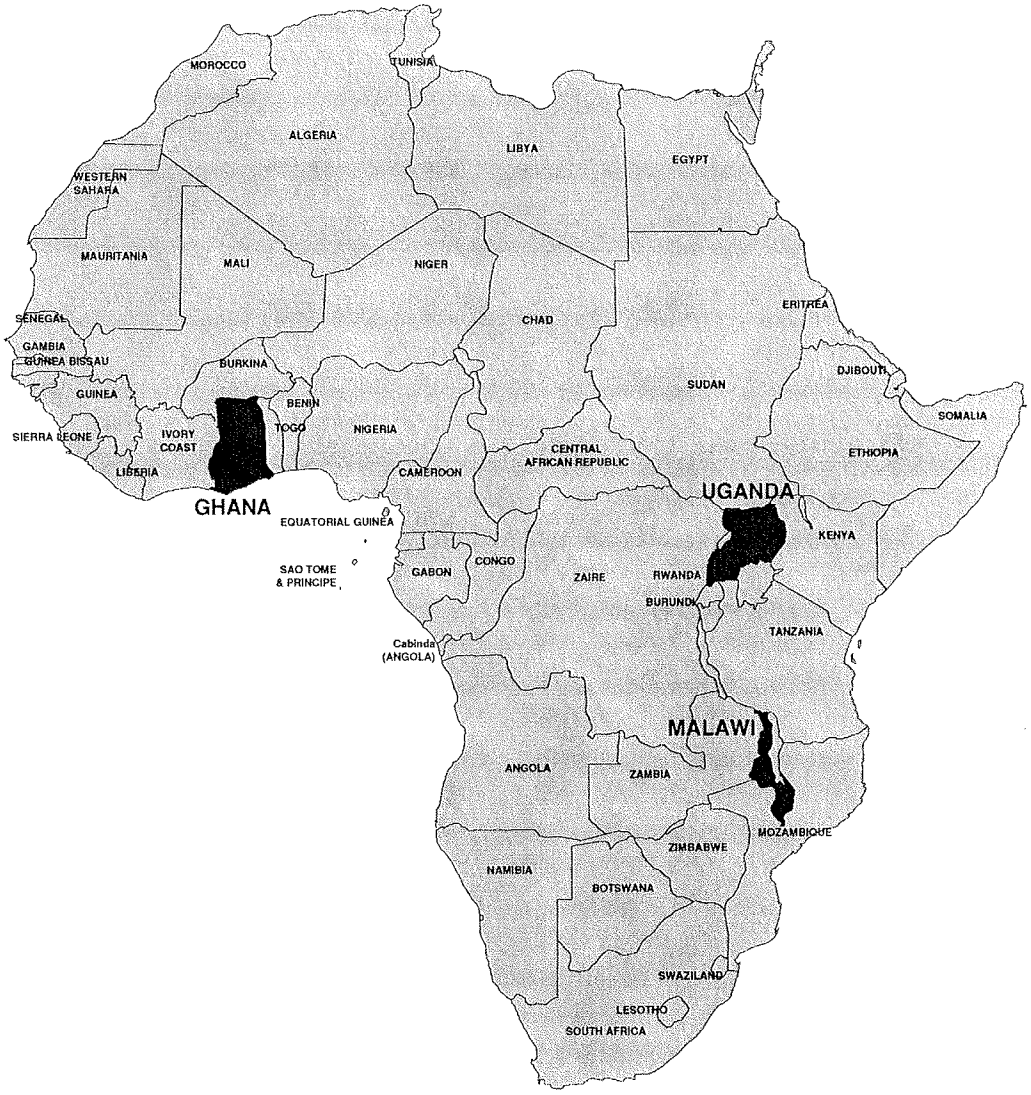
Malawi, Uganda, and Ghana are three developing countries with several common characteristics (Figure 3.1). Their economies are predominantly dependent on the production of primary agricultural commodities. They also have in common agriculture being the main source of employment. They finally have a low level of urbanization: 36 % of the total population in Ghana, 15.1 % in Malawi, and 14.5 % in Uganda (World Bank Group, 2002). This chapter presents some relevant background information about the above mentioned countries which have been experiencing food security issues since their independence. The chapter is divided in three sections: section 1 introduces the overview of Malawi, section 2 is about Uganda, and section 3 is about Ghana.

Table 1 includes some key socio-economic and environment information for all three countries included in this study.

3.1 MALAWI

The republic of Malawi is a long narrow land-locked country situated in Southern Africa. Malawi covers a total area of 241,140 square kilometers (World factbook 2001). The country is bordered to the Southwest and East by Mozambique, to the Northwest by Zambia, and to the Northeast by Tanzania (see Fig 3.2). The country's total population

Figure 3.1:Map of Africa



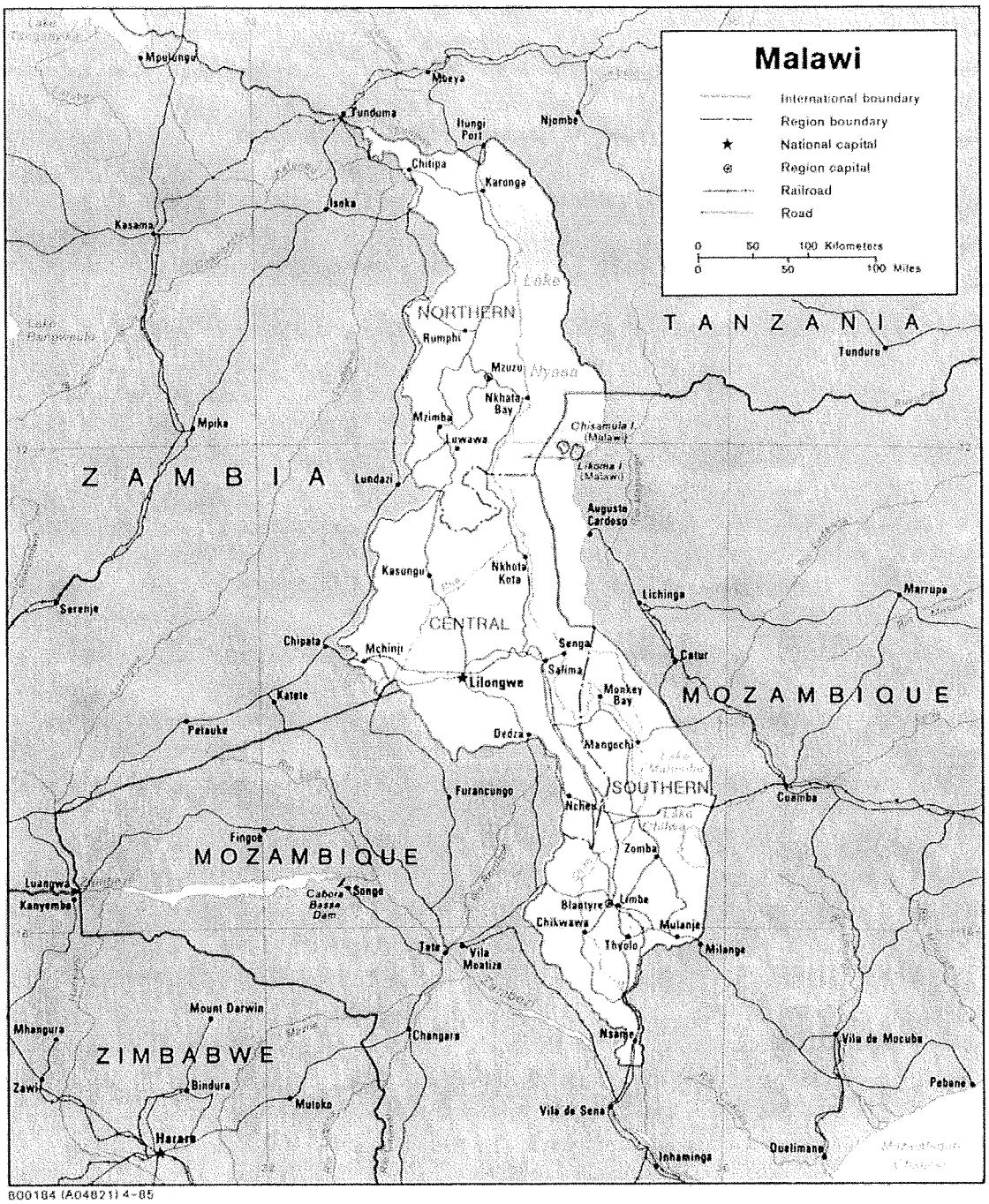
Source: Map Art (Maps for graphic design). Vol1, 2, 3 &4. Modified by Nancy Bannister

Table1: Ghana, Malawi and Uganda in brief

Indicator	Ghana 2001	Malawi 2001	Uganda 2001
Demography and Social Statistics			
Total population	19.7 million	10.5 million	22.8 million
Urban population (% of total)	36.4	15.1	14.5
Population growth rate (%)	2.1	2.1	2.6
National Poverty Rate (%)		60	35
Life Expectancy at birth (years)	56.9 @	38.8 @	42.1 @
Child Malnutrition (%)	25	25	38
Improved water source (% of tot.pop with access)	64 @	50 @	
Environment			
Surface area (sq.km)	238.5 thousand	241 thousand	
Economy			
Food supply per capita (per capita kcalories in 2000)	2699	2181	2359
GDP (current $) per capita	269	172	250
GDP growth (annual %)	4	2.8	4.6
Agriculture value added (% of GDP)	35.9	37.1	42.4
Exports of goods and services (% of GDP)	52.2	27.9	10.5
Imports of goods and services (% of GDP)	70.5	41.7	30
Dietary energy supply (per capita kcals/day)	2699 @	2181 @	2359 @
Trade and Finance			
Total imports of food per year in US $	3,781	34	1,501
Foreign direct investment (current $)	45 million @		220 million @
Total debt service (% of exports of goods and services)	19.3 @	11.6 @	23.7 @
Debt as % of GDP in 2000: debt/GDP	0.78	0.88	0.16
Aid per capita (current $)	43.2 @	31.6 @	36.9 @

Source: World Development Indicators database, April 2002
Note: @ means the value was of year 2000

Figure 3.2: Map of Malawi



Source: University of Texas Library Online

is estimated at 10.5 million and has a growth rate of about 2.1 % per annum (World Bank 2002). Malawi's child mortality rate is among the highest in Southern Africa and the life expectancy is 39 years. Malawi is ranked as the fifth poorest country in the world and has more than 60 % of its population living below the United Nations established poverty line (World Factbook, 2003). A combination of scarce natural resources and high population density make human resources development critical to the future of the country. The economy is highly dependent on agricultural exports, mainly tobacco and tea. Overall the low rates of economic growth during the 1980s and the first half of 1990s resulted in declining per capita incomes for a prolonged period. Income per capita in Malawi is among the lowest in southern Africa (World Bank, 2002). Real wages and incomes have decreased almost continuously since independence, and very drastically during the first half of the 1990s. In February 2002 the World Bank declared that more than 3 million people face a risk of starvation. The country was hit by a severe famine caused by a poor harvest in 2000/2001 resulting in low maize stocks, flooding in several districts (2002), and a dry spell (early 2002).

On top of chronic malnutrition, Malawi is experiencing very high rates of illiteracy, a high population growth, the world's highest HIV/AIDS infection rates, and widespread child labor. All these problems make the labor force shift to the informal sector of the economy.

Malawi is an agricultural country and agriculture is the most important sector in its economy as it employs about 90 % of the population. Agriculture contributes more than 37 % of Gross Domestic Product and accounts for almost 85 % of

the country's export earnings (World Bank, 2002). In 1997, export earnings came from tobacco (59 %), tea (19 %), groundnuts (2 %), and other crops (12%). In Malawi, maize is the main food crop and is grown on 95 % of the cultivated area. Other crops are tobacco, tea, cotton, sugarcane, groundnuts, rice, coffee, cassava, and pulses. Since the late 1980's the Malawi government has engaged some crucial agricultural reforms, under the Structural adjustment Program, to achieve self-sufficiency. However, floods in the early 1990's, soil fertility decline, and low agricultural output prices caused some serious food shortage in Malawi (Table 1 presents some evidence of the study countries performance).

Being extremely poor, Malawi has a tough time solving the food shortage problem. Despite the government's good intention to make food available on a consistent basis, food production is very low. To overcome the deficit, the government of Malawi imports food ($ 32 million in 2001). In Malawi, there is a gap between the poor and rich because of a difference in resource endowment, access to credit, use of technology. In addition government policies were biased toward the large-scale farmers. Malawi has been also affected by floods and drought for the past two consecutive cropping seasons. In the latter season, floods affected more than 29,700 farming families in 14 districts (World Bank, 2002). Severe drought has had destructive effects on crops in a number of areas. The bad weather also provoked a reduction in maize production. Overall the cumulative effects on household food security resulted in an estimated food shortage of more than 400,000 tons for the 2002/2003 food supply year. Due to all these insufficiencies and shortages, Malawi is locked in a "vicious cycle of poverty" year in

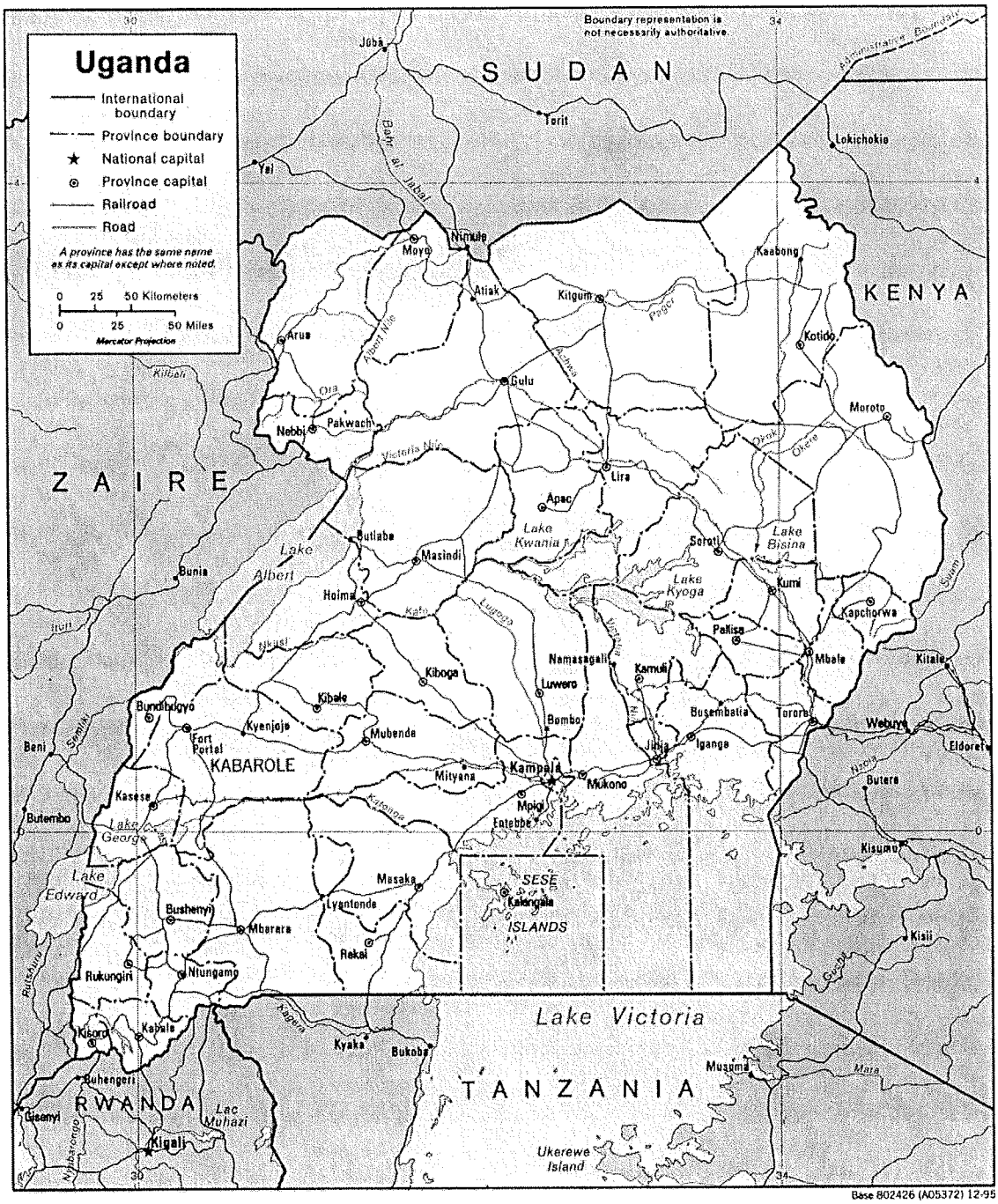
and year out. This long-term problem needs to be looked at closely in order to have any hope of eradicating or alleviating the food security problem. Since the early 1990's the government has set up goals in that regard: improving food security and nutritional status of the population, encouraging self-reliance through increased broad-based small industries and businesses, expanding and diversifying exports of crops and livestock products, and raising farm incomes and promoting economic growth while keeping the natural resources unchanged. To achieve these objectives, an efficient use of natural resources must take place and over-dependence on unstable external trade flows has to be eradicated.

3.2 UGANDA

Like Malawi, Uganda is also a landlocked country in East Africa with an area of 236,000 square kilometers (about the size of Oregon) and an estimated population of over 22.8 million people (World Bank 2001). The country is situated north and northwest of Lake Victoria. Uganda is bordered by Sudan on the north, Kenya on the east, Tanzania on the south, Rwanda on the southwest, and ex-Zaire on the northwest (see Fig3.3). Eighty five % of the total population lives in rural areas. With 55 % of the people living below the poverty line, Uganda is considered one of the poorest countries in the world with a high infant mortality rate (88 per 1,000) and a life expectancy at birth of 42 years (World Bank Group 2001).

Uganda has substantial natural resources, including fertile soils, regular rainfall, and sizable mineral deposits of copper and cobalt. Agriculture is the most important

Figure 3.3: Map of Uganda



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sector of the economy. It accounts for 44 % of the GDP, over 90 % of exports, and employs over 80 % of the labor force. Agricultural output comes almost exclusively from about 2.5 million small holders, 80 % of whom have less than 2 hectares of land. Only tea and sugar are grown on large estates. Food crop production accounts for 71 %, livestock 17 % and export crop 5 % of the agricultural GDP (World Bank 1993). Coffee is the major export crop and accounts for the bulk of export revenues. Starting in 1986, the government, with the support of foreign countries and international agencies, has demonstrated the desire to rehabilitate and stabilize the economy by undertaking some reforms such as raising producer production and export earnings and improving wages.

In the early 1990's the International Monetary Fund (IMF) introduced the Structural Adjustment Program (S.A.P). The program comprises a set of ambitious macro-economic policies targeted at developing countries to assist all sectors of their ailing economies (IMF 2000). The SAP aims the following principals: growth through export, privatization and liberalization, and free-market economy efficiency. The achievement of the above principals are reinforced through devaluation of the local currency, removal of import and export restrictions, and balancing budgets (by reducing public expenditure and eliminating price controls). Uganda was hoping to implement the program in order to establish a stable and reliable food security system along with a performant economic system. The Government and all the decision-makers supported the project and set up some reasonable goals to make the S.A.P an overall success.

Meanwhile Uganda is blessed with generally a good climate-fairly even temperatures and abundant rainfall. It has capacity to produce enough food for

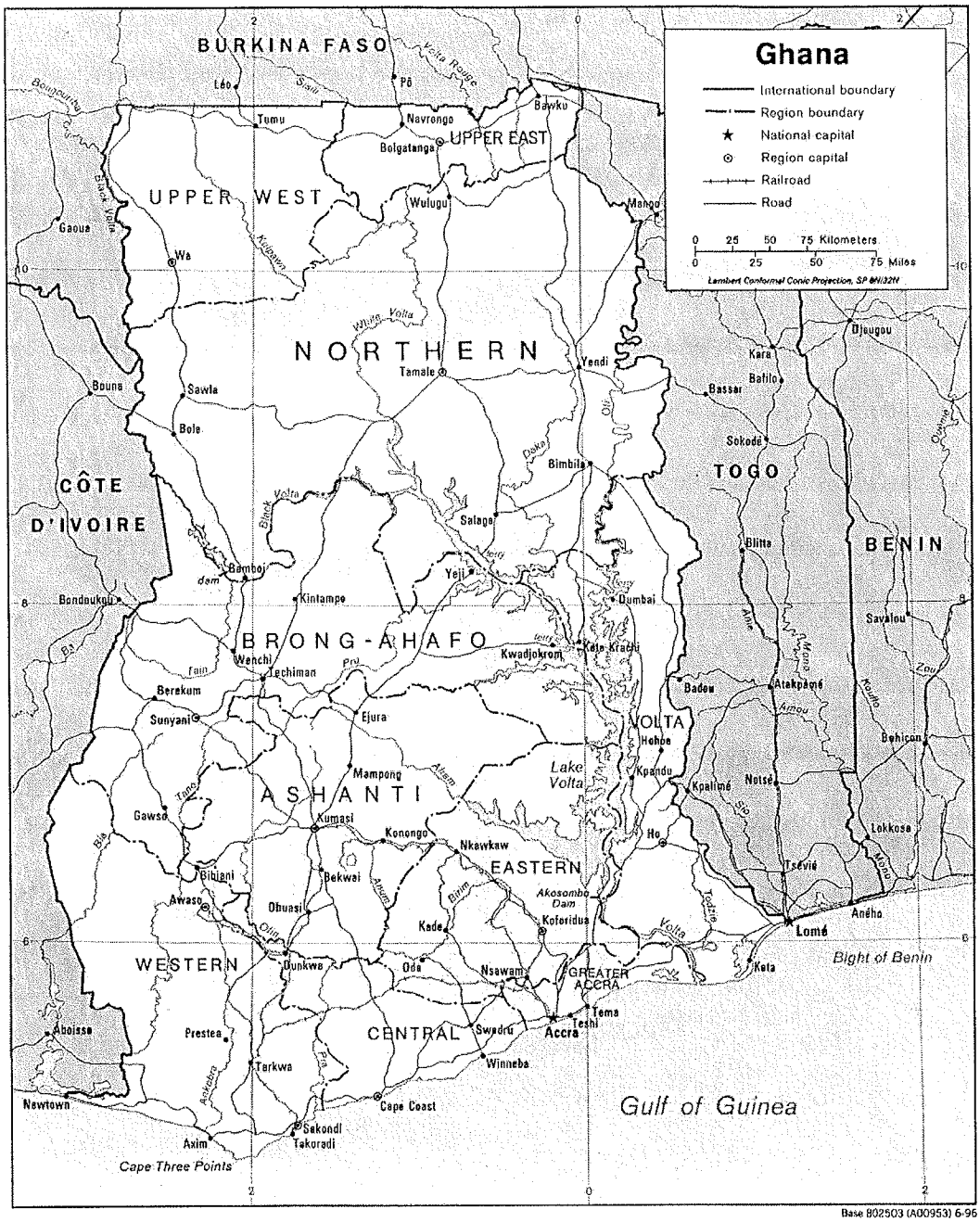
consumption and some surplus for export, particularly maize and beans. It is estimated that Uganda has 5.1 million cattle, 1.2 million pigs, 4.9 million goats, 0.8 million sheep and 20 million chicken. Fish catch is estimated at 250,000 metric tons annually (African Studies Association 1994).

Despite an excellent resource base in terms of land and climate relative to others in the region, Uganda still needs much more to achieve auto-sufficiency and a reliable food security system. Even with an annual growth rate of 6.4 % over the past 10 years, the country has yet to regain the gross domestic product level it had achieved in the past. Its $310 GNP per-capita places Uganda (ranked 180) close to the bottom of the World Bank list of World Development Indicators 2000. Over three-quarters of the country's population (77 %) live below the $2-a-day poverty line, and nearly 37 % live on less than $1 a day. The average Ugandan household spends about 64 % of total income on food. Using the cost of a 2,100-calorie food basket as a poverty line, 61 % of the population would be classified as poor. The situation is the worst in northern Uganda, where 39 % of the population is ultra-poor, compared with 29 % in the eastern region and 18 % and 17 % in the western and central regions (African Studies Association 1994).

3.3 GHANA

The republic of Ghana lies on the Gulf of Guinea, on the western coast of tropical West Africa. The country is similar in size to the Great Britain. Burkina Faso borders Ghana to the north, with Togo to the east, and Cote D'Ivoire to the west. The southern boundary opens onto the Atlantic Ocean (see Fig 3.4). The country total population was

Figure 3.4: Map of Ghana



Source: University of Texas Library Online

estimated at 19.7 million in 2000, comprised of a rich variety of ethnic groups. Ghana is well endowed with natural resources and the country has twice the per capita output of the poorer countries in West Africa (FAO, 2001). Even so, Ghana remains heavily dependent on international financial and technical assistance. Cocoa, coffee, timber, rice, cassava, peanuts, corn, shea nuts and bananas are some of the major agriculture products. In 1995-1997, Ghana made mixed progress under a three-year structural adjustment program in cooperation with the International Monetary Fund (IMF). On the minus side, public sector wages and inflation have increased over the years. Consequently, the local currency (CEDI) depreciated which had a negative effect on growth.

Agriculture is Ghana's most important economic sector, employing more than half the population on a formal and informal basis and accounting for more than 1/3 of the GDP and exports earnings (World Bank, 2002). The country produces a variety of crops in various climatic zones which range from dry savanna to wet forest and which run in east-west bands across the country. Agricultural crops, including yams, grains, cocoa, oil, palms, kola nuts, and timber, form the base of Ghana's economy. Despite the government effort to promote the agricultural sector, the country's overall agricultural output has consistently fallen since independence (1960s). Beginning with the drop in commodity prices in the late 1960's, farmers have been faced with fewer incentives to produce as well as with a general deterioration of necessary infrastructure and services. Farmers had also to deal with increasingly expensive inputs, such as fertilizer, because of overvaluation of the local currency (CEDI). Food production has fallen as well, with a

decline in the self-sufficiency ratio since 1978-80, coupled with a 400 % increase in food imports.

In Ghana the usual problems of food insecurity are apparent: low income, low yields, insufficient production, poor storage facilities, inadequate processing facilities, vulnerable water supplies. In addition, accelerating rates of deforestation are bringing new pressures on the environment and the people who rely on it for their livelihood. Meeting food and nutritional needs is very challenging for a number of people in Ghana. In Accra (the capital city) for example urban consumers purchase a wide variety of food away from home on a daily basis. The majority of these are street foods purchased and often consumed away from the household. Almost 40 % of the total food budget goes to purchasing street food (FAO, 2002). It appears that eating street food would improve the local diet and correct the lack of certain nutrients that were not available at the household level. In terms of current caloric intake, roughly 40 percent of households in Accra could be classified as food secure. Since 1993, the nutritional status of children in Accra has been deteriorating, with prevalence of stunting (low height for age) at almost 18 % and wasting (low weight for age) at 0.3 % (Maxwell et al. 2000).

CHAPTER 4

DATA SETS, MEASURES, AND METHODOLOGY

This chapter is composed of three major sections, which are also divided into sub-sections. Section one reviews the data sets employed and the selection of the sample households used in this study. Section two presents the different measures of food security indicators. Section three examines the statistical estimation methods used to analyze food security in Malawi, Ghana, and Uganda.

4.1 DATA SETS AND SAMPLE SELECTION

The analysis is based on data from three national household expenditures surveys, the Ghana Living Standards Survey IV conducted in 1998-1999, the Uganda National Household Survey (1999-2000), and the Malawi Integrated Household Survey (1997-1998). All surveys are nationally representative, covering both urban and rural areas, and were conducted over a full year's time. The surveys aim to help decision-makers to deal with policy issues such as education, migration, health, distribution of income and household behavior and welfare. The sample sizes, survey durations, and information about the food data collection for each country are given in the Table 2.

Table 2: The data sets

	Ghana	Malawi	Uganda
Year of Survey	1998-1999	1997-1998	1999-2000
Duration of survey (Months)	12	12	12
Number of households (*)	5,387	8,917	9,966
Reference period for food data collection (days)	30 days	28 days	7 days
Recall period (days)/a	1 day	1 day /or 3 days	7 days
Number of food items (**)	109	274	47

Source: Survey documentation obtained from the Africa Household Survey databank or International.

(*) These numbers represent the households included in the analysis after data cleaning and for which data on all independent variables used in the regression analysis are available.

(**) This is the number of food items after cleaning and processing.

Note: /a; the recall period is 3 days if the diary is kept by the enumerator and 1 day if kept by a household member.

MALAWI

The 1997/1998 Integrated Household Survey (I.H.S) was a socio-economic survey of the living standards of households in all 25 administrative districts of Malawi

and the 4 major urban centers of the country. These 29 areas constituted the survey strata.

In rural areas a three-stage sample design was used, while in urban areas a two-stage design was employed. In rural areas, the three stages consisted of traditional authorities (TA) for the first stage and enumeration areas (EA) within the traditional authorities as the second stage. Twelve EAs were selected in each pre-selected TA. Both TAs and EAs were selected with probability of selection proportional to the population size. Twenty households were randomly selected within the selected EAs as the third stage of sample selection. All selected households in an EA were interviewed in the same calendar month. Interviewing was carried out in each of the twelve selected EAs in turn through the twelve months of the survey year in order to capture seasonal variations in the socio-economic characteristics of the population in the TA.

In urban areas, EAs were selected with probability of selection proportional to population size. Ten households were randomly selected within these EAs. All selected households within a selected EA were interviewed in the same month. The number of EAs in an urban area in which interviews were conducted in any month was the total number of EAs selected in the urban area divided by 12.

The food data collection took place as follows. For food purchases, households were to maintain a diary for a minimum of 14 days and a maximum of 28 days, recording the quantity, unit of measure, and expenditure on each item purchased every day. One diary was given to each household member above 10 years old that could maintain the diary him or her self, while the enumerator maintained a diary for the remaining members

above 10 years. If kept by the enumerator the recall period was a maximum of three days. If kept by household member, the recall period was daily. For food obtained from own production, barter, gifts and other non-cash sources, enumerators visited each household once recording the quantity acquired over the previous three days, unit of measure, and estimated value. The total number of food items is 274 (Smith et al. 2003).

The National Statistical Office (NSO) managed the survey, administering questionnaires to 12,960 households over a 12-month period, November 1997 to October 1998. The data set consisted of 10,698 households when the cleaned data were released in early May 2000. However, as the diary of expenditure was not consistently maintained by enumerators across the country, upon additional assessment of the data, only 6567 households were judged to have reliable expenditure information for the derivation of household food security indicators[2].

UGANDA

The sampling design of the Uganda National Household Survey (UNHS) was generally stratified two-stage sampling, except in some districts where census mapping was not done in the 1991 Population and Housing Census. For these latter a three-stage design was used. For the two-stage sampling design, the first stage was the selection of the enumeration area (EA) while the second and ultimate stage was the selection of the household.

[2] To select which household should be included or excluded, a simple means comparison (t-test) statistical procedure was carried out. The results showed that the excluded households are likely to be poorer than the included households for the analysis. Therefore they differ.

The food data collection took place as follows. For the stratification, each district was treated as a separate stratum, with further sub-stratification being district town, other urban areas within the district, and rural areas. However the districts of Kampala and Mpigi were exceptions where the whole of Kampala was treated as urban, whereas Mpigi had four sub-strata. There were thus a total of 116 strata in Uganda.

During a single interview, households were asked the quantity in local units, units of measure, and value of food acquired from purchases, consumption out of home production, and gifts over the last 7 days. The number of food categories is 47 (Smith et al. 2003).

Overall of 10,700 and plus households surveyed, only 9,966 households were retained to conduct this study after data cleaning (see Table 2).

GHANA

The Ghana Living Standards Survey (GLSS) is a multi-purpose survey of households in Ghana, which collects information on the many different dimensions of their living conditions.

The GLSS IV survey was collected over 12 months (from April 1, 1998 to March 25, 1999) to ensure continuous recording of household expenditures and changes occurring thereof. A two-stage stratified sampling design was used. For the first stage of the sample selection, 300 Enumeration Areas (EAs) were chosen using systematic sampling with probability proportional to size. In the second stage, 20 households per EA were selected. The total sample size is therefore 6,000 households. Note that two

households were dropped before the data set was released. After data cleaning 5,387 households were retained to conduct this study.

The food data collection took place as follows. Households reported their expenditures on food purchases (for 103 foods) and quantities in local units of home produced foods consumed (57 foods) over 6 visits with 5-day reference period for each. The total reference period was 30 days. To facilitate recall, a diary of daily consumption and expenditures was used. If a literate household member was available, this person maintained the diary and then submitted it to the enumerator at the next visit to enter into the main questionnaire. If not, then the enumerator visited the household on a daily basis to maintain the diary. On one of the visits households were also asked to report the total value of the gifts in food they had received over the last year (Smith et al.2003).

4.2 MEASURES OF FOOD SECURITY INDICATORS.

Household calorie availability per adult equivalent and diet diversity are the two dependent variables of this study. It is important to keep in mind that the food data collected in household expenditure surveys reflect the quantity of food acquired by a household rather than consumed by its members.

4.2.1 HOUSEHOLD CALORIE AVAILABILITY PER ADULT EQUIVALENT

Household daily calorie availability is the measure of food quantity employed in this study. It is the estimated quantity of food acquired per day by a surveyed household

from purchases, consumption from own production and in-kind gifts. It measures the total amount of food available to a household on an average per day. It is expressed in Kilocalories, and denominated in adult equivalents. The number of "adult equivalents" in a household is determined by scaling the requirements of each individual in the household to those of a reference adult, based on age, sex, and assumption of moderate activity level. It is crucial to understand that the needs of household members differ depending on their age and sex. For example 2900 kilocalories per day is the required calories for an adult male between the ages of 30 and 60, with moderate activity levels (FAO/WHO/UNU 1985). To calculate the number of adult equivalents, a weight is assigned to each of the members in a household according to their age and sex characteristics relative to that of an adult male. Note that between the ages of 1 to 5, there is no difference between boys and girls regarding the adult equivalent. It is thought that children within that age range need to consume relatively the same quantity of food.

To construct the measure, metric quantities of food acquired by the household over the survey reference period are first derived[3]. Following, standard food-to-nutrient conversion tables are used to compute calories acquired, which is finally divided by the number of days in the reference period and the number of adult equivalents.

4.2.2 DIET DIVERSITY

The measure of diet diversity employed here is the number of food groups, out of 12, that a household acquired food from over the reference period. The groups are

[3] See Smith, Aduayam et. Al. (2003) for details.

cereals, roots and tubers, pulses and legumes, milk and milk products, eggs, meat and offal, fish and seafood, oils and fats, sugar and honey, fruits, vegetables, and miscellaneous category.

4.3 STATISTICAL METHODS

Two major questions are examined in this study:

1. Do diet quantity and diet quality tell us different things about who in a population is food insecure and the prevalence of food insecurity?

2. Do they have different determinants?

To answer the first question, correlation analysis and contingency tables are employed. To answer the second, community fixed-effects regression analysis (both Ordinary Least Squares and Two-Stage Least Squares) is employed.

Another important question that needs to be addressed is whether OLS or 2SLS is a better method for answering question 2. Households decide on the time they want to spend on food, how much to eat, how many food items to purchase. This multidimensional decision making within the household demonstrate that income is not independent to food purchasing. The theoretical argument being that income is not exogenous, it means that income depends on labor and labor depends food consumed. Therefore an endogeneity problem could be found between income and food (reverse causality). If there is an endogeneity problem linked with total household expenditure, the 2SLS method is more appropriate to use than the OLS method. Otherwise, both methods do a good job of providing coefficient estimates, but OLS is more efficient.

4.3.1 CORRELATION AND CONTINGENCY TABLE ANALYSIS

Correlation coefficients are index numbers that show to what extent two variables are linearly related. They can take on values that range from –1 to 1. To apply this method to our problem, we ask whether household calorie availability per adult equivalent is related to diet diversity and to what extent. One should expect a positive association between diet diversity and household daily caloric availability per adult equivalent.

The correlation method has some limits. This statistical method could be driven sometime by just one part of the distribution; therefore the method could be biased. Note that these correlation coefficients are a good exploratory tool, but should not be the only method used to check on the connection between two or more variables. This leads us to our next statistical technique: contingency tables.

Contingency tables are a second statistical method that could allow us to check on the association between household calorie availability and diet diversity. Two measures of food insecurity were created from the data from all three countries: "food energy deficiency" (FED) and "low diet quality" (LDQ). Household FED is closely related to the notion of access to food. It measures whether a household has sufficient food available to meet its members' requirements for a major macronutrient-energy. It addressed only diet quantity aspect of food. FED is a dummy (0,1) variable indicating whether a household falls below a certain energy intake requirement. Specifically, a household's energy availability is compared to a requirement that is based on its age and

sex composition. The energy requirement used is the light physical activity level (Smith 2003). LDQ is a dummy (0,1) variable that indicates whether a household falls within the bottom tercile of the number of different good groups acquired at a household level. The method of contingency tables cross-classifies two variables by two or more attributes (Hoddinott 2001). The contingency tables analysis conducted in this thesis reports on three statistics that need particular attention: specificity, sensitivity, and chi-square.

Specificity: the proportion of households in the country who are food energy deficient and who also have a low quality diet.

Sensitivity: the proportion of households in the country who are not food energy deficient and who also appear not to have a low quality diet.

Chi-square statistic: indicates whether there is a statistically significant association between food energy deficiency and low quality diet.

4.3.2 REGRESSION ANALYSIS

4.3.2.1 THEORETICAL FRAMEWORK FOR NUTRIENT DEMAND MODEL

A nutrient demand model is used to examine the determinants of food security in Ghana, Malawi and Uganda using the national surveys mentioned above.

The conceptual foundation for this analysis is a household decision model in which members maximize utility, most often through some bargaining process, subject to nutrition provisioning functions, budget constraints and full-income constraints. This section is taken from Smith and Aduayom (2003).

Utility functions may be specified as:

$$U_i(N_1,...,N_I,F_1,...F_K,X_0,T_L), i = 1,...,I,$$

where the N_i, i= 1, ...,I are members' nutrition provisioning functions, the F_K, k=1,... K, are individual food consumed by each member, X_0 is non-food commodities and services consumed, and T_L is leisure time. Nutrition provisioning is the process through which goods, especially food, are combined with care time to provide for a person's nutritional health, or status. We specify nutrition provisioning functions as:

$$N_i(Z_1,\ldots, Z_J, X_{N0}, T_N, \Omega_N), i = 1,\ldots,I.$$

where $$Z_J(F_1,\ldots,F_K),\ j = 1,\ldots,J.$$

Here the Z_J, j = 1,...,J are nutrients such as calories, proteins and fats (the macronutrients) or vitamin A, Zinc, and Iron (micronutrients), all of which are derived from foods. The variable X_{N0} is non-food inputs into nutrition provisioning (e.g., medicines), T_N is time spent in nutrition provisioning (e.g., feeding a child) and the vector Ω_N contains relevant individual, household, and community characteristics. The reduced-form[4] nutrient demand functions take the form:

$$Z_J^*(P_F, P_0, w, E, \Omega_N), j = 1,\ldots, J$$

Where P_F and P_0 are vectors of food and non-food prices, respectively, w is a vector of household members' wages, and E is a vector of exogenous incomes.

[4] A reduced-form equation is an equation that includes only exogenous variables. It's an alternative solution we go with because a full structural equation may be a bit challenging to deal with for some instances.

In this framework, people are seen to directly value food for its physical attributes (flavor, odor, appearance and texture) as well as for its status and symbolic value and for preparation and consumption time costs. People value the nutrients contained in food indirectly through their influence on nutritional status. The framework incorporates both diet quantity and quality. Diet quantity can be expressed as the sum of the calorie values of foods consumed and thus focuses only on one of the nutrients (Z_1, for instance). Diet quality, by contrast, is characterized by all of the nutrients needed for nutritional health ($Z_1, \ldots, Z_J$).

It is important to check whether there is any trade off between diet quality and quantity faced by households. Households may value more food quantity (say eat more rice) than the necessary nutrients (say vitamin A and zinc) because of some socio-cultural reasons. The trade off is to fill up the tummy (exhibit the law of utility and preferences) and therefore give up on additional nutrients or calories.

4.3.2.2 ECONOMETRIC MODEL

Based on the above reduced-form nutrient demand equation, diet quantity or diet quality (Y) is hypothesized to be determined by K explanatory variables, denoted X_k according to the following empirical specification:

$$Y_{ic} = \alpha + \sum_{k=1}^{K} \beta_k X_{k,ic} + \quad \mu_c + \upsilon_{ic},\ \upsilon_{ic} \sim N(0, \sigma^2),\ i = 1,\ldots,I \quad c = 1,\ldots,C,$$

where i denotes households, c denotes communities, α is a scalar, β is a Kx1 vector of parameters, and υ is an error term. The μ_c are unobservable community-specific, household-invariant effects, and the υ_{ic} are stochastic.

The use of OLS results in unbiased and consistent estimates of the β_k when there is no endogeneity problem. Because I will employ a measure of total, rather than exogenous, income in the regressions, I will test for endogeneity of income using instrumental variable estimation. Such endogeneity may arise due to the influence of a third factor on both our dependent variable and income (endogeneity by definition requires zero covariance between the error term and the explanatory variables). The Durban-Wu-Hausman test for a significant difference between uninstrumented and instrumented parameter estimates is employed using ownership of household assets as instruments (Davidson and Mackinnon 1993). Before performing the test, I will undertake both relevance (Bound, Jaeger, and Baker 1995) and overidentification (Davidson and Mackinnon 1993) tests to ensure that an appropriate set of assets is employed. Relevance test determines whether the selected instruments can in fact explain variation in the potentially endogenous variables to be instrumented. The test is an F test on joint significance of the instruments in a predicting equation for each potentially endogeneous variable. The overidentification test determines whether the candidate instruments directly affect the dependent variable other than through the potentially endogeneous variable to be instrumented.

Since the use of the OLS in the presence of such endogeneity is unadvised, Two-stage least squares (2SLS) procedures would be used to control for this endogeneity

problem via household assets. The assets are dummy variables that comprised mainly household items and appliances, like tables, chairs, refrigerator, radios and sewing machines, and vehicles.

4.3.2.3 INDEPENDENT VARIABLES

This section outlines the explanatory variables used in this study. The explanatory variables considered are income (replaced by total expenditures per capita for a reason I will explain shortly), education, household size and age-sex composition, and gender and age of household head. The descriptive statistics for these variables are shown in Table 2. Note that prices are not included explicitly as explanatory variables. However, price heterogeneity across communities is captured by the community fixed effects terms.

TOTAL EXPENDITURES PER CAPITA

Total expenditure is the value of all the acquisitions for food and non-food items by the household. Expenditures include cash purchases, the value of gifts received by the household and the value of home produced items consumed. Total expenditures are divided by the number of household members to derive total expenditures per capita. Based on past experiences, expenditures are found to be more appropriate and easy to work with than income because households are found to be more comfortable revealing their expenditures rather than their income level. Indeed in developing countries, information about income is found to be very difficult to get from household members. The surveyed household members are more comfortable answering questions regarding

their purchases rather than telling their income level (Garrett et al. 1999). Therefore expenditures are a better representation than income of total resources available to the household.

EDUCATION

Education is measured using dummy variables indicating whether any adult member has a primary education and any adult member has a secondary education. These two reflect the education level attained by any person > 18 years. Education, as a form of human capital, should be positively correlated with diet diversity but its effect on diet quantity is ambiguous. On the one hand, where food consumption is inadequate, education may serve to increase adult household members' awareness of the need to ensure adequate food consumption. On the other hand, where food consumption is in excess of needs, education may lead households to reduce consumption in order to avoid obesity and the associated increased risk of chronic diseases (Smith and Aduayom 2003).

DEMOGRAPHIC COMPOSITION

Household size and age-sex composition and age of the household head are included to account for possible scale effects and demographic structure of the household. A dummy variable is also included in this category to account for whether or not the household is headed by a female.

CHAPTER 5

RESULTS

This chapter presents the empirical results. I start off with the descriptive statistic results of the two dependent variables. Then follows the presentation of the correlation coefficients and contingency tables results. Then follows the presentation of the different tests and all the regression analysis results. The final section provides answers to the two main questions asked in the introduction: do the two indicators of food insecurity tell us different things about who in a population is food insecure and the prevalence of food insecurity? And do the indicators of food security used in this study have different determinants?

5.1 DESCRIPTIVE STATISTICS OF THE DEPENDENT VARIABLES

Table 3 presents not only the descriptive statistics results of the two dependent variables, but also contains the descriptive statistics of all the explanatory variables that will be used in the regression analysis. Reference period refers to the time period over which food collection takes place in total. Whenever a household is visited once, then the reference period equals the recall period defined as the period in which the food data was collect. The reference periods for food data collection differ from one country to another; therefore caution must be used in comparing means of diet diversity across countries. Table 2 details the reference periods for food data collection in all three countries. The reference is 30 days in Ghana, 7 days in Uganda, and 28 days in Malawi.

Table 3: Descriptive Statistics

Variable	Ghana				Malawi				Uganda			
	mean	sd	min	max	mean	sd	min	max	mean	sd	min	max
Dependent Variables												
Calories acquired per adlt eqvlt	3664	2247	156	11999	2483	1367	24	8219	3955	1965	42	11936
Number of food groups required	9.21	1.71	1	12	7.17	2.21	1	12	7.05	2.14	1	12
Explanatory Variables												
Total expenditures per capita a/	3364	2803	299	62099	13.79	24.55	1	603	975	1156	58	42517
Adult education:any primary	0.38	0.49	0	1	0.59	0.01	0	1	0.60	0.49	0	1
Adult education:any secondary	0.30	0.46	0	1	0.21	0.00	0	1	0.21	0.41	0	1
Household Size	4.27	2.55	1	18	4.40	2.31	1	18	5.19	3.05	1	42
Female headed household	0.34	0.47	0	1	0.24	0.43	0	1	0.26	0.44	0	1
Age of household head (years)	46.06	15.42	18	99	41.23	15.40	16	118	43.46	15.89	12	99
Percent females 0-16	18.62	19.46	0	83	20.06	19.44	0	80	22.55	19.39	0	83
Percent females 16-30	11.54	17.86	0	100	15.62	17.59	0	100	12.63	16.06	0	100
Percent females 30p	20.94	23.39	0	100	15.28	19.93	0	100	15.34	20.50	0	100
Percent males 0_16	18.56	19.33	0	80	19.12	19.05	0	80	23.07	19.49	0	88
Percent males 16-30	11.77	22.53	0	100	14.95	21.78	0	100	11.40	18.76	0	100
Percent males 30p	18.57	25.30	0	100	14.97	19.84	0	100	15.01	21.02	0	100

Notes: Means are adjusted for survey design (weighted mean)

a/Currencies: Uganda: Uganda Shillings (on January1,1999, $US 1 = 1,362.00 Uganda Shillings)
Malawi: Malawi kwacha (on January 1, 1999, $US 1 = 31.07 Kwacha)
Ghana:Ghana Cedi (on January1, 1998, $US 1 = 2,270.00 Cedis)

The average of calories acquired per adult equivalent is highest in Uganda (3955 kilocalories) and lowest in Malawi (2483 kilocalories). In Ghana, the average calories per adult equivalent is 3664.

5.2 CORRELATION COEFFICIENTS AND CONTINGENCY TABLES

5.2.1 CORRELATION COEFFICIENTS

Table 4 presents the correlation coefficients between household calorie availability and diet diversity in Ghana, Malawi and Uganda. There are positive associations between calorie availability and diet quality in all three countries. All correlation coefficients are positive and statistically significant at the 1 percent level. The correlation is smallest in Malawi (0.1706) and highest in Ghana with a numerical value of 0.223. The correlation coefficient between the two dependent variables is 0.1937 in Uganda. These results help in answering whether the two dependent variables of the study are the same. The relatively low magnitudes of the correlation between these two variables suggests that they measure two distinct aspects of food security.

Table 4: Correlation Coefficients between household calorie availability per adult equivalent and number of food groups acquired.

GHANA	MALAWI	UGANDA
0.2233	0.1706	0.1937
P=0.0000	P=0.0000	P=0.0000

5.2.2 CONTINGENCY TABLES

Tables 5 through 7 present the contingency table results for all three countries. The results are summarized in Table 8. Within the tables, there are three numbers of interest: specificity, sensitivity, and a chi-squared test.

Table 5: Contingency table between FED and LQD (Ghana 1998)

	Low quality diet	Not low quality diet	Total
Food energy deficient	1390	875	2265
Not food energy deficient	1418	1704	3122
Total	2808	2579	5387

Specificity	0.61
Sensitivity	0.55
Chi-squared test	133.8***

Note: *** denotes statistically significant at the 1 percent level

FED is food energy deficiency (binary 0-1 variable)

LQD is low quality diet (binary 0-1 variable)

Table 6: Contingency table between FED and LQD (Malawi 1997)

	Low quality diet	Not low quality diet	Total
Food energy deficient	2809	3024	5833
Not food energy deficient	1182	1902	3084
Total	3991	4926	8917

Specificity (0.48), sensitivity (0.62), and chi-squared test (78.84***)

Table 7: Contingency table between FED and LQD (Uganda1999)

	Low quality diet	Not low quality diet	Total
Food energy deficient	1599	1430	3029
Not food energy deficient	2489	4448	6937
Total	4088	5878	9966

Specificity (0.53), sensitivity (0.64), and chi-squared (249.18***)

Table 8: Contingency table results for Ghana, Malawi, and Uganda

Variable	Ghana	Malawi	Uganda
Specificity	0.61	0.48	0.53
Sensitivity	0.55	0.62	0.64
Chi-square	133.8	78.84	249.18

Specificity is defined as the proportion of households who are food energy deficient and who also have a low quality diet. For example 1390 households out of 2265 that are food energy deficient in Ghana also have low quality diet. Specificity results are the highest in Ghana (0.61) and lowest in Malawi (0.48). In Uganda the specificity is 0.53.

Sensitivity is defined as the proportion of people who are not food energy deficient and who also appear not to have low quality diet. For example, 4448 households out of 6937 in Uganda are not food energy deficient and do not have low quality diet. The sensitivity results are 0.55 for Ghana, 0.62 for Malawi, and 0.64 for Uganda. Note that in Ghana, specificity is higher than sensitivity results. However, in Malawi and Uganda sensitivity results are higher than those of specificity.

Chi-squared test looks at whether there is a statistically significant association between these indicators of food insecurity. Note that all these results have high chi-squared and are statistically significant at the 1 percent level.

These results concur with the correlation coefficient results: diet quantity and diet quality appear to represent two distinct dimensions of food security. To illustrate, the percent of food insecurity using only FED as indicator is respectively 42 for Ghana, 65 for Malawi, and 30 for Uganda (see Table 9).

Table 9: Comparing the magnitude of food insecurity in Ghana, Malawi, and Uganda

	Ghana	Malawi	Uganda
% of food insecure using FED as indicator	42	65	30
% of food insecure using LQD as indicator	52	48	41
% of food insecure if either FED or LQD	68	79	55

The same percent of food insecurity using LDQ as the only indicator is respectively 52 for Ghana, 48 for Malawi, and 41 for Uganda.

Uganda has the lowest prevalence of food insecurity by both indicators. However, using FED as an indicator, Malawi has higher food insecurity than Ghana, but the opposite is true when using LDQ as an indicator. This is because diet quantity is more severe food security problem in Malawi than Ghana; diet quality is more severe problem in Ghana than Malawi.

5.3 REGRESSION ANALYSIS

5.3.1 CHOICE BETWEEN OLS AND 2SLS

RELEVANCE TEST

One of the biggest concerns in running 2SLS is to make sure that the presence of endogeneity could be solved by the use of the appropriate instruments. We want to know out of the candidate set of instruments which ones to use. Relevance test helps us to choose the best instruments to use in our regression. In other words we want to know whether the instruments actually predict the endogenous variable well. Relevance test is

Table 10: Regression Results for Ghana

Variables	Calorie availability per adult equivalent				Number of food groups			
	OLS (preferred)		2SLS		OLS (preferred)		2SLS	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Total expenditures per capita	0.43	8.11 ***	0.33	4.26 ***	0.0002	6.95 ***	0.00035	3.98 ***
Elasticity	0.42				0.062			
Adult education:any primary	-65.38	-1.04	-39.75	-0.57	0.4272	6.76 ***	0.38	5.53 ***
Adult education:any secondary	-152.08	-1.77 *	-98.96	-0.98	0.5100	6.90 ***	0.42	4.68 ***
Household Size	-135.39	-7.07 ***	-159.57	-6.48 ***	0.1365	9.23 ***	0.18	7.76 ***
Female headed household	-29.74	-0.37	-24.23	-0.29	-0.1960	-2.50 **	-0.21	-2.46 ***
Age of household head (years)	5.59	2.61 *	3.08	1.19	-0.0025	-1.62	0.00	0.75
Percent females 16-30 years	3.24	1.34	4.57	1.95 **	-0.0023	-1.13	0.00	-2.09 **
Percent females 30 or more	9.69	2.78 ***	12.28	4.44 ***	-0.0031	-1.17	-0.01	-3.55 ***
Percent males 0-16 years	-5.77	-3.14 ***	-5.69	-2.96 ***	-0.0043	-2.91 ***	0.00	-3.09 ***
Percent males 16-30 years	-17.91	-5.99 ***	-14.65	-5.76 ***	-0.0147	-7.44 ***	-0.02	-7.80 ***
Percent males 30 or more	-13.41	-4.60 ***	-9.57	-3.43 ***	-0.0185	-8.77 ***	-0.03	-7.76 ***
R-squared	0.554		0.550		0.424		0.43	
Specification tests (p-values)								
Instrument Relevance			0.000(F=32.3)				0.000 (F=31.0)	
Overidentification			0.460				0.810	
Durban-Wu-Hausman			0.510				0.410	
Number of clusters			300				300	
Number of observations			5387				5387	

Note:* = significant at the 10 % level; ** = significant at 5 % level; and *** = significant at 1 % level.

Table 11: Regression Results for Malawi

Variables	Calorie availability per adult equivalent				Number of food groups			
	OLS		2SLS(preferred)		OLS		2SLS(preferred)	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Total expenditures per capita	9.66	4.06 ***	43.37	6.78 ***	0.007	3.23 ***	0.139	8.61 ***
Elasticity			0.24				0.27	
Adult education:any primary	-16.14	-0.29	-49.43	-0.94	0.316	3.9 ***	0.186	0.02 **
Adult education:any secondary	29.85	0.37	-247.63	-2.87 ***	0.937	9.05 ***	-0.146	-1.13
Household Size	-103.41	-10 ***	-72.70	-5.3 ***	0.099	5.98 ***	0.219	5.96 ***
Female headed household	1.71	0.03	-16.83	-0.3	-0.205	-2.32 ***	-0.278	-2.28 **
Age of household head (years)	-3.50	-2.45 **	-1.91	-1.17	-0.012	-5.22 ***	-0.006	-1.64 *
Percent females 16-30 years	6.10	3.46 ***	-1.77	-1.42	0.000	-0.06	-0.004	-1.51
Percent females 30 or more	5.46	2.67 ***	-6.23	-4.5 ***	-0.001	-0.76	-0.014	-5.4 ***
Percent males 0-16 years	-1.28	-1.07	-6.24	-3.55 ***	-0.002	-1.22	-0.016	-5.36 ***
Percent males 16-30 years	-3.72	-2.86 ***	4.34	2.11 ***	-0.004	-2.51 ***	-0.007	-1.49
Percent males 30 or more	-2.40	-1.47	3.10	1.52	-0.002	-0.73	-0.010	-2.98 ***
R-squared	0.31		0.14		0.56			
Specification tests (p-values)								
Instrument Relevance			0.000 (F=63.02)				0.000 (F=63.02)	
Overidentification			0.60				0.32	
Durban-Wu-Hausman			0.00				0.00	
Number of clusters	538		538		538		538	
Number of observations	6567		6567		6567		6567	

Note:* = significant at the 10 % level; ** = significant at 5 % level; and *** = significant at 1 % level.

Table 12: Regression Results for Uganda

Variables	Calorie availability per adult equivalent				Number of food groups			
	OLS		2SLS(preferred)		OLS		2SLS(preferred)	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Total expenditures per capita	0.47	5.53 ***	1.29	6.78 ***	0.00044	4.86 ***	0.0028	8.80 ***
Elasticity			0.32				0.39	
Adult education:any primary	235.34	2.34 **	-210.50	-3.55 ***	0.65	6.71 ***	0.1119	1.68 *
Adult education:any secondary	217.66	1.78 *	-423.60	-3.75 ***	1.39	11.25 ***	-0.2355	-1.28
Household Size	-94.85	-7.36 ***	-84.10	-5.52 ***	0.05	4.62 ***	0.0850	3.45 ***
Female headed household	-162.00	-1.82 *	66.60	0.93	-0.49	-5.9 ***	-0.5490	-6.05 ***
Age of household head (years)	0.49	0.26	4.80	2.36 **	-0.01	-7.29 ***	-0.0004	0.12
Percent females 16-30 years	9.62	3.72 ***	4.00	1.38	0.0004	0.17	-0.0191	-3.42 ***
Percent females 30 or more	11.81	4.73 ***	2.60	0.96	-0.0064	-2.93 **	-0.0308	-7.03 ***
Percent males 0-16 years	-2.73	-2.05 **	-2.50	-1.67 *	-0.0012	-0.83	-0.0019	-0.76
Percent males 16-30 years	-3.70	-2.18 **	-12.50	-5.21 ***	-0.0183	-11.19 ***	-0.0442	-11.32 ***
Percent males 30 or more	-0.36	2.23	-9.40	-3.54 ***	-0.187	-9.04 ***	-0.0494	-11.37 ***
R-squared	0.15		0.25		0.28			
Specification tests (p-values)								
Instrument Relevance			0.000 (F=32.9)				0.000 (F=47)	
Overidentification			0.37				0.340	
Durban-Wu-Hausman			0.00				0.000	
Number of clusters	975		975		975		975	
Number of observations	9965		9965		9965		9965	

Note:* = significant at the 10 % level; ** = significant at 5 % level; and *** = significant at 1 % level.

Table 13: Regression results for calories per adult equivalent: Comparison across countries

Variables	GHANA (OLS)		MALAWI (2SLS)		UGANDA (2SLS)	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Total expenditures per capita	0.43	8.11 ***	43.37	6.78 ***	1.29	6.78 ***
Elasticity	0.42		0.24		0.32	
Adult education:any primary	-65.38	-1.04	-49.43	-0.94	-210.50	-3.55 ***
Adult education:any secondary	-152.08	-1.77 *	-247.63	-2.87 ***	-423.60	-3.75 ***
Household Size	-135.39	-7.07 ***	-72.70	-5.3 ***	-84.10	-5.52 ***
Female headed household	-29.74	-0.37	-16.83	-0.3	66.60	0.93
Age of household head (years)	5.59	2.61 *	-1.91	-1.17	4.80	2.36 **
Percent females 16-30 years	3.24	1.34	-1.77	-1.42	4.00	1.38
Percent females 30 or more	9.69	2.78 ***	-6.23	-4.5 ***	2.60	0.96
Percent males 0-16 years	-5.77	-3.14 ***	-6.24	-3.55 ***	-2.50	-1.67 *
Percent males 16-30 years	-17.91	-5.99 ***	4.34	2.11 ***	-12.50	-5.21 ***
Percent males 30 or more	-13.41	-4.60 ***	3.10	1.52	-9.40	-3.54 ***

Table 14: Regression results for number of food groups: Comparison across countries

Variables	GHANA (OLS)		MALAWI (2SLS)		UGANDA (2SLS)	
	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat
Total expenditures per capita	0.0002	6.95 ***	0.139	8.61 ***	0.0028	8.80 ***
Elasticity	0.062		0.27		0.39	
Adult education:any primary	0.4272	6.76 ***	0.186	0.02 **	0.1119	1.68 *
Adult education:any secondary	0.5100	6.90 ***	-0.146	-1.13	-0.2355	-1.28
Household Size	0.1365	9.23 ***	0.219	5.96 ***	0.0850	3.45 ***
Female headed household	-0.1960	-2.50 **	-0.278	-2.28 **	-0.5490	-6.05 ***
Age of household head (years)	-0.0025	-1.62	-0.006	-1.64 *	-0.0004	0.12
Percent females 16-30 years	-0.0023	-1.13	-0.004	-1.51	-0.0191	-3.42 ***
Percent females 30 or more	-0.0031	-1.17	-0.014	-5.4 ***	-0.0308	-7.03 ***
Percent males 0-16 years	-0.0043	-2.91 ***	-0.016	-5.36 ***	-0.0019	-0.76
Percent males 16-30 years	-0.0147	-7.44 ***	-0.007	-1.49	-0.0442	-11.32 ***
Percent males 30 or more	-0.0185	-8.77 ***	-0.010	-2.98 ***	-0.0494	-11.37 ***

a simple F-test on the joint significance of the instruments when the endogenous variable is the dependent variable.

The test is performed by randomly choosing a set of instruments from each country that would generate the highest F-value. In Malawi, bed and table were chosen for both diet quantity and diet quality. In Ghana, furniture, sewing machine and stove were applied for diet quantity and bicycle, motorcycle, car were chosen for the diet diversity variable. In Uganda, furnishings, jewelry/watches, and house were used for diet quantity and furnishings and jewelry/watches were used for diet quality (see Appendix 1 for details). In Malawi, the relevance test results are F= 63.02 for both household calorie availability per adult equivalent and diet diversity. In Uganda those results are respectively 32.9 and 47. In Ghana those results are respectively of 32.3 and 31. Note that all p-values associated with the F-statistics are significant at the one percent level.

OVERIDENTIFICATION TEST

This test determines whether the instruments affect the dependent variable other than through total expenditure per capita (income). The null hypothesis tested is that:

(a) instruments are uncorrelated with the errors

(b) the model is correctly specified.

The hypothesis is rejected if the test "p-value" is less than 0.1.

The p-value results are the following for our two dependent variables. In Ghana it's 0.46 for the food quantity and 0.81 for the food quality variable. The results are respectively 0.37 and 0.34 for Uganda; and 0.60 and 0.32 for Malawi.

In all three countries the "p-value" are greater than 0.1. Therefore we do not reject the null, which implies that there is no overidentification problem in any country. Thus the chosen instruments sets are valid for performing the Hausman test.

DURBAN-WU-HAUSMAN TEST

The null hypothesis is: total expenditure is not endogenous. The null is rejected if the Chi-square "p-value" is less than 0.01. For Ghana the p-values are 0.51 and 0.41 for the measures of diet quantity and diet quality respectively. The tests fail to reject the null hypothesis. There is no endogeneity problem associated with total expenditure per capita, and the more efficient OLS estimation technique should be used. However, for Malawi and Uganda, the p-values are all less than 0.1 (see Tables 11 and 12). Therefore, there is an endogeneity problem and 2SLS must be used.

5.3.2 THE DETERMINANTS OF DIET QUANTITY AND QUALITY

All OLS and 2SLS regression results are reported in Tables 10-12. The preferred results, based on the tests performed above, are summarized in tables 13 and 14. The specification tests[6] demonstrated that total expenditure per capita is endogenous in the determination of both calorie availability and diet quality in the cases of Malawi and Uganda, but not for Ghana. In the following section, despite having both OLS and 2SLS results, the discussion would only focus on the preferred results for all three countries.

For Ghana, Malawi and Uganda the coefficients on per capita expenditures are positive and statistically significant at 1 percent level of significance for both calorie availability and diet diversity. These results show the crucial role of income in facilitating access to food for all households. Since total expenditures are in different currencies, I cannot compare the coefficients across countries. However, I can compare the elasticity (the percentage change in the dependent variable given a one percent change in an independent variable) values. For the household calorie availability per adult equivalent, the elasticity is highest in Ghana (0.42), followed by Uganda (0.32). For Malawi, the elasticity is 0.24 (see Table 13). For diet quality, the elasticity results are respectively 0.39, 0.27, and 0.062 for Uganda, Malawi, and Ghana (see Table 14).

The preferred table results of all three countries display a negative association between diet quantity and both primary and secondary education. The association appears to be negative and statistically significant at 1 percent level of significance in Uganda (for both primary and secondary education), in Ghana and Uganda (only for secondary education). In all three countries, the negative relationship between household calorie availability per adult equivalent and education means that education appears to bring awareness of the need to limit calorie intake in order to avoid excess weight. The preferred results show a positive association between diet quality and the two different levels of education. In Ghana both primary and secondary education results are positive and statistically significant at 1 percent level of significance. In the cases of Malawi and

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[6] Relevance test, overidentification test, and Durban-Wu-Hauman test were performed to correct the

Uganda having a secondary education does not seem to make any difference in terms of the diet quality. Having a primary education within the household tends to systematically improve diet quality. One could explain the difference in magnitude of the coefficients by the quality of education and training offered in the countries.

The preferred results in all three countries suggest also that the gender of household head appears to make no difference when it comes to diet quantity. However, female headed household and diet quality are negatively associated (all coefficient are significant at 5 % level). It means that having a female as opposed to male household head worsen diet quality in all three countries.

Household size appears to be negatively associated with calorie availability and positively associated with diet quality. Larger households appear to have access to less calorie per adult equivalent than smaller households. In terms of diet diversity, bigger households diversify their diet much more than smaller ones.

The age of household head is negatively associated with diet quality in all three countries. However, the relationship between the age of household head and diet quality turned out to be non-significant in either Ghana or Uganda. In Malawi, an aging household head worsens diet quality. The age of household head is positively associated with household calorie availability per adult equivalent in both Ghana and Uganda and negatively associated with household calorie availability per adult equivalent in Malawi. The age of household head appears not to make any difference in terms of food calorie availability in Malawi because the coefficient turned out to be insignificant at any level of

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endogeneity problem.

significance. However, an aging household head appears to significantly improve food calorie availability in both Ghana and Uganda.

5.4 ANSWERS TO THE RESEARCH QUESTIONS

The first question investigates whether the indicators of food insecurity tell us different things about who in a population is food insecure and the prevalence of food insecurity. The empirical findings from Ghana, Malawi, and Uganda suggest that the two indicators are related but they appear to be different based on the contingency tables and the correction coefficients results (see Tables 4-9). The two indicators systematically do tell us different things about how an agency such as the World Food Program (W.F.P) determine where to allocate its aid and therefore concentrate on populations that do not meet diet requirements.

The second question investigates whether calorie availability and diet quality have the same determinants. Also do the determinants have positive or negative effects? The following organization is used to analyze the determinants of food security: diet quality and diet quantity.

DIET QUALITY

Among the determinants considered in this study, diet quality appears to have the following determinants in Ghana and Uganda: income, education, household size, and female-headed household (see Appendix 1). Income, education, and household size have a positive effect on diet quality. These results imply that an increase in income at the

household level will help improve the dietary quality within the same household. At the same time an improvement in education has a positive effect on dietary improvement. The higher the education level the better the diet quality. Note also that household size improve the overall diet quality. It is important to note that female headed household has a negative effect on diet quality. This striking result means that having a female head of household deteriorate the diet quality. In Malawi, age of head of household has a negative effect diet quality.

DIET QUANTITY

Household calorie availability appears to have the following determinants: income, education, household size, and age of household head in both Ghana and Uganda. However, in Malawi, age of head of household appears not to make any difference in terms of household calorie availability (not significant). Once again income displays a positive relationship with calorie availability. This means that any increase of income at the household level will improve the household food availability. Education has a negative effect. It implies that educated people tend to eat less calories but seek for better food quality. Age of household head has a positive effect on household calorie availability in both Ghana and Uganda. This result is not significant in Malawi.

The common determinants for both household calorie availability and diet quality in all three countries are Income (positive effect in both cases), education (negative effect on diet quantity but positive effect on diet quality), and household size (negative effect on diet quantity but positive effect on diet quality). In the cases of Ghana and Uganda, age

of household head appears to be a determinant for calorie availability; and in Malawi age of household head appears to make a difference in terms of diet quality.

Increasing the income level in all three countries will tremendously improve household food availability in terms of it quality and quantity. Both education and household size tend to lower the diet quantity and improve the diet quality.

CHAPTER 6

SUMMARY AND CONCLUSIONS

The results of this study point to the importance of using both household calorie availability per adult equivalent and diet diversity as indicators of food security for helping to eradicate food insecurity in Sub-Saharan Africa. The non-substituability between the two indicators (refer to contingency tables and correlation coefficient results) suggests that both measures should be used for targeting food-insecure populations and identifying the types of policies needed to reduce food insecurity. One should not expect the use of household expenditure surveys in Ghana, Malawi and Uganda to provide all answers to the food insecurity issue. The use of the expenditures will provide only some insights and at the same time raise some questions that need to be addressed by future researchers and policy-makers. This chapter is divided in two sections: section 1 summarizes the findings and section 2 considers policy implications.

6.1 MAIN FINDINGS

The study has shown a weak association between diet quantity and diet quality in all three countries, indicating that the two indicators of food insecurity used in this thesis are not substituable for one another. Indeed, they represent two distinct dimensions of food security. This answers partially the question whether the two dependent variables are the same. This also shows to researchers and decision-makers the importance of

using of both diet quantity and diet quality variables for assessing food security problems in the developing world.

Note that Uganda has the lowest prevalence of food insecurity by both indicators. However, using FED as an indicator, Malawi has higher food insecurity than Ghana, but the opposite is true when using LDQ as an indicator. This is because diet quantity is more severe food security problem in Malawi than Ghana; diet quality is more severe problem in Ghana than Malawi.

This study has shown the crucial role of income (proxy of total expenditures in this study) in securing a satisfactory diet. Income appears to support households in their attempts to improve both diet quantity and quality.

It is very important to note that, after controlling for income, education has a negative effect on household calorie availability but a positive effect on diet quality. This suggests that households with better education level are more likely to meet their dietary quality requirements. Indeed, education makes people more aware of the necessity of eating right and good in order to be mentally and physically productive and also avoid health problem issues.

The study showed also that household size has a negative effect on household calorie availability per adult equivalent but a positive effect on diet quality. It means that large households are less able to secure adequate food quantity but are likely to have a better diet quality than smaller ones.

The empirical results also suggest that the gender of household head does not make any real difference in terms of diet quantity. However, it is important to note that

gender of household head has a negative effect on diet quality. This striking result means that having a female head of household simply worsens diet quality compared to having a male head of household.

The age of household head has a negative effect on diet quality in Malawi. It implies that the age of household head matters when it comes to diet quality. This empirical result appears not to make any difference in Ghana and Uganda. However the age of household head matters when it comes to diet quantity in both Ghana and Uganda. The coefficients are positive and significant. In Malawi, this result turned out to be insignificant.

In conclusion, in all three countries, income, education, and household size appear to be key determinants for both household calorie availability per adult equivalent and diet quality.

6.2 POLICY IMPLICATIONS

This study has shown that the non-substituability between household calorie availability per adult equivalent and diet diversity could be taken advantage of by researchers and decision-makers in targeting food insecure populations. However, the concern is what would be the outcome of the simultaneous use of diet quantity and diet quality in solving the challenging problem of food insecurity?

Using three countries in Sub-Saharan Africa is a good start to see where food insecurity stands, however more countries need to be involved in order to generalize the results and findings.

Meanwhile, the study has shown that income is once again pivotal to any attempt to improve food security in a serious and sustainable fashion. This sustainability should be done for the most needing households by the leading institutions.

Given the effect of education in improving nutrition, governments must invest in education to improve the poor figures shown on the data set (only 38 % of households have a member with primary education in Ghana, 61 % in both Malawi and Uganda). Lack of secondary education is obvious in all three countries (only 30 % of households have a member with any secondary education in Ghana, 22 in Malawi and 22 also in Uganda) (see Appendix 2). However, this study has shown that raising education levels will not improve diet quantity.

The striking result seeing female head of household do worse than their counterpart male headed households when it comes to diet quality need further investigation to comprehend and analyze the matter properly.

In summary, the findings suggest that income, education, and household size are key determinants of diet quality and quantity. These determinants are very important to focus on in order to win the battle against hunger. Also, a particular attention needs to be paid from policy makers towards female-headed households. These characteristics are fundamental in order to win the battle against hunger.

To complement the above policies, dietary diversification must be a priority in the governments' agenda to ease accessibility to high quality food, for example through supplementation programs. For example, Sifri and Darnton-Hill (2002) discuss the importance of diet diversity for reducing micronutrient deficiencies in Africa. They stated

that despite some encouraging progress, micronutrient malnutrition remains a public health problem affecting all countries in Africa. To solve this problem, they believe that multimicronutrient supplementation program is the approach to explore. They insist that food-based approaches such as dietary diversity are both sustainable and culturally well accepted in the African context. Many countries in Africa are progressing with food fortification efforts including wheat flour fortification with iron in Zimbabwe and vitamin A fortification of sugar in Zambia and many other West African countries. They concluded that successful dietary diversification programs rely on sound nutrition education and behavior change activities.

Appendix 1: summary of the regression results signs

	Ghana		Malawi		Uganda	
	Kcal_ae	Numfoodg	Kcal_ae	Numfoodg	Kcal_ae	Numfood
Income	+	+	+	+	+	+
Education	-	+	-	+	-	+
Household size	-	+	-	+	-	+
Female headed household	ns	-	ns	-	ns	-
Age of head of household	+	ns	ns	-	+	ns

Ns: non-significant

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