A REVIEW OF AGRICULTURE, FOOD SECURITY AND HUMAN NUTRITION ISSUES IN UGANDA

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Abstract

Uganda faces a wide range of development challenges, among them regional and seasonal food insecurity and varying degrees of adult and child malnutrition. This paper provides a brief review of topics and available evidence regarding agriculture, food security and malnutrition in Uganda. It is intended to document important source material and provide an overview of topics for non-specialists or those moving into new areas of concern.

Keywords: agriculture, health, nutrition, Uganda

JEL Codes: I12, I31, O19, Q18

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1. Introduction

Uganda faces many development challenges, among them food insecurity and adult and child malnutrition. Uganda is among the least well-nourished countries in the world. In 2005, the United Nations World Food Program conducted a Comprehensive Food Security & Vulnerability Analysis (CFSVA) in Uganda which showed that 6 per cent of households were food insecure and 21% were moderately food insecure and at risk of becoming food insecure if conditions deteriorated (McKinney, 2009). According to von Grebmer, et al. (2011), Uganda has a Global Hunger Index (GHI) score of 16.7, placing it 42nd out of 81 countries ranked in 2011; its hunger situation is considered *serious*. Malnutrition accounts for 40% of all child deaths in Uganda (Bridge, et al., 2006), and the prevalence of childhood anemia exceeds 70% (WFP, 2011). Uganda's food security situation is complicated by the presence of more than 150,000 refugees from neighboring countries, many of whom lack the means to produce or access food.[1]

This paper provides a review of topics and evidence regarding nutrition, food security and related subjects in Uganda. It is by no means comprehensive in its scope or coverage, but is intended to document important source material and provide an overview of topics for non-specialists or those moving into new areas of concern. The material is organized under a series of broad thematic headings; however, it is important to recognize that most of issues covered in the paper are interconnected both in their causes and their impacts. Throughout, reference is made to data derived from the Uganda Demographic and Health Survey (UDHS). DHS survey data for Uganda are nationally representative and publicly available.[2] DHS data provide the most comprehensive assessment of nutrition outcomes available for Uganda.

2. Malnutrition, food insecurity and health

Even in the absence of a specific crisis, many communities in Uganda struggle with chronic malnutrition, especially among children. One study showed low mid-upper arm circumference (MUAC) in 21.6% of Ugandan children fewer than 30 months old (Kikafunda, et al., 1998b).[3] The prevalence of stunting among children under five years of age is nearly 40% across the country, and is higher in Karamoja and the southwest, where it exceeds 50% (WFP, 2011; FAO, 2010). Nevertheless, the overall trend in underweight and stunting among children has been downward in recent years (Figure 1), and the under-five child mortality rate has been falling, albeit slowly (Figure 2). Nevertheless, the Millennium Development Goal to cut the number of underweight children in half before 2015 remains elusive. With only 48% of the Ugandan

[1] Although relative security in northern Uganda allowed the UNHCR to close its program for internally displaced persons (IDPs) at the end of 2011, regional developments – including tensions in South Sudan, the Democratic Republic of the Congo, and Somalia – make the refugee and IDP situation tenuous; see UNHCR (2012).

[2] See the appendix for details.

[3] MUAC is the circumference of the upper arm, typically measured at the mid-point between the shoulder and elbow. MUAC has been shown to be a reliable indicator of nutritional status in children and in some cases has been a reliable predictor of mortality.

population having access to improved sanitation, and only 67% having access to an improved source of drinking water (UBOS and Macro International, 2007), efforts are still needed to create the environmental conditions conducive to improved nutrition.

The average prevalence of malnutrition in Uganda hides important variation related to differences in underlying regional and socioeconomic characteristics. Children from rural areas face higher risk of being malnourished: 40% of rural children under five years are stunted versus 26% of their urban cohorts; 17% of children under five are underweight in rural areas, compared with 11% in urban areas. The most vulnerable regions are Karamoja, a north sub-region, where 54% of children are stunted and 36% are underweight, and the southwest region, where 50% of children are stunted and 19% are underweight (UBOS and Macro International, 2007). The under-five mortality rate is 172 per thousand births in the lowest wealth quintile, compared with 108 per thousand births in the highest wealth quintile (UBOS and Macro International, 2007).

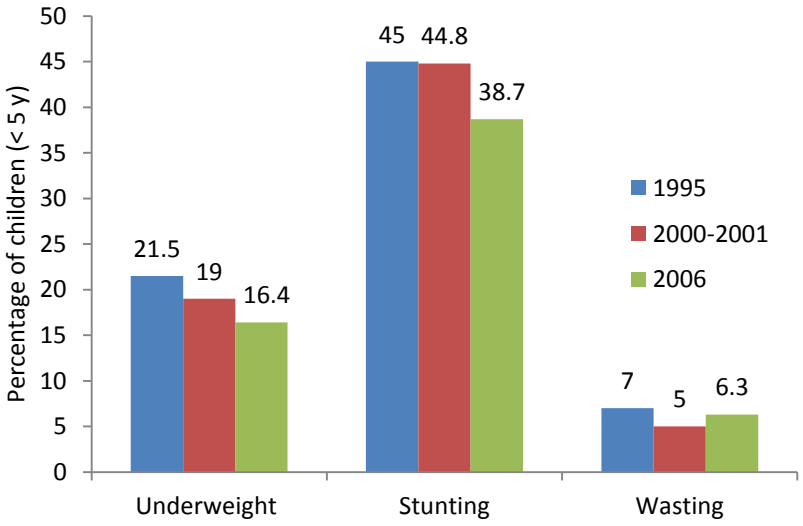

Figure 1. Prevalence of undernutrition among children under 5 years in Uganda (Source: Nutrition Landscape Information System, World Health Organization)

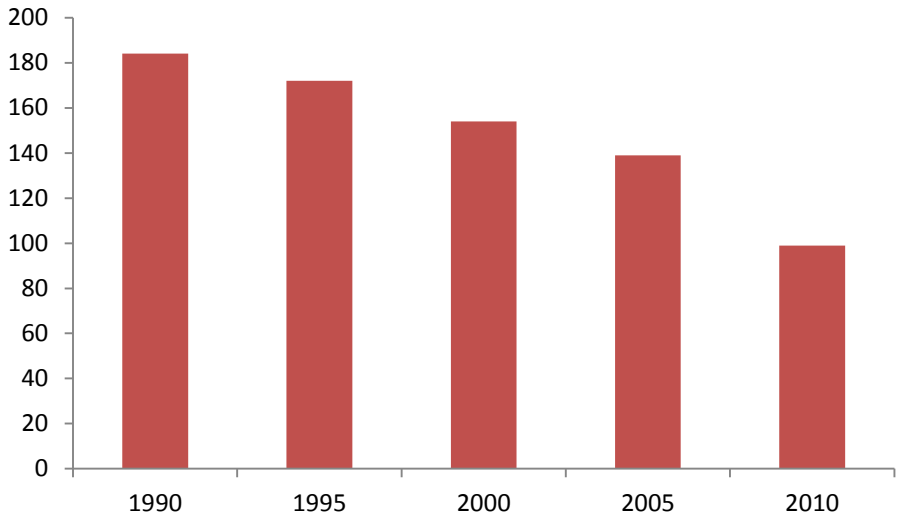

Figure 2. Under-five mortality rate (per 1000 live births) in Uganda
(Source: Nutrition Landscape Information System, World Health Organization)

Maternal health, a key factor influencing a baby's health, is an area of particular concern. Encouragingly, the maternal mortality ratio has declined substantially in recent years, from 880 per 100,000 births in 2000 to 550 per 100,000 births in 2005. Ugandan women as a whole tend to receive antenatal care (ANC) from skilled providers at a high rate (94%) (FAO, 2010).[4] However, only 17% received antenatal care before the fourth month of pregnancy, as recommended by the WHO. Moreover, only 23% of mothers received postpartum care within two days of delivery. As many as 74% of women who had given birth in the five years prior to the 2006 DHS survey reported receiving no postpartum care at all (UBOS and Macro International, 2007).

Studies show that the duration of breastfeeding is associated with the risk of stunting. For example, Kikafunda, et al. (1998b) report the risk of stunting was much lower for children breastfed to 18 months than for those breastfed only in early infancy. Although breastfeeding is widespread in Uganda, only 60% of women satisfied the guidelines proposed by the WHO that suggest exclusive breastfeeding for the first six months of a child's life (UBOS and Macro International, 2007).

Overall, Uganda does not lack food: 72.4% of households are categorized as food secure (WFP, 2011), and a declining expenditure share for food—from 68% in 1990 to 44% in 2002—indicates an overall improvement in food access (FAO, 2011a). Nevertheless, the typical Ugandan diet lacks diversity and fails to provide sufficient micronutrients. Moreover, seasonal

[4] This 94% figure reflects the cumulative percentage of women who reported 1 or more visits. Specifically, 6% of women reported one ANC visit; 42% reported 2-3 visits; and 47% reported four or more visits. National policy recommends that women receive at least four ANC visits (UBOS and Macro International, 2007).

patterns of food insecurity persist in many parts of the country. For example, although we are not aware of recent data that disaggregate food insecurity by agroecological zone (AEZ), Bahiigwa (1999) reports data from 1997 and 1998 that show highly varying patterns of food insecurity across AEZs and seasons, but consistently high rates in the Pastoral system (Table 1).

The degree of undernourishment is indicated by the depth of hunger. On average, a food-insecure Ugandan falls 240 kcal short of the minimum food needed, in terms of dietary energy (FAO, 2010). Due to adverse climate, low agricultural productivity and civil unrest, Karamoja is the most vulnerable region with 208,000 people (20%) estimated to be food insecure and 387,000 people moderately food insecure. The prevalence of food insecurity is somewhat higher in the southern part of Karamoja: 30% in Moroto and 23% in Nakapiripirit. The largest absolute number of food insecure, 500,000 people, is found in Busoga, where roughly 15% of the region's population is estimated to be food insecure (McKinney, 2009).

Table 1: Household Food Insecurity rates by Agroecological Zone (AEZ), July 1997-June 1998

	% Food Insecure within AEZ	
AEZ/farming system	July-December 1997	January-June 1998
Teso	38.1	50.8
Plantain/Robusta	48.6	19.9
Plantain/Millet/Cotton	69.3	49.6
Northern	28.6	53.6
Montane	32.9	24.0
Pastoral	75.8	95.7
All	48.3	41.0

Source: Adapted from Bahiigwa (1999) Table 4; for descriptions of farming systems, see Table 2 below.

Although rural dietary diversity remains low and tied to harvest patterns and local availability, urban Uganda has been experiencing a nutritional transition – from a dietary emphasis on plantain, starchy roots, and cereals to greater emphasis on rice, pulses, nuts and green leafy vegetables. Consuming one meal a day is not uncommon in rural areas or among the urban poor, especially during the pre-harvest period. Overall, consumption of fruits, vegetables, and animal protein (including fish) has been discouraged by high and rapidly rising costs as well as poor availability, especially in rural areas (FAO, 2010).

Micronutrient deficiency is a severe and widespread problem in Uganda. Riboflavin deficiency was reported in 2009 in Northern Uganda (UNICEF, undated) as was a high frequency of vitamin A and vitamin B-12 deficiency; iron, zinc, and calcium deficiencies are also prevalent in Kampala (FAO, 2010). As an example, 19% of Ugandan women and 20% of children have vitamin A deficiency (VAD), with prevalence rates higher in rural areas. Although vitamin A supplementation takes place in Uganda, coverage is uneven. For example, only 28% of women in the southwest region received vitamin A within eight weeks of giving birth to their last child, compared with 64% of mothers in Teso, West Nile, Acholi and Karamoja. This pattern likely reflects greater levels of humanitarian intervention and assistance the latter areas. Nearly three quarters of children under five years and half of women suffer from anemia (UBOS and Macro International, 2007). Based on the 2006 DHS data, only 30% of children aged 6-35 months and 31% of mothers with a child under three years had consumed iron-rich foods in the 24 hours preceding the survey (UBOS and Macro International, 2007). According to FAO (2010b), the prevalence of zinc deficiency in Uganda is still unknown, but is suspected to be high since access to zinc-rich foods is very limited. Anemia is also caused by both vitamin A deficiency and by folate deficiency. For example, Ndeezi et al. (2011) describes both B12 and folate deficiency in Ugandan children.[5]

Uganda previously had a high prevalence of iodine deficiency disorder (IDD), as a result of low iodine concentrations in soils and low consumption of iodine-rich foods such as fish (FAO, 2010; Bimenya, et al., 2002). As an example, Uganda's total goitre rate was 74.3% in 1991. However, as a result of the 1994 Universal Salt Iodization strategy, Iodized salt is now widely consumed (>90%) by Ugandan households, and the rate of iodine deficiency disorder has fallen dramatically (Bimenya, etc., 2002).

Alongside dietary inadequacy, illness and infection is identified as another factor contributing to malnutrition among young children. In Uganda, the overall contributors to child mortality are malaria (25%), anemia (14%), pneumonia (10%) and diarrhea (13%) (Bridge, et al., 2006). Hoorwey (1976) underscored the problem of a vicious circle in which low nutritional status weakens immunity to infection, and subsequent infection results in poor nutritional status. In the week preceding interviews conducted by Kikafunda, et al. (1998b), 32% of children had experienced an episode of fever, and 23% had experienced an episode of diarrhea. Patterns of repeated episodes of diarrhea can aggregate kwashiorkor, a severe form of protein-energy malnutrition (Hoorwey, 1976). In the late 1990s, 10% of Ugandan children were estimated to have kwashiorkor (Kikafunda, et al., 1998b).

Limited access to clean water and improved sanitation contributes to high rates of infection and high child mortality rates. In Uganda, access to improved sources of drinking water is highly unequal between urban (90%) and rural (63%) areas. Distances of 1 km or more to reach a household's main water source are not uncommon, and were reported by 60% of Moroto households (McKinney, 2009). Water treatment after collection is relatively rare; 56% of

[5] Ndeezi et al. (2010) also report zinc deficiency in HIV infected children in Uganda. They measured the zinc status of 247 HIV-infected children aged 1-5 years, and found that 54.3% of them had low serum zinc (< 10.0 μmol/L). They argue that increasing access to antiretroviral therapy could decrease the prevalence of zinc deficiency.

households in McKinney's study reported that they did nothing at all to treat water following collection. Of greater concern is that 44% of households obtaining their water from unsafe sources used no treatment. In terms of sanitation, 14% of rural households and 3% of urban households report no use of a toilet (UBOS and Macro International, 2007). McKinney (2009) reports that 91% of households in Karamoja had no improved toilet of any kind.

The overall poor state of nutritional outcomes in Uganda is widely recognized by public officials and a range of health and nutrition interventions have been introduced in response. The Uganda National Food and Nutrition Policy (UNFNP), which was approved in 2003, targets improvements in food security, nutrition and incomes for all Ugandans. The Health Sector Strategic Plan (HSSP) II of 2005-2010 aims to reduce child hunger and emphasizes micronutrient supplementations (McKinney, 2009). Another policy targeting food security is the Uganda Food and Nutrition Strategy and Investment Plan (UFNSIP), which was enacted in 2005. The Uganda National Development Plan (NDP) of 2010 also provides for interventions to improve overall nutrition Ugandans (FAO, 2010). A recent and important milestone is the development and passing of the 5-year Uganda Nutrition Action Plan (UNAP) for 2011-2016.

3. Agricultural production, livelihoods and food security

Uganda's economy is dominated by agriculture. More than 80 percent of Uganda's workforce is engaged in agriculture and approximately 30 percent of Uganda's total land area is dedicated to agriculture. Food crops accounted for approximately half of agricultural GDP in 2003, followed by cash crops (17%), livestock (16%) and fisheries (12%) (RoU, 2004). Uganda's primary export is coffee. Other important agricultural products include tea, cotton, tobacco, cassava, maize, millet and pulses. The country's southern climate is tropical, with two distinct dry seasons. In contrast, the northeastern region is semiarid. Uganda faces a number of environmental challenges including deforestation, overgrazing, loss of wetlands and soil erosion.

Despite that agriculture supports most livelihoods and is the main source of exports – contributing as much as 85% of export earnings in recent years – the overall share of agriculture in GDP has declined in recent years, from around 50% in the early 1990s to 23% in 2008 (RoU, 2004; FAO, 2009b). Declining agricultural prices, a slowdown in the growth of agricultural production, and insecurity in northern and eastern Uganda have all contributed to the drag on agriculture (FAO, 2010).

Uganda's agricultural sector is based primarily on smallholder farms, 80% of whom own an average of only 2 hectares of land but contribute 70% of agricultural production (RoU, 2004; Bahiigwa, 1999). Over half of all agricultural production is consumed domestically. This structure has a number of implications for food security both at household and national levels. As small farms are largely dependent on weather and underlying soil fertility, food insecurity emanates from inadequate rainfall, excessive rainfall, pests and diseases, and low crop yield (Bahiigwa, 1999). Weak purchasing power, high transportation costs, and poor distribution infrastructure exacerbate food insecurity. The 2008-09 Uganda Census of Agriculture found that 57% of 3.6 million surveyed agricultural households reported periods in the previous 12 months when they were unable to maintain consumption at a normal level (UCA, 2010). According to

FAO (2010a), 27% of the rural population falls below the poverty line, and 63% of total household expenditure in rural areas goes toward food.

FAO (2010) lists Uganda's major agricultural products (in decreasing order based on overall volume in 2005) as plantain (green cooking bananas locally known as *matooke*), cassava, sweet potatoes, maize, cow milk and millet. Traditional cash crops include coffee, cotton, tea and tobacco; main fruits and vegetables include pineapples, passion fruits, tomatoes, onions and cabbages. Plantain and sweet potatoes are grown mainly in the western and central regions while cassava is grown mainly in the northern and eastern regions. Maize is grown country-wide, but predominates in the west and the far north and east of the country. Figure 3 displays the cropping calendar for the main food crops grown in Uganda. Due to poor storage capacity, gaps in the cropping calendar frequently translate into hungry seasons, especially in the northern region (FAO, 2010). Agricultural production in Uganda is defined largely by a set of farming systems, categorized according to agro-ecological zones, underlying soil types, rainfall and cropping patterns (FAO, 2010). These main farming systems are summarized in Table 2 and mapped in Figure 4.

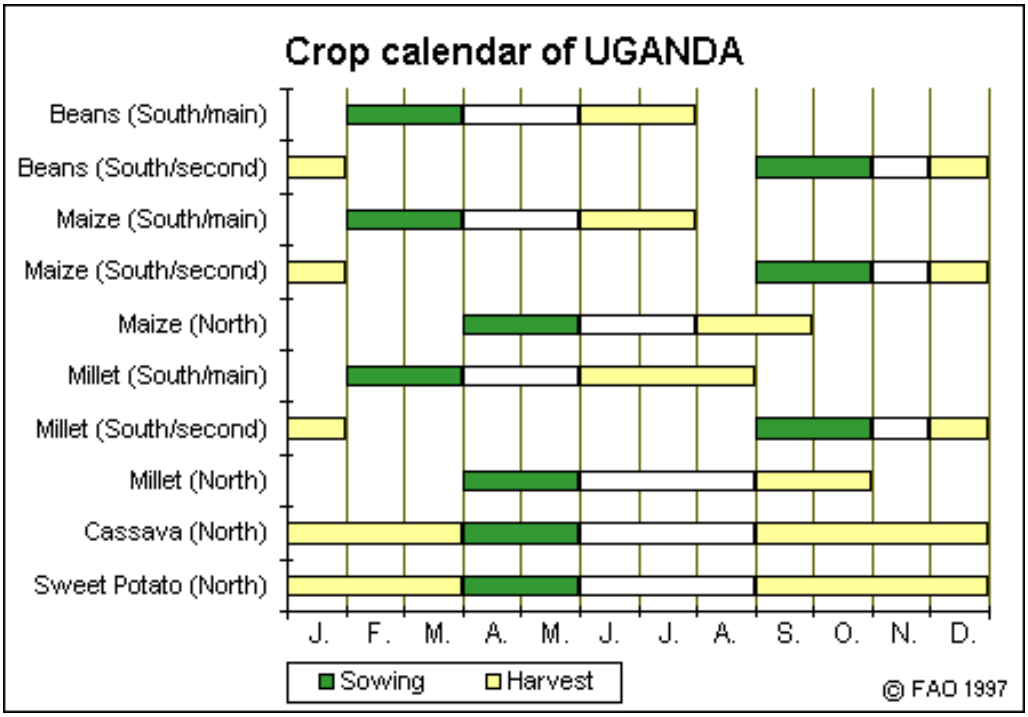

Figure 3. Crop calendar for main food crops cultivated in Uganda (Source: FAO, 2010)

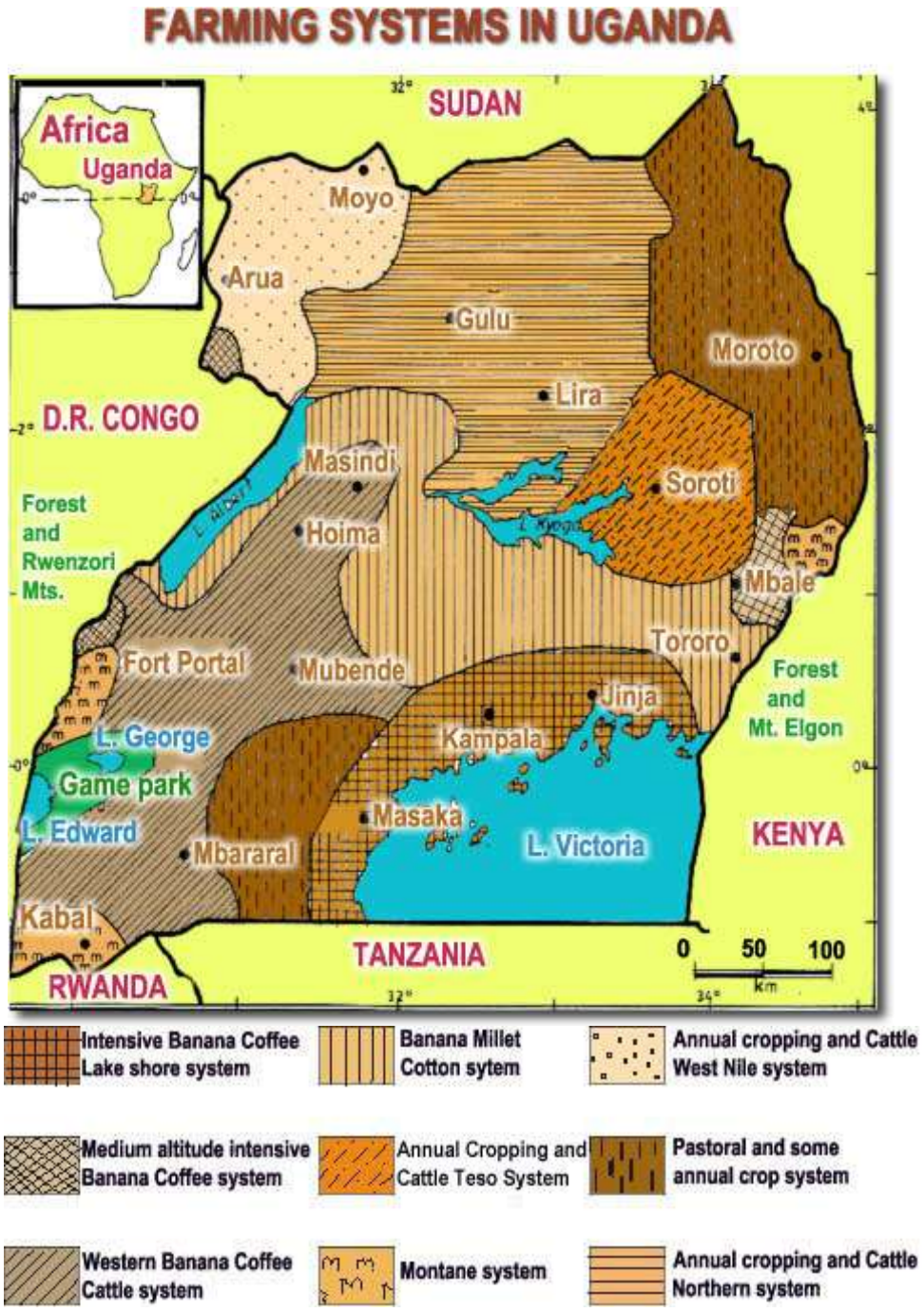

Figure 4. Map showing main farming systems in Uganda
(Source: www.fao.org/ag/AGP/AGPC/doc/Counprof/uganda/uganda.htm#3.%20CLIMATE%20AND%20AGROECOLOGICAL)

Table 2. Primary farming systems in Uganda

System	Characteristics	Districts
Teso (Eastern Uganda)	Annual crops	Soroti, Kumi, Kaberamaido
High rainfall banana-coffee (Lake Victoria and Western Uganda)	Bananas, Robusta coffee, mixed food crops	Bundibugyo, parts of Hoima, Kabarole, Mbarara, Bushenyi, Mubende, Luweero, Mukono, Masaka, Iganga, Jinja, Kalangala, Mpigi and Kampala
Banana/finger millet/cotton (Western and Eastern Uganda)	Cotton, Robusta coffee, beans and maize	Kamuli, Pallisa, Tororo, parts of Masindi and Luweero
Northern	Cotton, tobacco, finger millet and cassava	Gulu, Lira, Apac, Kitgum
West Nile	Tobacco, cotton, coffee, sorghum and cassava	Moyo, Arua and Nebbi
Montane (mountainous of West and East)	Arabica coffee, bananas, maize, temperate crops	Kabale, Kisoro, parts of Rukungiri, Bushenyi, Kasese, Kabarole, Bundibugyo, Mbarara, Mbale and Kapchorwa
Pastoral (Northeast and Southern Uganda)	Pastoral livestock combined with sorghum and millet	Kotido, Moroto, parts of Mbarara, Ntungamo, Masaka, Ntungamo, Masaka and Rakai

Sources: FAO, 2010; MAAIF, 1995.

Uganda is an important food exporter to regional neighbors, but faces challenges in accessing global markets. As a landlocked country, inefficient rail, air, and water transport makes export problematic, and poor road conditions – especially during the rainy season – also impede domestic agricultural trade (FAO, 2010). Additionally, many Ugandan staples are not actively traded in global markets (Benson et al., 2008). Uganda is self-sufficient for most food groups, except cereals (mainly wheat and rice) and vegetable oils (FAO, 2010; Benson et al., 2008). By volume, maize contributes more than half of all food exports, contributing 5% of Kenya's requirements and important amounts for Rwanda, Burundi, Tanzania and southern Sudan (Benson et al., 2008). Uganda's leading export earner remains coffee, although coffee's export share has declined, from 60% in 1999 to 19% in 2003 (Ssewanyana and Bategeka, 2007). For Ugandans, banana is both a major staple (*matooke*) and an important cash crop. Banana accounts for as much as 25% of the total value of agricultural output. Smale and Tushemereirwe (2007) provide a comprehensive assessment of the banana economy of Uganda. With the highest per capita consumption of banana in the world (0.70kg /person/day) in the world, Ugandans obtain 30% of their calories, 10% of their protein and 5% of their fat from bananas. Cooked banana and banana juice have cultural values in weddings and funeral rites; the leaves are used for steaming food, sheaths are used for making ropes and crafts, and stems provide fodder . For small farms (those less than 0.5ha) banana is the most widely grown crop and accounts for 38% of total utilized agricultural land.), Pender, et al. (2004) estimates the average profitability of banana production is 4.5 times as high as that of the cereal production, controlling for labor use, land management, and other factors. Nearly two-thirds of total production comes from the western region, 30% from the central region, with the remainder in the eastern region. In these areas, banana is one of the most important food security crops. There are two main types of banana crops: cooking bananas (used to make *matooke*) and beer bananas (*mbidde*).

Contributing 17 percent of agricultural GDP and 7.5 percent of total GDP (FAO, 2009b), livestock is an important component of Uganda's agricultural production. More than half of Ugandan households and more than two thirds of Ugandan farm households are estimated to raise cattle (Benin, et al., 2008). The eastern region has the highest percentage of free-range birds (37.3%); and the central region has the largest proportion of exotic poultry (FAO, 2007). Smallholder poultry production systems predominate in Uganda; commercial production is limited. Women and children take the most responsibility for poultry farming. In a study of poultry in five districts of Arua, Kanungu, Lira, Jinja and Tororo, 83% of respondents were reported to keep chickens, followed by goats (67%), cattle (38%), pigs (29%) and ducks (13%) (FAO, 2009b). Poultry is a key source of money, nutrition, and social value. Studies suggest poultry is frequently converted to other forms of capital (e.g. housing or well-being of children), and is used to weather unforeseen events. By tradition, chickens are treated as companions, and are widely used in marriage and funeral ceremonies (FAO 2007; FAO 2009b).

Probably due to the traditional role of poultry farming there has been limited attention directed to veterinary policies, and no comprehensive poultry laws or policies have been established in Uganda (FAO, 2009a; FAO, 2009b). In a five-district study conducted by FAO (2009b), 65% of respondents were reported to have experienced an increase in poultry diseases in the past decade. Diseases constitute the main barrier to expanded poultry production, with Newcastle disease (which has a mortality rate exceeding 60%) as the main risk (Mukiibi-Muka, 1992). Parasites, both external and internal, also threaten poultry production since very limited modern disease

control methods have been applied (FAO, 2007). Moreover, even though highly pathogenic avian influenza (HPAI) has not been found in Uganda, an outbreak could be catastrophic for both poultry and humans. The current policy framework of the poultry sector is guided by the Plan for the Modernization of Agricultural (PMA), which seeks to convert subsistence farming into commercialized agriculture (FAO, 2009a).

Although Uganda has a favorable climate and a generally good distribution of surface water, Kabanda and Kahangire (1994) argue that irrigation development is needed to increase agricultural production. They give several reasons. First, except near the Nile, water resources are highly seasonal and quantities are limited.[6] Second, evaporation offsets rainfall in many circumstances, and exceeds rainfall in some of the lake areas, contributing to water shortages. Third, some areas, such as Karamoja, are naturally lacking in water resources. Finally, most bodies of water in Uganda are shared with neighboring countries, and irrigation development could help to reduce political conflicts regarding water use. As of 2004, less than 15,000 ha of land were under formal irrigation projects and approximately 67,000 ha were covered by informal irrigation schemes, out of a total of 202,000 ha estimated to be potential irrigable. To cope with erratic rainfall and population pressure, the Uganda government has taken steps to develop irrigation as part of an overall strategy to ensure food security. This position is reflected in the government's Plan for Modernization of Agriculture (WWAP, 2006).

On average, Ugandan smallholders own approximately 0.3 ha of arable and permanent cropland, which in total constitutes about 65% of the total arable area in the country (FAO, 2010). Uganda is perceived as having among the most fertile land in tropical Africa, but the rate of soil depletion and degradation is also among the highest in sub-Saharan Africa, with an estimated average nutrient depletion of 70kg of nitrogen (N), phosphorus (P) and potassium (K) per year (Nkonya, et al., 2005). As a result, observed yields are believed to be less than one third of potential yields (Pender, et al., 2004). Nkonya, et al. (2005) analyzed the determinants of nutrient inflows and outflows based on a survey conducted in 451 households of 107 villages in central, eastern, northern and western Uganda. Results suggested crop diversity, high livestock stocking densities, education, access to non-farm income, and access to extension services all were positively correlated with soil nutrient balance, while market access was negatively associated with soil health. As a result, the authors emphasize the importance of extension services to promote the adoption of soil fertility and seed technologies.

Soil erosion is another contributor to soil degradation. Pender, et al. (2004) report that population density is positively correlated with rates of soil erosion, while better market access, higher levels of education, and land tenure security are negatively correlated with soil erosion. Sseguya, et al. (1999) found banana residue to be the resource most frequently used to mitigate soil degradation in the Lake Victoria district, while less than 1% of farmers interviewed applied mineral fertilizer to their annual crops. Manure, coffee husks and compost were perceived as the

[6] Also see the USGS/USAID FEWSNET report "A Climate Trend Analysis of Uganda" available at http://pubs.usgs.gov/fs/2012/3062/FS2012-3062.pdf. The report contains several maps of observed and projected temperature and rainfall, along with a discussion of implications for food security. The results suggest general warming and drying, to an extent potentially large enough to negatively affect populations across northern Uganda.

most effective means to maintain soil fertility, but appropriate application was found to be constrained by lack of technical know-how.

Declining soil fertility in Uganda has motivated researchers to investigate the potential for modern inputs to boost agricultural production. According to the 2005-06 UNHS, during the first season of 2005, on average 94% of parcels used local seeds, leaving only 6% using improved seeds. The eastern region had the highest usage of improved seeds (12%), while the western region rates of use as low as 2%. At the national level, only 3% of parcels used pesticides, herbicides and fungicides. Nkonya and Kato (2001) point out of that such patterns of low external input use reflect high transaction costs, lack of financial services such as agricultural credit, limited availability of breeder and foundation seeds, and a limited involvement of private traders in input distribution. The availability of improved seeds has been constrained by the dominance of the Uganda Seed Project (USP), which not only excludes private traders from entering the input market, but also raises input prices.

As in most developing countries, credit services in Uganda are largely underdeveloped in urban areas and nearly absent in rural areas. The importance of financial service is highlighted by the increasingly important role of micro-credit, both in the Poverty Eradication Action Plan (PEAP) and the Plan for Modernization of Agriculture (PMA). The government also has implemented a number of programs to meet the credit needs of the poor, such as the Rural Farmers Scheme (1987), but as of 2006, only one in ten households applied for credit, and 24% borrowed from informal sources such as landlords, employers, relatives and friends. Twenty- three percent of households did not apply for any loans because they did not want to be indebted (UBOS, 2006b). Mpuga (2008) provides an in-depth assessment of constraints to agricultural credit. He argues that farmers' low economic and legal status largely exclude them from the legal framework and deny them a mechanism to articulate their inherent demand for credit. Most farmers in Uganda lack education, which means many of them do not fully understand the concept of commercial credit. Limited land ownership means lack of collateral, which also creates a challenge to extending credit in rural Uganda.

One final impediment that undermines the agricultural sector and creates important health and nutrition risks is the presence, and relatively poor understanding of aflatoxin and related toxins. Mycotoxin is a toxic fungal secondary metabolite that affects approximately 25% of the world's crops. It can contaminate a wide range of agricultural commodities at various stages in the food chain. Aflatoxin, the by-product of *spergillus flavus/parasiticus* is the most- studied mycotoxin. Research indicates that aflatoxin has ability to affect the function of DNA and can be carcinogenic, mutagenic, and geratogenic (Bryden, 2007). Aflatoxin B_1, B_2, G_1 and G_2 are classified as Group 1 human carcinogens, of which B_1 is of greatest concern as it contributes to a high incidence of human liver cancer (Farombi, 2006; Bryden, 2007). Found in the milk of animal with feeds contaminated by aflatoxin B_1, aflatoxin M_1 is classified as a Group 2B human carcinogen. With a mild and humid climate, average temperature of 25°C and bimodal rainfall of 500 to 2000 mm per annum, Uganda has conditions conducive to the growth of *spergillus flavus/parasiticus* and its by-product aflatoxin (Kaaya and Warren, 2005).

The aflatoxin problem is believed to be extremely serious in Uganda. Kaaya and Warren (2005) review past research on aflatoxin in Uganda. The earliest attempts at estimating the extent of

aflatoxin contamination in food concentrated on groundnuts, in 1966. In a nationwide study, 15% of sampled products were estimated to contain more than 1000 ppb of aflatoxin B_1, which far exceeds standard recommendations (such as that of the United States Food and Drug Administration) of maximum aflatoxin levels of 20 ppb. In another aflatoxin study that analyzed 480 different food samples, beans were found to be the most seriously contaminated food item, followed by maize and sorghum; rice samples were found to be free from aflatoxin. In 54 samples collected from Districts of Kampala and Jinja, Sebunya and Yourtee (1990) found that poultry feeds and maize contained detectable levels of aflatoxin B_1 above of 20 ppb. Another study of aflatoxin in Ugandan maize suggested that seven of eight samples obtained from shops and markets were contaminated by aflatoxin B group on a level of 0-50 ppb during the storage period, and over 30% above of samples exceeded 20 ppb. Moreover, research showed imported baby foods were contaminated at lower rates than domestically-manufactured foods (Kayya and Warren, 2005).

The serious situation of aflatoxin contamination of human food and animal feedings, as a consequence, affects Ugandans both nutritionally and economically. Exposure to aflatoxin can cause cancer, acute illness, immune system dysfunction, and nutritional disease. According to Kaaya and Warren (2005), consumption of aflatoxin-contaminated food was highly correlated with hepatoma in Uganda. Economically, mycotoxin contamination is associated with losses due to crop rejection and reductions in animal production, as well as increases in costs of detection and regulation, storage and transportation, technological improvement, overall reductions in consumer confidence and food security (Bryden, 2005).

Factors associated with aflatoxin contamination in Uganda include improper and inadequate drying techniques, inappropriate storage methods on farm and at retail levels, high moisture content and insect damage in grains, and physical damage during harvest that makes maize and groundnuts vulnerable to fungal infection (Kaaya and Warren, 2005). Strategies to control aflatoxin focus on preventing the infection process, regulating the environment, and enhancing both pre-harvest and post-harvest handling and management. Some success has been achieved through the use of aoxigenic fungi to out-compete toxigenic fungi, by timely harvest and rapid and adequate drying, packaging and harvesting, and by discouraging the consumption of "high risk" food (Hell and Mutegi, 2011). Few existing studies assess the prospects for aflatoxin prevention strategies in Uganda although several institutions currently have research on aflatoxin underway, including Markerere University, the Government Chemist Laboratories, and the Uganda National Bureau of Standards. Some groups within the National Agricultural Research Organization (NARO) also work with researchers at Makerere University on mold and aflatoxin detection and control (Kaaya and Warren, 2005).

4. Vulnerability, weather shocks and coping strategies

Ugandan agriculture is highly vulnerable to the vagaries of weather. With only a small proportion of land irrigated, Uganda's agriculture is highly dependent on rainfall. As underscored by the Poverty Eradication Action Plan (PEAP) and the Plan for the Modernization of Agriculture (PMA), Uganda's heavy reliance on rain-fed agriculture is a primary factor undermining the country's agricultural performance. According to data from the 2005-06

UHNS, forty-two percent of households reported that their agricultural production was affected by drought or insufficient rainfall, and fifteen percent had experienced floods and hailstorms. In general, drought, heavy rains, crop diseases and livestock diseases were reported as the most common shocks to household livelihoods.

Farmers' perceptions of and adaptations to climate variability were studied by Mwerera and Majaliwa (2010) through a survey conducted in Kabale and Nakasongola districts (representing the Kabale-Rukungiri Highlands in western Uganda and the Central Baruli Farmlands and Central wooded savanna of central Uganda). Results indicated drought as the main shock to households (reported in 90% of cases) compared to less covariate shocks such as pest/disease outbreak (6.1%) and human disease (3.1%). Most farmers (81%) reported that they noticed recent changes in weather patterns. In response, 62% did nothing and 26% sold livestock. Farmers also reported that climate fluctuations had adverse effects on crop yields (39%) and income (35%), and increased the incidence of malaria (60%).

Asiimwe and Mpuga (2007) linked weather shocks, particularly rainfall fluctuations, to household incomes and consumption expenditures, finding a correlation between household welfare and deviations between contemporaneous seasonal rainfall and long-run average rainfall. Using quarterly rainfall figures contemporaneous to observed agricultural production, they found substantial negative deviations from long-run average rainfall during both the first (March to May) and second (September to November) planting periods. For most of the country, the dryness lasted through the first (June to August) and second (December to February) harvests. The north and west of Uganda were found to have larger negative rainfall shocks than the central and eastern areas of the country. Overall, holding other factors constant, above-average rainfall in the first planting season resulted in lower household consumption and above-average rainfall in the second planting season resulted in higher household consumption .The authors found that a number of factors dampened the negative implications of rainfall shocks, including education, farm size and household size. The same study highlighted the heavy burden that weather shocks can create for low-income households, given the limited range of coping strategies available. When confronted with unexpected shortfalls, 32% of the interviewed households reported receiving help from friends and relatives, 8% sold assets, 4% borrowed informally, and less than 1% used formal credit; 57% of the households experiencing shocks received no help at all (Asiimwe and Mpuga, 2007).

Although on-farm storage is a potential way to mitigate seasonal and inter-year production shocks, farmers typically sell food at low prices immediately following harvest and then purchase grain later at higher prices. In some cases, this pattern reflects unreliable means for on-farm storage and in some cases a need for cash. Such behavior not only leads to food insecurity between harvests, but also results in very low rates of household saving (Kasente, et al., 2000). Calculations from the 1999-2000 UNHS suggest that 90% of Ugandan households never participate in any form of formal savings (Asiimwe and Mpuga, 2007).

In the absence of storage and savings, drought and other environmental stresses that undermine crop production and livestock rearing can lead to widespread hunger and, in extreme cases, famine. Okori, et al. (2009) conducted a survey in Lira and Kitgum districts of northern Uganda to examine the causes of and farmers' perceptions regarding famine during a period of high food

stress. Seventy four percent of the respondents were reported to have experienced extreme food shortages, consistent with a pattern of localized famine, and over half of them linked this to insufficient agricultural production. Farmers mentioned poor harvest (91%), lack of water (86%), poor animal health (74%) and livestock death (37%). During the famine, households mainly depend on cultivated vegetables (91%), followed by wild leaves, fruits and roots (75%), sorghum (70%) and cassava(69%). The primary coping strategies included gathering edible wild vegetables (84%), working for others in exchange for food (62%) or money (48%), and migration to urban areas (13%).

5. Civil unrest and price volatility

Civil unrest undermines a range of activities that support food security, largely by depressing production and interrupting the marketing of output, thereby reducing income from cash crops (Messer and Cohen, 2004). Shock from armed conflict is reported as the most serious shock experienced by households in Northern Uganda. Starting from the mid-1980s, a long period of conflict occurred between the Ugandan People's Defense Forces and the rebel Lord's Resistance Army (LRA). In addition to direct attacks on local people, many individuals became internally displaced persons (IDPs) following the government's 2002 relocation order (Birner, et al., 2011). The relocation of individuals from their farms to relatively safe IDP camps crippled agricultural production, leaving millions of people food insecure and malnourished. Vulnerable group such as women, children, and those with HIV tend to be even more strongly affected. At the same time, coping capacities are weakened by the armed conflict and displacement, mainly due to the loss of various forms of wealth, including savings of livestock, draught animals, rural homes, grain stores, and trading centers. On the other hand, warring parties often use food as a weapon to attract supporters and punish enemies, making food insecurity not only an outcome of conflict, but also a cause of conflict (Bukuluki et al., 2008; Munyonyo, 2012; Messer and Cohen, 2004).

The 2006 DHS survey included information to specifically investigate the living conditions and health status of those living in IDP camps and areas of the north of Uganda. Poverty is highly concentrated in the north, with 69% of the population living in IDP camps and 76% of those living in Karamoja falling into the lowest wealth quintile. Underweight affected one in five children in IDP camps and more than one in three in Karamoja. Children living in IDP camps experienced higher rates of infant mortality (123 deaths per 1,000 live births) and higher under-five mortality (200 deaths per 1,000 live births) than either their non-IPD cohorts in the north, or other Ugandan children. Forty four percent of children under five in IDP camps had diarrhea at some time in the two weeks before the survey, compared to the national average of 26 percent. The DHS data also show that children in IDP camps were highly likely to have had fever (61%) and acute respiratory infection (ARI) (27%) in the two weeks preceding the interview, and to experience diarrhea (44%) and anemia (78%). At the same time, children with diarrhea or fever were most likely to receive treatment from health care provider (90%) or antimalarial drugs (69%). As for diet, although children living in IDP camps and Karamoja consumed a low proportion of foods rich in vitamin A, both were at low risk for vitamin A deficiency (VAD) (9% and 6%, respectively) due to high frequency of supplementation (51% and 47%, respectively).

Although various policies and programs in Uganda aim to address health and nutrition concerns, including the Poverty Eradication Action Plan (PEAP), the Emergency Relief Rehabilitation

Programme (ERRP), and the National Food and Nutrition Policy, Bukuluki et al. (2008) argue that none of these programs address conflict areas. Some scholars view education as one of the most valuable 'portable' assets that can be delivered in areas with civil unrest, since education empowers people to communicate with authorities, develop social networks, diversify livelihood strategies, and more easily escape poverty. However, education resources and rates of school enrollment are extremely low in northern Uganda. For example, in Ongalo, only one person had completed secondary school during the previous thirty years up to 2004. In Kaberamaido, the average teacher to student ratio for primary school was 1:200 (Bird and Higgins, 2009).

While civil unrest in Uganda has been a localized problem, a number of studies have examined the nationwide problem of price shocks in the context of global staple price increases during 2007-08. From one perspective, adverse effects of rising global food price could be expected to be modest in Uganda, primarily because Uganda many Ugandans are isolated from global markets because many of Uganda's staples (e.g. cassava, sweet potatoes, and matooke) are not traded actively in the global food market. However, fifty seven percent of rural Ugandans are net buyers of staples, as are 92 percent of urban households. Facing rising prices for maize, rice and wheat in 2008, many consumers shifted to purchases of plantains, cassava and sweet potato, whose prices rose somewhat less dramatically (by about one third) and then declined quickly. Even so, Simler (2010) estimates that the 2007-08 global price shock was transmitted to more than 700,000 Ugandans living below the poverty line. In urban areas, approximately one million people became poore as a result of price rises (Simler, 2010). Based on a calorie-income relationship, Tiwari and Zaman (2010) estimated that due to the mid-2008 price shock, 34% of Ugandans became undernourished, assuming a baseline of 1810 Kcal per day as the minimum dietary norm.

6. Education, gender and nutrition outcomes

Numerous studies suggest a woman's educational attainment is a key determinant of health status for her family members, especially her children. Wamani et al. (2004) examined how socio-economic indicators were associated with child stunting in Uganda, and found that a mother's educational level was the most robust predictor of a child's growth outcome, and a far better predictor than father's education level, an index of household assets or an indicator of land ownership. UBOS and Macro International (2007) reported that women with secondary education were more likely to participate in making specific household decisions, including how many children to have, than women with no education or primary education only, which reflects enhanced empowerment. Hobcraft (1993) argued that a woman's educational level directly affected the adoption of modern healthcare practices. Moreover, education can lead a woman to be more confident, which can lead to greater use of health services for her family and children (Cleland, 1990). Within most Ugandan communities, however, gender bias is widespread, with the result that only 42% of girls complete primary school, compared with 55% of boys (Kasente, 2003).

In a study of child nutrition and health status, Vella et al. (1992) found that in north-west Uganda, parental education remained a significant predictor of child health even after controlling for a range of socioeconomic factors. Education, in part, was found to lead to changed beliefs regarding the importance of improving a child's health status. Education parents were found to

be more willing to accept the concept of family planning, to learn to use health facilities, to undertake child immunization, and to more equally allocate family resources. However, the same study indicated that child mortality was not explained by parental education levels; instead, it was correlated with parents' economic wealth. Similiarly, Kikafunda et al. (1998b) demonstrated that children from families with low economic status were more likely to be stunted than those from families with middle economic status. They argue that this is because economic wealth increases child survival by providing greater birth spacing, improved sanitation and better food supplies.

As part of the same study, Kikafunda et al. (1998b) used regression to analyze the risk factors of children <30 months in rural and semi-urban communities in central Uganda. They found that neither current breastfeeding nor the age of weaning affected the incidence of stunting or underweight, but the duration of breastfeeding greatly affected child stunting. In particular, children who were breastfed for more than 18 months and up to 24 months had a significantly higher incidence of stunting – an almost sevenfold increase over those who were breastfed only in early infancy, perhaps because children who are still being breastfed at a late age are reluctant to accept other foods or because those children came from poorer families. Vella et al. (1992) also found evidence of a negative correlation between breastfeeding and weight-for-age, weight-for-height and height-for-age for children aged 0-59 months. Kikafunda et al.'s (1998b) results confirm the cumulative nature of stunting in response to chronic malnutrition: older children in their study had a higher incidence of being stunted than younger children. Stunting was six times greater for children between 12-18 months than for those below 12 months, and ten times greater for children >18 months. Children who had never consumed milk were twice as likely to be underweight as those who consumed cow's milk as a regular part of their diet. Food taboos could not explain child stunting or underweight.

The overwhelming importance of mothers to the health and nutritional status of children is greatly undermined not only by low educational levels, but also by the high work burden of most rural Ugandan women. Women are the most important source of agricultural production in Uganda, contributing 80 percent of agricultural labor. Women are responsible for 80% of the food crop production and more than half of the cash crop production (Kasente, et al., 2000). Women are typically responsible for weeding, post-harvest processing and storage, while men primarily take charge of land clearing. Although women play a central role in food production, men tend to have an overwhelming advantage in access to and ownership of the land. Compared to other countries in sub-Saharan Africa, Ugandan women's economic autonomy and right of access to land is more constrained. In most areas cultural practices permit women access to land only through relatives such as fathers or husbands. In many communities, prohibitions on women's ownership of land preclude them from growing perennial crops. Although most agricultural products are grown by women, for the most part they cannot independently control their share of farm income. Lacking resources such as modern inputs, improved technologies and extension services, women are trapped in a cycle of low agricultural productivity and chronic poverty (Kasente, et al., 2000). Not surprisingly, rural women are twice as likely to be classified as undernourished as urban women (14% compared with 6%, respectively) (UNHS, 2006).

In summary, Ugandan women lack decision-making power, control over household income, and access to land. Confronted with early marriage, teenage pregnancies, limited control over sexuality and fertility, and a high prevalence of sexual violence, the challenges to improving their health and nutrition condition are substantial (Food and Nutrition Technical Assistance II Project (FANTA-2)).[7] UBOS and Macro International (2007) reported that only 35% of women made their own decisions on household purchasing; two in ten made their own decisions regarding their own health care. Women's diets tend to be insufficient and less diverse than men's diets, as cultural traditions favor food allocation to men. Moreover, food taboos often prohibit the intake of nutrient-rich foods. Even during pregnancy, women still have a heavy work burden that includes agricultural work, hauling water and collecting firewood.

7. Impact assessment of nutrition interventions

The Ugandan government has advocated nutrition education as a direct pathway to improve the health and nutritional status of women and children, but given that 39% of Ugandan women aged 15 to 49 cannot read (UBOS and Macro International, 2007), nutrition information remains inaccessible to a large number of households. Although agricultural extension workers and primary and secondary school teachers can transmit nutrition information, their potential impact is limited by the nature of their interactions. Health and nutrition centers are therefore seen as playing an important role in providing nutrition education to mothers. However, Kabahenda (2006) argues that health and nutrition centers have limited geographic coverage, and therefore calls for greater efforts to expand the country's nutrition education programs.

Although the literature provides relatively few studies regarding the efficacy of nutrition education interventions in Uganda, one exception is evidence surrounding the pilot nutrition education intervention, which was conducted in two villages of Kabarole district in 2001. A 4-week education program focused on teaching mothers how to serve nutritious meals to children. The main purpose of the program was to enhance food diversity and provide children with an adequate set of nutrients. Participants were shown to have improved knowledge regarding the selection and preparation of food for young children when compared to a control group, which consisted of women from a distant area who were given sewing classes instead. To evaluate the efficiency of the nutrition intervention activities, group interviews were conducted with the participants, their friends and spouses in 2002. Participants had made notable improvements on meals, and were willing to share the nutrition knowledge obtained from the program. A follow-up nutrition education program was implemented that involved teaching food cooking and food selection skills to less literate adults. After one month of intervention, meals had observable increases in the variety of grains, fats and sweets, legumes, meats, fruits, and vegetables. Food

[7] Uganda's total fertility rate stands at 4.4 in urban areas and 7.1 in rural areas (UBOS and Macro International, 2007). Frequent pregnancies not only distract mothers' from caring for children, but also interrupt breastfeeding, thereby increasing the risk of malnutrition for subsequent children. A high rate of adolescent pregnancy is another problem in Uganda. Twenty-five percent of girls between 15 and 19 bear children, and forty percent of these are in the lowest wealth quintile. When children are born out of wedlock, which is all too often the case, the adolescent mother and her child can be highly vulnerable (FANTA-2, 2010).

categories that did not change measurably were bananas, tubers and starchy vegetables, and nuts (Kabahenda, 2006).

In addition, Ndeezi and co-authors conducted a micronutrient intervention among 847 HIV-infected children aged 1-5 years. Their intervention consisted of 10 multivitamins and 4 minerals, compared with the recommend dietary allowance of six multivitamins. Results indicate that doubling the allowance of micronutrients did not significantly change mortality or growth (Ndeezi et al., 2010), or the incidence of diarrhea (Ndeezi et al., 2012), but it did improve the B12 and folate status (Ndeezi et al., 2011). In addition, Hotz et al. (2012) found that introduction of beta carotene–rich orange sweet potato in rural Uganda could improve Vitamin A status among children.

Kikafunda et al. (1998a) examined the effect of zinc supplementation on preschool children randomly selected from nursery schools in a low-income suburb of Kampala. The experiment was designed in such a way that a child was randomly assigned to receive either a zinc supplement or a placebo. Participants were selected from three different schools stratified by socioeconomic status. Zinc supplementation resulted in a small but statistically significant increase in MUAC: children with zinc supplementation gained 1.1 mm compared to a baseline, while children with placebo supplementation lost 0.3 mm. Zinc supplementation had a positive correlation with weight gain for children from the school with the highest socioeconomic status, indicating that zinc was likely a limiting nutrient only for children with better nutritional status. However, as the authors point out, due to a lack of prior understanding regarding sensitivity to mild zinc deficiencies in sample population, different zinc supplementation levels could produce different, and even conflicting, results.

A vitamin A supplementation trial was conducted among 181 HIV-infected children from Mulago Hospital, a large hospital serving urban and semi-urban populations near Kampala. Children received either a vitamin A supplement or a placebo. After three months, the vitamin A supplemented children showed a declined mortality rate. At the same time, they had a lower prevalence of persistent cough and chronic diarrhea, but no change in prevalence of fever, ear discharge, bloody stools or hospitalizations (Semba et al., 2005). In response, and in order to prevent illness and decrease rates of child mortality, the Ugandan government has implemented a vitamin A capsule supplementation program. UBOS and Macro International (2007) reports that 36% of children age 6 to 59 months had received a vitamin A supplement in the six months prior to the survey; and a third of surveyed mothers received vitamin A supplements during the postpartum period. Moreover, food-based interventions to increase dietary intake of vitamin A have been undertaken, for example the orange-fleshed sweet potato program in central Uganda (Odongo, et al., 2002). In the study area, 70% of mothers were reported to be consuming vitamin A rich food (UBOS and Macro International, 2007).

Finally, Iannotti and Gillespie (2002) examined the effectiveness of three community programs that were directly or indirectly related to nutrition intervention. The programs were the Foundation for Credit and Community Assistance (FOCCAS), the Gulu Relief and Health Rehabilitation Project (GRHRP) and the Ssembabule Child Survival Project (SCSP). They showed that GRHRP led to a decrease in the prevalence of severe wasting (WHZ < -3) from 5% to 2%, but also increased stunting and moderate wasting compared to a 1998 baseline. The SCSP was found to dramatically increase breastfeeding rates, from 65% to 100%, and to boot

early initiation of breastfeeding, from 3% to 40%. In terms of nutrition education, the FOCCAS project provided weekly education sessions in village banks; GRHRP selected mothers from the community and offered them food demonstration sessions; and Ssembabule provided lessons on drought-resistant crops and micronutrient-rich foods. In general, households in the project areas either exhibited improvements in feeding practices, or maintained small gardens to grow and consume micronutrient-rich food. Long-term follow-up assessments for these interventions have not been conducted, however.

8. Agriculture and nutrition projects underway

For the past ten years, the Government of Uganda (GOU) has actively refined its agricultural development strategy. Uganda is the first African country to concurrently participate the Comprehensive Africa Agricultural Development Program (CAADP) and the agricultural Development Strategy and Investment Plan (DSIP), which were signed on March 31 and March 16, 2010, respectively. Uganda also has been selected as one of twenty countries to benefit from the U.S. Feed the Future (FtF) Presidential Initiative. As part of the program, Northern Uganda, the central "Maize Belt," and Southwest Uganda have been chosen as target areas for program interventions. Under the Uganda CAADP Compact and DSIP, the United States will provide more than $200 million to support Ugandan development initiatives. The three foci of the program are (1) Nutrition, (2) **Agriculture**, and (3) **Connecting Nutrition to Agriculture**.

The United States Agency for International Development (USAID) has provided support to increase agricultural productivity in three main phases. During phase one (1990s through early 2000), interventions introduced farmers to post-harvest handling technologies and aimed to support the private sector seed industry and input distribution system. In phase two (2003 through 2008) farmers were trained in the use of various yield-enhancing technologies, and linked to markets. The third and current phase focuses on integrating smallholder farmers into value chains for maize, coffee and beans, with the aim of increasing income and thereby providing nutritional benefits for agricultural households. With respect to health improvements in Uganda, USAID efforts have focused on training health outreach workers and providing services for treatment and prevention of tuberculosis, malaria, and childhood diseases. In 2010, USAID reached more than 9.5 million children and 1.9 million women of reproductive age with health services including immunization, de-worming and obstetric care. USAID also assisted the GOU to establish a system to plan and monitor nutritional interventions. As a result, 85% of cooking oil in Uganda is vitamin A fortified, and 85% of table salt is iodized.

In addition, USAID has been working to mitigate conflict caused by the Lord's Resistance Army in north Uganda by facilitating reconciliation and promoting dialogue among local government and civil society. In 2010, USAID helped over 17,000 Ugandans in the war-affected areas of northern Uganda using 30 small peace-promoting grants. USAID also has promoted peace efforts in Karamoja, where residents are recovering from decades of ethnic conflict.

Since 1963, the World Food Program (WFP) has operated a range of projects designed to help Ugandans to fight against hunger. Efforts have included food assistance, livelihood support, and education. Current strategies being supported in Uganda focus on emergency humanitarian

action, food and nutrition security, and agriculture and market support. Many food-based projects are geographically concentrated in Karamoja and southwest parts of the country, and include school meals, a health and nutrition program focusing on mothers and children, and support of livelihoods and crop production. With respect to the agricultural sector and agricultural markets, the WFP helps smallholder households through its Purchase for Progress (P4P) programme with a fund of $50 million per year. It also works with FAO and other partners to strengthen the structure of Uganda's agricultural markets. For 2012, the WPF aims to provide direct food assistance to 266,000 Ugandans, including malnourished children, refugees, and extremely vulnerable households in Karamoja. In total, 1.2 million Ugandans are expected to receive direct assistance from the WFP in 2012.

Appendix: Data Availability

Two large country-wide series of data available for Uganda are the Demographic and Health Surveys (DHS) and the Uganda National Household Survey (UNHS). DHS survey data are available for 1988, 1996, 2001, 2006 and 2009. Characteristics of the sample include data covering birth history, anemia and anemia testing, anthropometry, birth registration, cause of death, early childhood education, HIV knowledge and testing, malaria, micronutrient intakes, reproductive calendar, TB, tobacco use, vitamin A, and maternal mortality.

The UNHS datasets were collected in 1992, 1996, 1999, 2002 and 2006 and (for 1996-99) include a partial panel data component. The UNHS includes information on a range of household welfare indicators, including income, consumption, housing, labor market participation, education and health). The UNHS survey follows the approach of the World Bank's Living Standards Measurement Study (LSMS). The survey consists of an integrated household questionnaire supported by a community questionnaire to collect information on available facilities, service delivery, prices and general conditions facing households. Most rounds include modules focused on agriculture, and most also include a range of questions related to health and ancillary concerns. Additional information includes household production, wage employment, education, credit and savings, household business activity, remittances, and other sources of income.

References

Asiimwe, J. B. and Mpuga,P. (2007) Implications of Rainfall Shocks for Household Income and Consumption in Uganda. AERC Paper 168. Nairobi: African Econ. Research Consortium.

Bahiigwa, Godfrey B. A. (1999) Household Food Security in Uganda: An Empirical Analysis. Research Series No. 25. Kampala: Economic Policy Research Center. Accessed 09/12/12 at http://www.eprc.or.ug/pdf_files/researchseries/series25.pdf.

Benin, S., Thurlow, J., Diao, X., Kebba, A., Ofwono, N. (2008) Agricultural growth and investment options for poverty reduction in Uganda. Discussion Paper 00790. International Food Policy Research Institute, Washington, DC.

Benson T., Mugarura S., Wanda K. (2008) Impacts in Uganda of rising global food price: the role of diversified staples and limited price transmission. *Agricultural Economics* 39, 513-524.

Bimenya, G.S., Olico-Okui, Kaviri, D., Mbona, N. & Byarugaba, W. (2002) Monitoring the severity of iodine deficiency disorders in Uganda. *Afr. Health Sci.*, 2 (2): 63–68. Accessed 09/06/2012 at http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2141571.

Bird, K., and Higgins, K. (2009) Conflict, education and the intergenerational transmission of poverty in Northern Uganda. Project Briefing No. 23. Oversease Development Institute, Chronic Poverty Research Center, UK.

Birner, R., Cohen, M. J., and Ilukor, J. (2011) Rebuilding Agricultural Livelihoods in Post-Conflict Situations: What are the Governance Challenges? The Case of Northern Uganda. Uganda Strategy Support Program (USSP) Working Paper no. USSP 07. Accessed 05/23/2012 at http://www.ifpri.org/sites/default/files/publications/usspwp07.pdf

Bridge, A., Kipp, W., Raine, K., Konde-Lule. J. (2006) Nutritional status and food consumption patterns of young children living in western Uganda. *East African Medical Journal* 83(11): 619-625.

Bryden, W. L. (2007) Mycotoxins in the food chain: Human health implications. *Asia Pacific Journal of Clinical Nutrition* 16: 95-101.

Bukuluki, P., Mugumya, F., Neema S., Kafuko, A., and Ochen, E. (2008) Gender, Food Security and AIDS in Internally Displaced People's Camps in Uganda, Implications for HIV Responsive Policy and Programming. International Food Policy Research Institute, Washington, DC.

Cleland, J.G. (1990) Maternal education and child survival: further evidence and explanations. In Voll, J., Caldwell, S., Findley, P., Caldwell, G., Santow, J., Braid and Broers-Freeman, 1990. *What We Know about the Health Transition: The Cultural, Social and Behavioural Determinants of Health*, 400- 419. Canberra: Health Transition Centre, the Australian National University.

FANTA-2 (2010) The Analysis of the Nutrition Situation in Uganda. Food and Nutrition Technical Assistance II Project (FANTA-2), Washington, DC: AED.

FAO (2007) Poultry sector country review. Prepared by Byarugaba, D. K.. Makerere University, Uganda: FAO Animal Production and Health Division. Accessed 12/04/11 at ftp://ftp.fao.org/docrep/fao/011/ai378e/ai378e00.pdf

FAO (2009a) Poultry policies, legislation and strategies in Uganda. Prepared by Azuba, R. M., Byarugaba, D. K., and Haan, N.. Rome: *AHBL – Promoting strategies for prevention and control of HPAI.* Accessed 12/04/11 at http://www.fao.org/docrep/013/al691e/al691e00.pdf

FAO (2009b) The role of poultry in peoples livelihoods in Uganda. Prepared by State, A. E., Birungi, P. B., Haan, N.. Rome: *AHBL - Promoting strategies for prevention and control of HPAI*. Accessed 12/04/11 at http://www.fao.org/docrep/013/al690e/al690e00.pdf.

FAO (2010) Uganda Nutrition Profile 2010. *Nutrition and Customer Protection Division.* Food and Agriculture Organization of the United States. Accessed 12/04/11 at ftp://ftp.fao.org/ag/agn/nutrition/ncp/uga.pdf.

FAO (2011a) Country Profile: Food Security Indicators – Uganda. Accessed 06/28/2012 at http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/country_profiles/eng/Uganda_E.pdf.

FAO (2011b) Hunger Map. *The State of Food Insecurity in the World 2010.* Food and Agricultural Organization of the United Nations. 11/24/11 accessed at http://documents.wfp.org/stellent/groups/public/documents/communications/wfp229328.pdf.

Farombi, E. O. (2006) Aflatoxin contamination of foods in developing countries: Implications for hepatocellular carcinoma and chemopreventive strategies. *African Journal of Biotechnology* 5(1): 1-14.

Hell, K., Mutegi, C. (2011) Aflatoxin control and prevention strategies in key crops of Sub-Saharan Africa. *African Journal of Microbiology Research* 5(5): 459-466.

Hobcraft, J. (1993) Women's education, child welfare and child survival: a review of the evidence. *Health Transition Review* 3(2): 159-175.

Hoorwey, J. C. (1976) Protein-energy malnutrition and intellectual abilities: a study of teen-age Ugandan children. Mouton, The Hague.

Hotz, C., Loechi, C., Lubowa, A., Tumwine, J. K., Ndeezi, G., Masawi, A. N., Baingana, R., Carriquiry, A., Brauw, A.de., Meenakshi, J. V., and Gilligan, D. O. (2012). Introduction of β-Carotene–Rich Orange Sweet Potato in Rural Uganda Results in Increased Vitamin A Intakes among Children and Women and Improved Vitamin A Status among Children. *The Journal of Nutrition* 111.151829.

Iannotti, L., and Gillespie, S. (2002) Successful Community Nutrition Programming: Lessons from Kenya, Tanzania and Uganda. Linkages/AED, the Regional Centre for Quality of Health Care/Makerere University in Uganda, and UNICEF. Accessed 05/29/2012 at http://www.linkagesproject.org/publications/Successful-Community-Nutrition.pdf.

Kaaya, N. A. and Warren, H. L. (2005) A review of past and present research on aflatoxin in Uganda. *African Journal of Food, Agriculture, Nutrition and Development* (ISSN: 1684-5374) 5(1).

Kasente, D. (2003) Gender and Education in Uganda: Paper commissioned for the *EFA Global Monitoring Report 2003/4, The Leap to Equality.* Paris: UNESCO.

Kabahenda, M. K. (2006) Effect of Nutrition Education on Nutritional Status and Growth of Young Children in Western Uganda. Unpublished dissertation, University of Georgia, Athens, Georgia.

Kabanda, B. and Kahangire, P. (1994) Irrigation and hydro – power potential and water needs in Uganda – an overview. In Howell, P. P. and Anthony, J., 1994. *The Nile: Sharing a Scarce Resource: A Historical and Technical Review of Water Management and of Economical and Legal Issues*, pp. 217-226. New York: Cambridge University Press.

Kasente, D., Lockwood, M., Vivian, J., and Whitehead, A. (2000) Gender and the Expansion of Non-traditional Agricultural Exports in Uganda. UNRISD Contributions to the Fourth World Conference on Women, 12. United Nations Research Institute for Social Development (UNRISD), Geneva, Switzerland.

Kikafunda, J. K., Walker, A. F., Allan, E. F., and Tumwine, J. K. (1998a) Effect of zinc supplementation on growth and body composition of Ugandan preschool children: a randomized, controlled, intervention trial. *American Journal of Clinical Nutrition* 28: 1261-1266.

Kikafunda, J. K., Walker, A. F., Collett, D., Tumwine, J. K. (1998b) Risk factors for early childhood malnutrition in Uganda. *Pediatrics* 102(4): e45.

McKinney, P. (2009) Comprehensive Food Security & Vulnerability Analysis (CFSVA) Uganda. Rome, Italy: United Nations World Food Programme.

Messer, E., and Cohen, M. J. (2004) Breaking the Links Between Conflict and Hunger in Africa. 2020 Africa Conference Brief 10. International Food Policy Research Institute, Washington, DC. Accessed 05/21/2012 at http://www.ifpri.org/sites/default/files/pubs/pubs/ib/ib26.pdf.

Mpuga, P. (2008). Constraints in Access to and Demand for Rural Credit: Evidence from Uganda. A paper for presentation during African Economic Conference. African Development Band, Tunis, Tunisia.

Mukiibi-muka, G. (1992) Epidemiology of Newcastle disease in village chickens and the need to vaccinate them. In: Newcastle disease in village chicken. Proceedings No. 39 ACIAR Canberra, Australia, pp. 155-158.

Munyonyo, R. (2012) The Right to Adequate Food in Armed Conflict Areas of Uganda. Accessed 05/23/12 at http://www.ajol.info/index.php/mtafiti/article/viewFile/38355/37783.

Mwerera, R. L., Majaliwa, J.G.M., and Isubikalu, P. (2010) Climate change adaption strategies among agricultural communities in Uganda: The case of Kabale and Nakasongla districts. Second RUFORUM Biennial Meeting 20-24: 81-85. Entebbe, Uganda.

Ndeezi, G., Tumwine, J. K., Ndugwa, C. M., Bolann, B., and Tylleskar, T., (2011). Multiple micronutrient supplementation improves vitamin B12 and folate concentration of HIV infected children in Uganda: a randomized controlled trial. *Nutrition Journal* 10 (56).

Ndeezi, G., Tumwine, J. K., Bolann, B., Ndugwa, C. M., and Tylleskar, T., (2010). Zinc status in HIV infected Ugandan children aged 1-5 years: a cross sectional baseline survey. *BMC Pediatrics* 10(68).

Ndeezi, G., Thlleskar, T., Ndugwa, C. M., Tumwine, J. K. (2012). Multiple micronutrients supplementation does not reduce diarrhoea morbidity in Uganda HIV-infected children: a randomized controlled trail. *Paediatrics and International Child Health* 32 (1): 14-21.

Nkonya, E., Kaizzi, C., and Pender, J. (2005) Determinants of nutrient balances in a maize farming system in eastern Uganda. *Agricultural Systems* 85(2): 155-182.

Nkonya, E. and Kato, E. (2001) Agricultural Input Marketing in Uganda. A paper presented at the IFPRI Policy Workshop. Kampala, Uganda. Accessed 05/12/2012 at

http://ussp.ifpri.info/files/2011/10/agricultural-input-marketing-in-uganda-nkonya-and-kato-200.pdf

Odongo, B., Mwanga, R., Oworr, C., et al. (2002) Development and promotion of orange-fleshed sweet potato to reduce vitamin A deficiency in Uganda. Accessed 05/29/2012 at http://sweetpotatoknowledge.org/use-consumption/nutrition-interventions/Development%20and%20Promotion%20of%20Orange-Fleshed%20Sweetpotato%20to%20Reduce%20Vitamin%20A%20Deficiency%20in%20Uganda.pdf#.

Okori, W., Obua, J., and Baryamureeba, V. (2009) Famine Disaster Causes and Management Based on Local Community's Perception in Northern Uganda. *Research Journal of Social Sciences*, 4: 21-32.

Pender, J., Nkonya, E., Jagger, P., Sserunkuuma, D., Ssali, H. (2004) Strategies to increase agricultural productivity and reduce land degradation: evidence from Uganda. *Agricultural Economics* 31(2-3): 181–195.

RoU (2004) Increasing incomes through exports: a plan for zonal agricultural production, agro-processing and marketing. Republic of Uganda. Accessed 01/26/2012 at http://www.ugandaexportsonline.com/strategies/zoning_plan.pdf.

Sebunya, T. K., Yourtee, D. M. (1990) Aflatoxigenic aspergilli in foods and feeds in Uganda. *Journal of Food Quality* 13(2): 97-107.

Semba, R. D., Ndugwa, C., Perry, R. T., et al. (2005) Effect of periodic vitamin A supplementation on mortality and morbidity of human immunodeficiency virus-infected children in Uganda: a controlled clinical trial. *Nutrition* 21: 25-31.

Simler, K. R. (2010) The short-term impact of higher food prices on poverty in Uganda. World Bank Policy Research Working Paper 5210. Washington, DC: The World Bank.

Smale, M., Tushemereirwe, W.K. (Eds.) (2007) An economic assessment of banana genetic improvement and innovation in the Lake Victoria region of Uganda and Tanzania. Research Report 155, International Food Policy Research Institute, Washington, DC.

Sseguya, H., Semana, A. R., and Bekunda, M. A. (1999) Soil fertility management in the banana-based agriculture of central Uganda: Farmers constraints and opinions. *African Crop Science Journal* 7 (4): 559-567.

Ssewanyana, S. N. and Bategeka, L. (2007) Chronic poverty and economic growth in Uganda: The role of markets. Background paper for the Chronic Poverty Report 2007/08. Kampala, Uganda: Makerere University Economic Policy Research Center.

Tiwari, S., and Zaman, H. (2010) The Impact of Economic Shocks on Global Undernourishment. World Bank Policy Research Working Paper 5215. Accessed 05/23/12 at http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2010/02/23/000158349_20100223161348/Rendered/PDF/WPS5215.pdf.

UCA (2010) Summary Report on Uganda Census of Agriculture 2008/2009. Accessed 01/28/2012 at http://www.ubos.org/onlinefiles/uploads/ubos/pdf%20documents/UCASummary.pdf

Uganda Bureau of Statitics (UBOS) and Macro International (2007) Uganda Demographic and Health Survey 2006. Kampala, Uganda and Calverton, Maryland, USA: UBOS and Macro International Inc.

United Nations Children's Fund (UNICEF) (undated). Nutrition in Emergencies. Prepared for the Emergency Nutrition Network. Accessed 09/12/12 at http://www.unicef.org/nutrition/training/swf/S2L4/page16.swf

United Nations High Commission on Refugees (UNHCR) (2012) 2012 UNHCR country operations profile – Uganda. Accessed 09/02/12 at http://www.unhcr.org/pages/49e483c06.html.

Vella, V., Tomkins, A., Borghesi, A., Migliori, G. B., Adriko, B.C., and Crevatin, E. (1992) Determinants of child nutrition and mortality in north-west Uganda. *Bulletin of the World Organization* 70 (5): 637-643.

von Grebmer, K., Torero, M., Olofinbiyi, T., Fritschel, H., Wiesmann, D., Yohannes, Y., Schofield, L., von Oppeln. (2011) 2011 Global Hunger Index - The challenge of hunger: Taming price spikes and excessive food price volatility. Washington, DC: International Food Policy Research Institute.

Wamani, H., Tylleskar. T., Astrom, A. N., Tumwine, J. K., and Peterson, S. (2004) Mothers' education but not fathers' education, household assets or land ownership is the best predictor of child health inequalities in rural Uganda. *International Journal of Equity in Health* 3(1): 9.

WFP (2011) Uganda Overview. Accessed 12/02/11 www.wfp.org/countries/Uganda/Overview

WWAP (2006) National Water Development Report: Uganda. Prepared for the 2nd UN World Water Development Report "Water, a shared responsibility". Accessed 06/25/12 at http://unesdoc.unesco.org/images/0014/001467/146760e.pdf