EXAMINING THE LINKAGE BETWEEN LOCAL FOOD ECONOMIES AND HOUSEHOLD NUTRITION IN RURAL TANZANIA

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To My Sons Humphrey *and* Joseph

My Husband Njamasi

My Parents Mkunga Sr *and* Rose

and

My Siblings Sangalala, Mkunga Jr, Ntakano *and* Mwaimu

Regina, Faith *and* all My Nieces and Nephews

For the Love, Encouragement, Support and Prayers, and Believing in ME!!

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ACRONYMS AND ABBREVIATIONS

AIDS - Acquired Immunodeficiency Syndrome

ASLMs - "Agriculture Sector Lead Ministries (ASLMs)" that include the Ministry of Agriculture Food Security and Cooperatives (MAFC), the Ministry of Livestock and Fisheries Development (MLFD), the Ministry of Industry and Trade (MIT), and the Prime Minister's Office-Regional Administration and Local Governments (PMO-RALG).

BOT - Bank of Tanzania

CBOs - Community Based Organisations

CC - Cash Crop farming system

FAO - Food and Agriculture Organisation

FAOSTAT - Food and Agriculture Organization Corporate Statistical Database

GDP - Gross Domestic Product

GHI - Global hunger Index

HDDS - Household Dietary Diversity Score

HFIAP - Household Food Insecurity Access Prevalence

HFIAS - Household Food Insecurity Access Scale

HIV - Human Immunodeficiency Virus

IFAD - International Fund for Agricultural Development

IFPRI - International Food Policy Research Institute

Kcal - Kilocalories

MAFC - Ministry of Agriculture, Food and Cooperatives

MCL	-	Mixed Crop-Livestock farming system
MDGs	-	Millennium Development Goals
MFC	-	Mixed Food Crop farming system
MUAC	-	Mid-Upper Arm Circumference
SACCOS	-	Savings and Credit Co-Operative Society
SDGs	-	Sustainable Development Goals
SFC	-	Single Food Crop farming system
SPSS	-	Statistical Package for Social Sciences
TFDA	-	Tanzania Food and Drug Authority
TFNS	-	Tanzania Food and Nutrition Centre
TZS	-	Tanzanian Shilling
UN	-	United Nations
UNDP	-	United Nations Development Program
UNICEF	-	United Nations International Children's, Emergency Fund
URT	-	United Republic of Tanzania
USDA	-	United States Department of Agriculture
NBS	-	National Bureau of Statistics
WFP	-	World Food Program
WHO	-	World Health Organisation
VICOBA	-	Village Community Banks

ABSTRACT

Tanzania, a low-income country with high dependence on agricultural activities, has a large number of poor people who mostly reside in rural areas and are faced with food insecurity and malnutrition. Even with the increase in the Gross Domestic Product (GDP), the share of agriculture to GDP has continued to decline and income distribution remains poor. The challenge of food security has meant that Tanzania has a score of 28.8 in the 2017 Global Hunger index and the number of undernourished people has continued to increase. The local food economy in Tanzania plays a great role in influencing incomes and food security of rural households, and therefore it is important to examine the linkage between local food economies and household food security and nutrition. This study was conducted in two districts of Tanzania that have different agro-ecological and economic conditions, Kishapu in the Shinyanga Region and Mvomero in the Morogoro Region and examined the factors within the local food economy that affect household food security status. These districts were selected basing on nutritional vulnerability, lack of nutritional interventions and differences in rain patterns, farming practices and economic activities. Both qualitative and quantitative data were collected in two phases (before and after harvest) using household surveys in 2014 with the aid of structured questionnaires from 506 households as well as monthly market price surveys in 2014. Also, key informant interviews and focus group discussions were used to collect qualitative data. Four income quartiles were identified from the income data as well as four farming systems from the crop and livestock production data. Households in Mvomero had higher incomes, better market access, diversified income sources and better food security. Diet costs, influenced by price and seasons, impacted lower income households resulting to poor diet choices and more food insecurity. Households also had fewer means of coping with food and income shortages and would resort to consuming less or selling livestock and borrowing. Policies and strategies to improve farm production and farm incomes, improve market access, increase non-farm opportunities have meaningful implications for low-income rural households. These may include initiatives to improve transport and communications infrastructures, access to credit and market information, as well as nutritional education to households.

STATEMENT OF ORIGINAL AUTHORSHIP

I hereby certify that the submitted work is my own work, was completed while registered as a candidate for the degree stated on the Title Page, and I have not obtained a degree elsewhere on the basis of the research presented in this submitted work.

COLLABORATIONS

The data presented in this thesis were obtained from a survey and other research instruments carried out by the AgriDiet Tanzania Team in Tanzania. I played a major role in the preparation and execution of the survey, focus groups discussions, key informant interviews and market price surveys; and the data analysis and interpretations are entirely my own work. Any contributions from colleagues in the collaboration are explicitly referenced in the text.

FORMAT OF THE THESIS

This thesis submitted for examination includes two papers, which have been submitted and accepted for review. The first paper corresponds to Chapter Four and is titled 'Low Income Farm Households' Access to Markets and Household Food Security: The Case of Two Economically Distinct Areas in Rural Tanzania'; it is under review by the *African Journal of Food, Agriculture, Nutrition and Development*. The second paper corresponds to Chapter Five and has been published by the *African Journal of Agricultural and Resource Economics* and is entitled 'Seasonality, Food Prices and Dietary Choices of Vulnerable Households: A Case Study of Nutritional Resilience in Tanzania'.

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1.0 INTRODUCTION

This chapter introduces the research study by giving the background and context in which the study was carried out. It first presents an overview of the study from both international and national points of view related to issues of food security and nutrition; the economy of Tanzania; its agricultural sector; issues of agriculture and rural development together with the food economy and related policies and strategies in Tanzania. Furthermore, a statement of the problem and study objectives underlying this thesis, are presented later in the chapter. A detailed methodology is presented showing the processes adopted from study area selection, data collection to sampling procedures. Moreover, this chapter offers an explanation on the methods of data analysis adopted in the results chapter as well as the utility of the study. The conceptual framework guiding this thesis is also presented together with the overall structure of the rest of the thesis.

1.1 Overview of the Study

Food security and nutrition have been at the centre of discussion for many national and international platforms in recent years (FAO, 2013; Farrell, 2010; IFPRI, 2012) and different policy makers and policy strategists address these calling on practitioners to engage in good agricultural practices. The World Food Summit held in the Italian capital city of Rome in 1996, for example, projected to reduce hunger by half by 2015. Despite the policies and strategies that have been put forward aiming at addressing food security and good nutrition, the situation of food security and good nutrition is improving at a slow pace. The results of the concerted efforts by both national governments and the international community saw as part of the efforts to address food security and good nutrition, the signing of an international binding project of the Millennium Development Goals (MDGs) (MDG, 2000).

The MDGs are a set of eight ‘key’ objectives related to development that provide a comprehensive framework through which to address the most pressing issues of poverty. The Millennium Declaration was signed in year 2000 by 198 of the world’s leaders; and it established 2015 as a target by which the MDGs should be achieved. The objectives of the MDGs include; eradication of extreme hunger and poverty,

achievement of universal primary education, gender equality and women empowerment, reduction of child mortality, improvement of maternal health, combating diseases, and environmental sustainability. These objectives could not have been achieved without proper nutrition. The MDGs were to be achieved by the year 2015; however, gaps still remain for many countries in the world. The United Nations has therefore transformed these goals into 17 Sustainable Development Goals (SDGs), with new strategies and plans for Transforming Our World by the year 2030 with one of the agenda being the feeding of over 9 billion people in the world by 2050 (FAO, 2009; United Nations, 2016).

Of the 17 SDGs, Goal 2 intends to have zero hunger in the world by the year 2050 (United Nations, 2017a). The current situation in the world is that more than eight hundred thousand people are hungry and if the food and nutrition security is not improved, by 2050 more than two billion people will be undernourished (United Nations, 2017a). This therefore stresses the importance of addressing food security and nutrition issues in the world and especially in developing countries. Access to nutritious and healthy food is fundamental to human life. It is important to address the means by which the need can be sustainably secured for everyone. Increased food production alone will not solve the hunger problem. Along with ending hunger, the goal targets to improve food security and nutrition as well as promoting sustainable agriculture.

In line with the MDGs, in 1999 Tanzania launched the Development Vision 2025 with one of its major objectives to promote high quality livelihoods for Tanzanians (Planning Commission, 1999). The Vision 2025 aims at putting Tanzania as among the middle-income countries with high levels of industrialization, competitiveness, quality livelihood, rule of law, and an educated and pro-learning society (Planning Commission, 1999). With the upgrade from MDGs to SDGs, Tanzania has integrated and started to implement the SDGs through its medium-term plans such as the National Five-Year Development Plan 2016/17 - 2020/21 with reasonably good performance in some goals including SDG-2 while other need significant local effort and international support to be achieved ("United Republic of Tanzania .:. Sustainable Development Knowledge Platform", n.d.).

Other strategies developed in Tanzania which address food security and nutrition include 'The National Strategy for Growth and Reduction of Poverty' (NSGRP or *MKUKUTA*) formulated in 2005 as a tool for poverty monitoring in the country (URT, 2010). NSGRP is implemented in three clusters that include economic growth and the reduction of income poverty, improved quality of life and social wellbeing, and good governance and accountability. Further, *Kilimo Kwanza*, 2009 (or "Agriculture First"), which is a national resolve to accelerate agricultural transformation, shows that Tanzania is emphasising the importance of agriculture for development (Ngaiza, 2012).

In an effort to transition the country from a low-income country to a medium-income economy, in the financial year 2013-2014 the Tanzanian government adopted the Malaysian Big Fast Results (BFR Institute, n.d.) into its own Big Results Now (BRN) (URT, n.d.) strategy with six priority areas. One of these priorities was agriculture, aiming at making agriculture more commercial. The Big Results Now Strategy did not directly address nutrition issues in the economy (URT, n.d.) as its main focus in agriculture was on agribusiness which could have had income effects for households and may or may not result in nutrition improvement but not directly.

The Tanzanian economy is characterised by high dependence on the agricultural sector as a means of livelihood for many people (FAOSTAT, 2019). According to FAOSTAT (2011), this sector employs about 80 per cent of the total working population in the country, with women making up the largest percentage of the total agricultural workforce (NBS, 2015). The agricultural sector is an important sector of the Tanzanian economy, for example, agricultural output accounts for about 25 percent of the Gross Domestic Product (GDP) (World Bank, 2018a) and about 24 percent of export earnings (URT, 2015). The practice of agriculture in the country is however dominated by smallholder farmers who cultivate up to 3 hectares each of which 70 percent is cultivated by hand hoe, 20 percent by ox-plough, and the remaining 10 per cent by tractor (FAO, 2014).

Out of the 85 milion hectares annual cultivation in Tanzania, food cultivation occupies about 85 percent and the major food crops include maize, paddy, sorghum, millet, cassava, beans, bananas, and sweet potatoes. As a result of the farming activities in the country, the value added per agricultural worker has been increasing in recent years

though at a slower rate compared to GDP and per capita income (World Bank, 2018a). The level of food supply per capita in the country has been increasing on the average between 1994-2004 but fell slightly in 2009. The growth rate of agricultural activities has shown some variations over the years. For example, in 2007 the growth rate was 4 per cent, increased to 4.6 per cent in 2008 but fell to 3.2 per cent in 2009. Moreover in 2010 the growth rate in agriculture was 2.7 per cent while in 2011 it was 3.5 per cent (BOT, 2018). Despite the fluctuations in agricultural activities in the country, there has been an increase in the amount of the food produced in the country as a whole (BOT, 2018). Food production increased from 13 million tonnes in 2012/2013 to 16 million tonnes in 2017/2018 with each year producing a surplus as the requirements were lower than production (BOT, 2018).

The contribution of the crop subsector in agriculture to GDP has been showing a decreasing trend (BOT, 2017) from 10.4 per cent in 2012 to 9 per cent in 2016. The decrease in the contribution of the sector to GDP is attributed to the fact that GDP has been increasing at a faster rate due to the services sector while agriculture has been increasing at a slower rate. Although it represents a decreasing contribution to GDP, the agricultural sector is still a major source of livelihoods for most of the rural Tanzanians (NBS, 2015). Despite agriculture being a major source of livelihoods for many Tanzanians especially in the rural population (NBS, 2015) and its significant contribution to the national GDP (BOT, 2018), no significant impact has been observed on nutrition status for most of the rural people (Benson et al., 2018; ICF Macro, 2011).

The levels of stunting (low height for age) and underweight children in Tanzania during the period 2009-2015 have been decreasing but at a slow rate and have remained significantly higher than the acceptable levels (World Bank, 2018b). The prevalence of wasting has also been decreasing despite an increase being observed between 2009-2011 (NBS, 2017; World Bank, 2018c). Agricultural production is not the final determinant of the nutrition status of the people. The food goes through a number of processes before the household consumes it. This is because a single household does not produce everything it consumes; it has to access the market or other means to obtain what it needs (FAO, 2013), this therefore affect the value of the food the household needs in terms of quantity and quality.

1.2 Tanzania: An Overview

Tanzania is one of the poorest countries in the world and even though the poverty head count has decreased over the years, the absolute number of poor people has remained high (World Bank, 2018d; World Bank Group, 2015). It had a total GDP of USD 52,090 million as of 2017 which ranks it at number 82 out of 196 countries ("Tanzania GDP - Gross Domestic Product 2017 | countryeconomy.com", n.d.); between the years 2007 to 2017 the country GDP had more than doubled as shown in Table 1-1. The last official census calculated the population at about 45.9 million people (NBS, 2014a). There is a high malnutrition rate of 34.4 percent stunting in 2015 (World Bank, 2018e), Tanzania is still struggling to overcome this challenge. Despite the fact that most of the developing countries depend on agriculture and many people spend a large part of their incomes on food, it is not adequate both nutritionally and in quantity (FAO, 2013).

Table 1-1: Tanzania GDP, GDP per capita, GDP per capita PPP 2010 adjusted prices and Annual GDP Growth Rates

Year	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
GDP current USD (mil)	27368	28574	31408	33879	39088	44414	48220	45623	47388	52090
GDP per Capita current USD	651.3	658.8	701.6	733.4	820.2	901.7	950.4	872.3	877.5	936.3
GDP per Capita PPP 2010 prices	666.8	680.8	701.6	733.7	747.7	777.4	806.2	836.0	867.1	900.5
Annual GDP Growth Rate (%)	2.3	2.1	3.1	4.6	1.9	4.0	3.7	3.7	3.7	3.9

Source: (World Bank, 2018f)

Tanzania's economy is characterised by high dependence on the agricultural sector as a means of livelihood for many people (FAOSTAT, 2011). Agriculture is a dominant sector in most developing countries (World Bank, 2007) although it is underperforming in some countries (FAO, 2003). Women remain the major participants in the sector and they practice small-scale subsistence farming in small land areas (NBS, 2015). Farming practices by these individuals are affected by several human and technical factors as well as government policies and interventions (Boserup, 2017; Mwangi and Kariuki, 2015). While productivity has an impact on nutrition security through supplying sufficient quantities to households and markets (Aberman et al., 2018), other studies have indicated that production alone does not

necessarily mean higher food security and nutrition (Geissler and Powers, 2017; Kanter et al., 2015).

Recent data in Tanzania shows enormous and complex nutrition problems facing women and children (World Bank, 2018e, 2018c). As of 2015, about 10% of women were malnourished, 34.4 percent of children aged less than five years were stunted, 4.5 per cent were wasted and 14 per cent are underweight (NBS, 2017). Moreover, surveys (NBS, 2017) revealed a high prevalence of anaemia, with about 60 per cent of children aged less than five years and 45% of women aged 15-49 years were found to be anaemic.

1.3 Overview of the Agricultural Sector in Tanzania

Dubbed the backbone of the economy, agriculture in Tanzania contributed the largest share of Gross Domestic Product over the years ("Agriculture sector heaves relief", 2017; BOT, 2016). Nonetheless, the share of agriculture to GDP in recent years has been declining with the rise in the service industry and some manufacturing (BOT, 2018). Smallholders mostly dominate the agricultural sector in Tanzania (URT, 2015). If there is any surplus left, they would sell it to other households or to the market if they can access the market (Maziku, 2015).

The sector accounted for about 30 per cent of the national income (FAOSTAT, 2018) and three quarters of merchandise export while providing Tanzanians with food and nutrition as well as employment opportunities, with more than 75 per cent of Tanzanians being employed in agriculture (NBS, 2015). The agricultural sector in Tanzania includes sub-sectors such as crops, livestock, hunting and fishing (BOT, 2018). The following figure, Figure 1-1, shows the contribution of each sub-sector to the agricultural sector. The data shows that in 2016 there was an increase in the contribution of livestock, hunting and forestry as well as fishing sub-sectors while that of crop decrease and once again rose in 2017. These changes could be attributed to the changes in the government administration and the new agricultural sector development strategy that began in 2015.

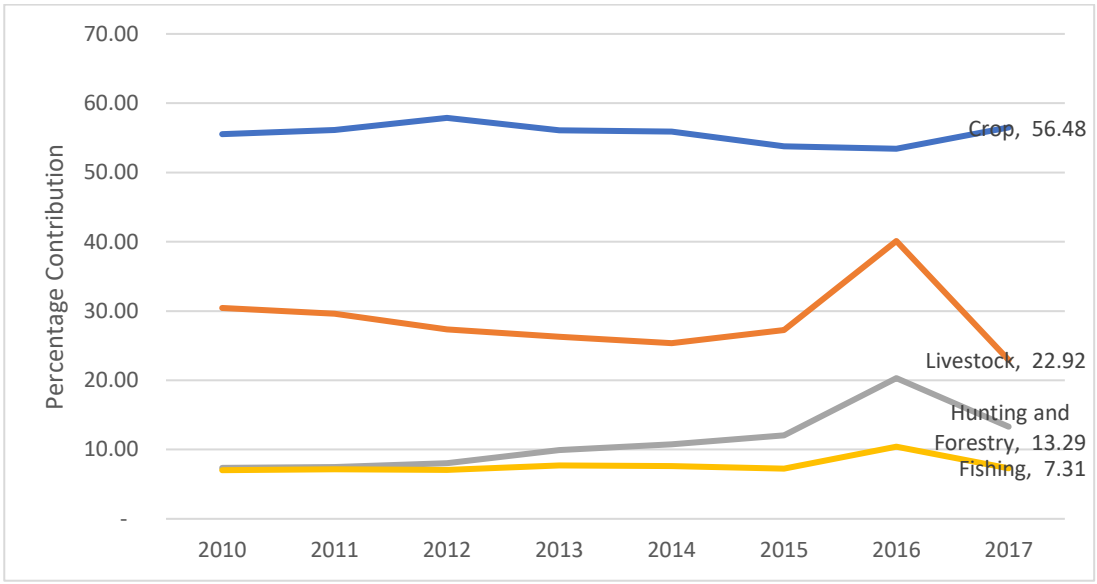


Figure 1-1: Sub-Sector contributions to the Agricultural Sector

Source: (BOT, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

The crop sub sector in agriculture showed a declining trend in its contribution from the year 1998 but it remains the highest contributing sub-sector with over 50 per cent contribution to the agricultural sector each year. Livestock, Hunting and Forestry and Fishing remain in second, third and fourth places each year (BOT, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018).

Moreover, the Agricultural sector although employing the majority of Tanzanians, in comparison with other sectors is not the best performing sector in terms of contribution to GDP (Figure 1-2). The services sector, although declining, has remained the highest contributing sector. Agriculture comes in second while at third place, the industry and construction sector are picking up speed, and this could be due to the new emphasis put on industrialising Tanzania.

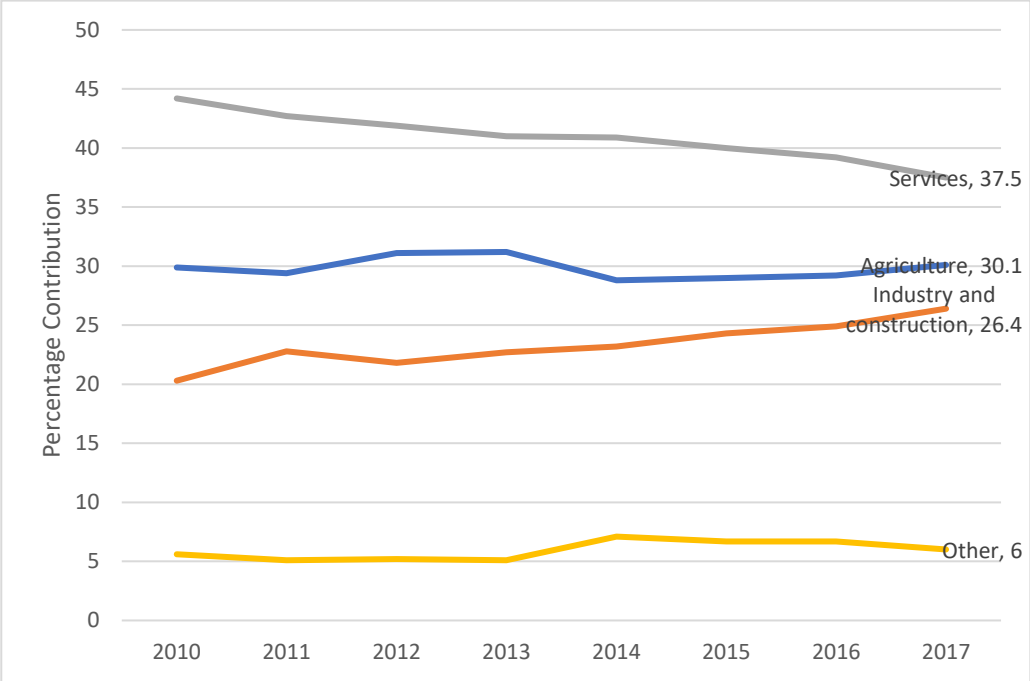


Figure 1-2: Sectoral Contribution to Gross Domestic Product

Source: (BOT, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

Figure 1-3 below present the annual growth rates of GDP by economic activity at constant 2007 prices. The contribution of agriculture to annual GDP growth rate shows a declining trend, but not because it is not important in the economy. The sector still employs the largest share of the population and is depended upon to feed the population and contribute to income. There may be a lack of forward and backward linkages between industry and agriculture giving rise to the growth in industry not contributing much to the growth in agriculture. In 2012 there was an overall decline in the annual growth rate of GDP by sector except for the agricultural sector, although all other sectors remained above the agricultural sector.

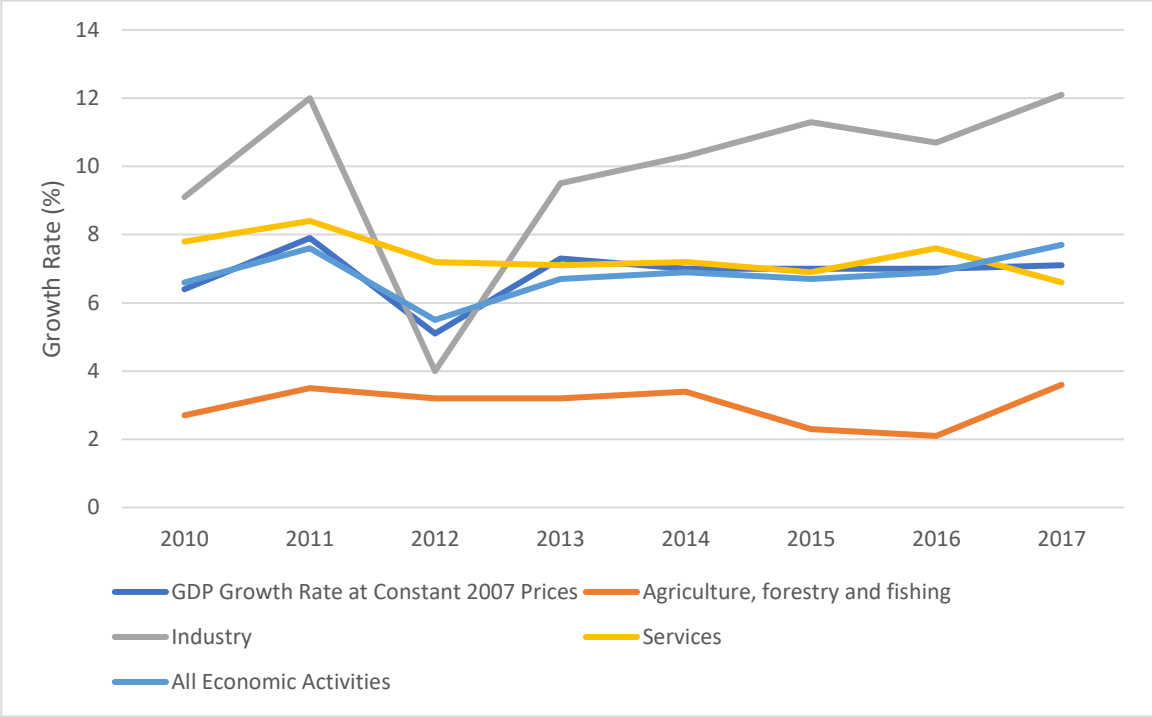


Figure 1-3: Annual Growth Rates of GDP by Economic Activity at Constant 2007 Prices

Source: (BOT, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

1.4 Agriculture and Rural Development in Tanzania

Agricultural activities in Tanzania largely occur in the rural areas, both small- and large-scale crop and livestock farming happens in the rural areas. The Tanzanian Rural Economy is mainly dependent on agriculture as its main source of income and food (NBS, 2014a). About 90 per cent of the rural population are farmers and most of whom are small scale subsistence farmers (NBS, 2015).

Middlemen control the access to market for very remote farmers and rural farmers have little to no means of taking their produce to the market (FAO, 2013; Okorie, 2014). Thus, their profits depend on the mercy of middlemen who can afford to invest enough and take the risk of travelling the bad roads of remote areas.

There was high income inequality observed in rural areas compared to urban areas in 2010/2011, while in 2012/2013 and 2014/2015 income inequality for urban was higher than in rural areas of Tanzania (NBS, 2014b). Agriculture remains key to rural development, even with the rise in other sectors, rural development largely depends on

the development of the agricultural sector in Tanzania because it is the sector that the rural population mostly depend on (NBS, 2014a, 2015). Together with other developments in infrastructure such as roads and electricity, health services, education, finance and industry; the agricultural sector will play a great role in developing the rural communities in Tanzania.

1.5 Food Security and Nutrition Conditions in Tanzania

1.5.1 Hunger and Food Security

Tanzania is a low-income country with a high poverty head count (World Bank, 2018d). Coupled with low income and poverty, the country has serious hunger problems with a Global Hunger Index (GHI) of 28.8 in the year 2017 (Global Hunger Index, 2018). Although it is still very high at 28.8 in 2017, the GHI has shown a declining trend from 42.9 in 1992, 42.4 in 2000 and 33.0 in 2008; it fell further to 17.3 in 2014 (Global Hunger Index, 2018).

The number of people who are undernourished in Tanzania has continued to increase (FAOSTAT, 2018) even with the continued increase in food availability as shown in the dietary energy adequacy column. Even with high energy availability and surplus food production overall, the data shows a continued prevalence of undernourishment and a lack of protein. Figure 1-4 below presents data on food production, requirement and gaps/surplus

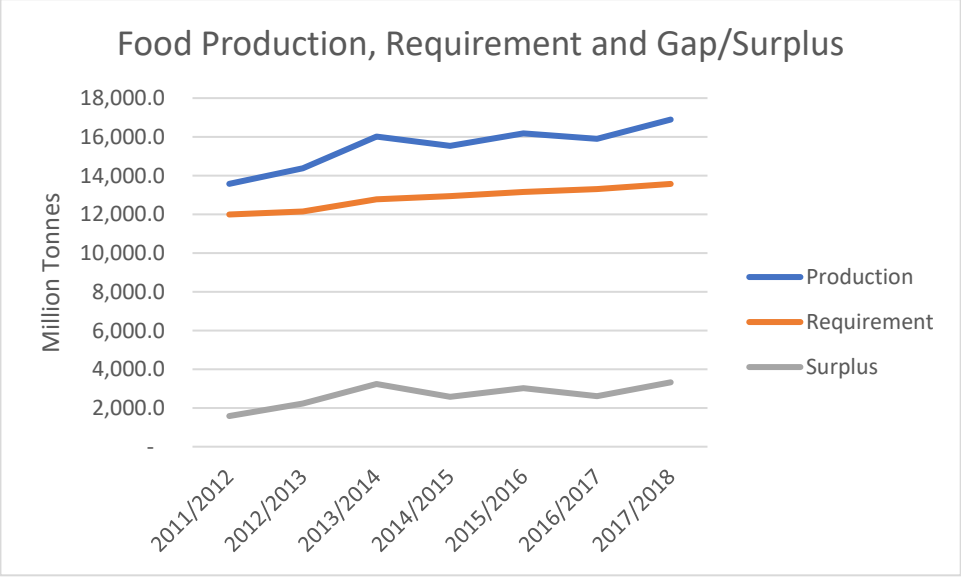


Figure 1-4: Food Availability Situation

Source: (BOT, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

Data from the national food security bulletin (Ministry of Agriculture, 2017) and the Bank of Tanzania Annual Reports (BOT, 2018) indicate a presence of food surplus over the years in the country.

1.5.2 Nutrition Conditions

The number of undernourished people in Tanzania has remained high and increasing (FAOSTAT, 2018) for years. However, the prevalence of undernourishment, although still high, has been declining at a slow pace. The same data from FAOSTAT (2018) displays an increase in the average energy and protein adequacy. Nevertheless, the depth of food deficit is still high even though also decreasing (World Bank, 2018g) as presented in Table 1-2 below.

Table 1-2: Number of People Undernourished, Prevalence of Undernourishment, Average Dietary Energy Adequacy, and Average Dietary Protein Adequacy

Year	Number of People (Million) Undernourished	Prevalence of Undernourishment (%)	Average Dietary Energy Adequacy (%)	Average Dietary Protein Adequacy (g/capita/day)	Depth of Food Deficit
2006-2008	13.9	33.2	103	43	-
2007-2009	14.8	34.1	103	42	-
2008-2010	15.4	34.5	101	42	257
2009-2011	16	34.5	102	41	259
2010-2012	16	33.6	103	43	258
2011-2013	16.2	33	104	44	248
2012-2014	16.5	32.6	104	46	241
2013-2015	16.8	32.2	104	-	237
2014-2016	17.3	32.1	105	-	238
2015-2017	17.8	32	106	-	-

Source: (FAOSTAT, 2018; World Bank, 2018g)

1.6 The Tanzanian Food Economy

1.6.1 Food Production, Imports and Exports

The top ten commodities produced in Tanzania include maize, cassava, sweet potatoes, bananas, sugarcane, rice/paddy, fresh vegetables, potatoes, millet and beans (FAOSTAT, 2018). Annual production of these commodities for the period of eight years is presented in Table 1-3 below. Other crops also produced in Tanzania include several types of leguminous crops such as pigeon peas, cowpeas and mung beans; also onions, tomatoes, carrots, spices, sorghum and millet.

Table 1-3: Production of the Top Ten Commodities

Production (Tonnes)	2010	2011	2012	2013	2014	2015	2016	2017
Maize	4733070	4340823	5104248	5356350	6737197	5902776	5916381	5939737
Cassava	4547940	4646523	5462454	4755160	4992759	5886440	5384315	5014624
Sweet potatoes	2424200	3573302	3018175	3470304	3500699	3454493	3843746	4244370
Bananas	3155710	3143835	2524740	2678680	3192030	3584532	3563596	3484788
Sugar cane	2800825	3021314	2716619	2992177	2800000	2840437	2986250	3001080
Rice, paddy	2650120	2248320	1800551	2194750	2621034	2979860	3005924	2871963
Vegetables	1500000	1634878	1755000	1800000	1852365	1717538	1773877	1817640
Potatoes	1472560	1555516	1235041	1767536	1738017		1459230	1749213
Milk,	1649857	1738683	1853099	1921640	1990183	2058726	1410358	1398491
Beans, dry	867530		1199267				1140605	1140444
Food Production Index	129.17	138.25	147.42	172.62	187.45	194.28	168.95	

Source: (FAOSTAT, 2018)

Food production data from the table above shows an increasing trend over the years with maize remaining the most important. It is the most used staple food for both urban and rural areas of Tanzania (FAO, 2018a). Despite the increase in production as depicted in the food production index above, Tanzania also imports crops such as wheat, palm oil, refined sugar, vegetable oil, rice and malt (FAOSTAT, 2018). Most of these imported crops shown in Table 1-4 are also produced here in Tanzania. The imports would include different variety to try to cover for deficit in supply.

Table 1-4: Food Items Imported

Imported Items (Tonnes)	2010	2011	2012	2013	2014	2015	2016

Wheat	1039812	1071813	1115920	793230	901241	846173	815962
Palm Oil	212351	227171	236724	246056	429462	341340	381806
Sugar refined	132032	161573	234263	222044	174983	210222	273953
Rice	74876	50851	197522	284787	-	28849	-
Vegetable Oil	-	15892	29005	37423	62946	16851	37660
Malt	65928	31773	37861	-	32457	26553	22449

Source: (FAOSTAT, 2018)

Moreover, exports include cashew nuts (with shell), sesame seed, wheat bran, dry beans, unmanufactured tobacco, and sunflower cake (FAOSTAT, 2018) among others. Exported crops in Table 1-5 below contribute to the national GDP. For example, Tanzania is one of the largest cashewnut producers in Africa (TanzaniaInvest, n.d.).

Table 1-5: Food Items Exported

Exported Items (Tonnes)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Cashew nuts (with shell)	102707	99425	130882	150882	196138	170162	217051
Sesame seed	65708	76017	76710	87727	116877	135081	133752
Wheat Bran	98529	100646	130533	131017	142543	-	132416
Dry Beans	83112	68379	98337	120449	84657	51865	97936
Unmanufactured Tobacco	69095	74022	107593	69449	76525	65682	74341
Sunflower Cake	39774	35756	88766	93831	64131	-	67438

Source: (FAOSTAT, 2018)

1.6.2 Markets, Food Access and Prices

One of the components of food security is access, which is also mentioned as an important aspect of food security by the Food and Agriculture Organisation of the United Nations (FAO, 2013). Most local foods are produced by smallholder farmers in rural areas with the average size of agricultural holding at less than 10 hectares and producing up to 80 percent of food in Asia and Sub-Saharan Africa (FAO, 2012). Some of these areas are hard to reach as the transport infrastructure is not well developed (Aggarwal et al., 2018; Mubila and Yepes, 2017; Stifel and Minten, 2017a).

To improve access to markets, the government of Tanzania together with Africa Development Bank Group (AfDB) works to improve roads, railways, ports, pipelines and airports (AfDB, 2013). Improvements in the transportation systems in Tanzania will improve both local and international access to markets and ease of doing business (AfDB, 2013).

Coupled with poor access to markets is food price volatility, which affects consumption decisions of both food and non-food items by individuals and households. The inflation rate has continued to fall over the years and the consumer price index has increased (World Bank, 2018h, 2018i). However, food inflation has remained high in the economy (Trading Economics, 2019). Table 1-6 below shows Tanzania data for Inflation, Food Inflation and Consumer Price Index for the years 2008-2017.

Table 1-6: Inflation, Food Inflation and Consumer Price Index

Year	Inflation (Consumer Prices %)	Food Inflation (%)	Consumer Price Index (2010 Prices)
2008	10.28		94.16
2009	12.14		100
2010	6.2	5	100
2011	12.7	10	112.69
2012	16	27.84	130.72
2013	7.87	13.5	141.01
2014	6.13	6	149.69
2015	5.59	4.9	158.02
2016	5.18	10.8	166.2
2017	5.32	7.5	175.04

Source: (Trading Economics, 2019; World Bank, 2018h, 2018i)

1.6.3 Nutritional Information of Foods

The Tanzania food composition tables provide nutrition information for raw and cooked food items and local dishes (Lukmanji et al., 2008). It was composed in order to give adequate information on diets of individuals so that problems related to diet such as diabetes, obesity, hypertension, stunting and other micronutrient deficiencies could be avoided and minimised (Lukmanji et al., 2008). Nonetheless, there is a lack of nutrition awareness and the importance of balanced diets among the population, and one of the objectives of the national nutrition strategy is to increase such awareness (TFNC, 2006, 2014; URT, 2011), therefore awareness creation has been identified as one of the key strategies to reduce malnutrition and related problems.

Furthermore, the Tanzania Food and Drugs Authority (TFDA) requires that all pre-packaged foods contain detailed nutrition labels and those who do not adhere are not

permitted to continue with their business (TFDA, 2016). Additionally, guidelines are provided for food promotion control, importation and exportation of food, investigation and control of food borne diseases, registration and licensing of food premises, importation and exportation of food, and good manufacturing practices of food products. All this is put in place so as to protect consumers by regulating safety, quality and effectiveness of food, medicines, cosmetics, medical devices and diagnostics (TFDA, 2019).

1.7 Policies and Strategies in Tanzania

Tanzania recognises the importance of agriculture, food and nutrition for the good of its economy and its people (China-DAC Study Group, 2011; Tandi Lwoga et al., 2011). Therefore, the country has put in place several policies, strategies and regulations to ensure that the agricultural sector develops, and the people have better access to food as discussed below.

1.7.1 National Agriculture Policy of Tanzania

The Tanzania Agricultural Policy 2013 was the latest major policy statement that came as an improvement of the 1997 policy that was also revised from the 1983 version. It addresses issues in agriculture sector ranging from crop cultivation, animal keeping and fisheries. The policy emphasises the central role agriculture plays in the economy of Tanzania. The policy envisions a modernised agricultural sector, which is at the same time commercial, highly productive and profitable. Its mission is to enable the process of transforming the agricultural sector into a more modern and competitive one while serving the food security and nutritional purposes of the country (URT, 2013). National Agriculture Policy (2013) recognises that even with a food surplus in some areas in the country, there are still other areas which are not food self-sufficient (ICF and MUCHALI, 2013). More so, there is a lack of knowledge about nutrition and so it is proposed to promote production and utilisation of food crops rich in nutrients (Mann and Truswell, 2017; Raymond et al., 2017).

Food security and nutrition have always appeared as part of the policy statements of the Agricultural Policies in Tanzania; the Tanzania National Agriculture Policy (URT, 1983), 1997 Agricultural and Livestock policy (URT, 1997) and the 2013 National

Agriculture Policy (URT, 2013). The 2013 policy notes how the country has been food self-sufficient over the years but with concerns regarding nutrition security and frequent periods of insufficiency (URT, 2013). Hence one of its objectives is to ensure that there is national food security, safety and nutrition enhanced through production, accessibility and utilization of sufficient quantity and quality of food (URT, 2013). To do so, the policy states that there will be promotion of food crop production according to agro-ecological areas; production of enough food crops for domestic demand and export; importation of food crops should adhere to internationally acceptable safety and quality standards; there should be production and use of crops with high nutrient content in areas experiencing nutritional problems. Similarly, the same 2013 policy intends to promote knowledge on good nutrition, strengthen and expand food storage structures to enhance food stability; and put in place mechanisms for continuous monitoring and assessment of food security, safety and nutrition at all levels.

Among other important issues addressed in the 2013 policy, agricultural marketing, agricultural financing and agro-processing are also emphasised. These will help in the quest to modernise the sector and improve its commercial aspects and profitability.

In line with these strategies and policies, the government's budget allocation to the agriculture sector has been increasing over the years in monetary terms as shown in

Table 1-7 below. However, the percentage allocation from the total budget to the sector has shown a declining trend as the government puts more emphasis on other sectors such as health, industry and construction

Table 1-7: Budget Allocation for the Agriculture Sector in Tanzania

Fiscal Year	Total Budget (In billion shillings)	Budget Frame as Percentage of GDP	Budget in Agriculture (In billion shillings)	Share of Agriculture in Total Budget (%)
2007/2008	5,269.00		379.5	7.2
2008/2009	7,235.30		513	7.09
2009/2010	9,513.70		666.9	7.01
2010/2011	10,769.60	21.00%	903.8	8.39
2011/2012	13,526.00	21.30%	926.2	6.85
2012/2013	15,192.00	23.30%	1,103.60	7.26
2013/2014	17,700.00	20.80%	908.1	5.13
2014/2015	19,853.30	20.50%	1,084.70	5.46
2015/2016	22,495.50	23.20%	1,001.50	4.45
2016/2017	29,539.60	27.00%	1,560.00	5.28
2017/2018	31,712.00	26.20%	1,044.00	3.29

Source: Government of Tanzania Budget Speeches 2007/2008 – 2017/2018

1.7.2 National Nutrition Strategy

The National Nutrition Strategy of Tanzania 2011/2012 – 2015/2016 was reviewed in 2011 with the goal of attaining adequate nutritional status for all Tanzanians. Eight priority areas were identified within the strategy: Infant and young child feeding; Vitamin and mineral deficiencies; Maternal and child malnutrition; Nutrition and HIV and AIDS; Children, women and households in difficult circumstances; Diet-related non-communicable diseases; Household food security; and Nutrition surveillance, surveys and information management (URT, 2011).

1.7.3 *Kilimo Kwanza* (Agriculture First) Strategy

During his term of office, the fourth president of Tanzania Hon Jakaya Kikwete, made agriculture a priority area. In 2009 he introduced a slogan called “Kilimo Kwanza” in Swahili which translates to “agriculture first” with the intention of transforming the agricultural sector. With this, there was an emphasis on agriculture so as to improve it as a sector and to improve the lives of the Tanzanians depending on agriculture so that ultimately the socio-economic goals of the nation would be realised. Under the Tanzania National Business Council chaired by the ruling president of Tanzania, the Kilimo Kwanza strategy originated from the private sector, unlike the previous strategies which were centrally planned and implemented by government institutions (Shamte, 2009).

Efforts were made to ensure that the sector is modernised, crop yield is improved, and challenges facing the sector are addressed through ten pillars: to instil political will in all Tanzanians; to mobilise financing, pursue institutional reorganisation such as good governance and monitoring and evaluation; promote product marketing; improve access to land for farmers and enable acquisition of credit using land; to attract and retain private investors in agriculture through policies and regulations; promote industrialisation through backward and forward linkages with agriculture; invest in research and development in agriculture as well as promote the application of modern science and technology as well as training and farm services; and to mobilise all Tanzanians for Kilimo Kwanza (Shamte, 2009).

With these pillars, Tanzania saw an increase in the total budgetary allocation in agriculture, and in the fiscal year 2010/2011, even the share of agriculture in the budget increased (Coulson, 2011; Ngaiza, 2012). Despite the efforts made through this strategy, Tanzania still experienced regular food shortages especially in semi-arid areas and this strategy is no longer pursued with the current government administration, partly because the focus is now on industrialising Tanzania.

1.7.4 Big Results Now Initiative

In the year 2014, the government of president Jakaya Kikwete signed and put in place the Big Results Now initiative famously known as BRN. This initiative was very similar to the Malaysian model Big Fast Results of 2009 that intended to transform the economy of Malaysia and attain fast and sustainable results in economic growth and development (BFR Institute, n.d.; van Wyk et al., 2016). Several countries in the region and outside tried to adapt the initiative each with its own name/slogan. For example, South Africa under president Zuma called it Operation Phakisa (2014). Malaysia's success story is what inspired other countries into adapting the initiative. Malaysia, on its side, saw an increase in exports, which largely contributed to its growth afterwards (BFR Institute, n.d.). With BRN, Tanzania intended to become a middle-income economy by 2025, this is in line with the Tanzania Vision 2025 and Millennium Development Goals (MDGs) (Planning Commission, 1999; URT, n.d.).

One of the priority areas in BRN was agriculture with more emphasis on commercial agriculture. It did not directly mention how nutrition or access to markets by households was addressed.

1.7.5 Agricultural Sector Development Strategy 2015/2016 – 2014/2025

This strategy aimed to transform the agricultural sector into a commercial, highly productive, internationally competitive, resilient and modern sector. The strategy aimed to achieve food security and reduced poverty while working towards the Tanzania Vision 2025. Unlike Kilimo Kwanza and Big Results Now, which were mainly for commercial agriculture, this strategy specifically addresses poverty and nutrition as one of its key areas of emphasis. There are four key strategic areas which are: improve sustainable water use and land management, strengthened and competitive value chains, improved agricultural productivity and strengthened institutions, enablers and coordination (ASLMs, 2015).

1.8 Statement of the Problem

The key issue addressed in this study is how the operation of local food economies impact on the nutrition status of rural households in Tanzania. Knowledge about this is important because most rural households depend on agriculture for their income and food (NBS, 2014a). Therefore, by analysing the local food economy it is possible to inform the households about the best way to achieve the best results in their daily practices of production, distribution and consumption of food for nutritional benefits. This can also help policymakers to identify key areas within food economies that need to be addressed in order to ensure better operation of the food economy and better nutritional outcomes.

The problem of malnutrition in Tanzania is prominent among the majority of the rural people regardless of being the major producers of food. If this problem is not addressed, rural households will continue with practices that are not beneficial to them nutritionally and financially and women and children will especially suffer because they are more vulnerable (Kakota et al., 2015; Mbwana et al., 2017). This study expects to add knowledge on the linkages between the food economies and household nutrition addressing specific issues such as seasonality, fluctuations in food prices,

accessibility of markets, household incomes, household characteristics (size), location, and food availability.

1.9 Study Objectives

The main objective of this thesis is to examine the linkages between local food economies and household nutrition in rural Tanzania. This is addressed by the following specific objectives:

i. To assess the linkage between low-income farm households' access to markets and food security
ii. To examine the effect of cost of diet on choice of food items consumed in the household
iii. To identify the coping strategies that low-income farm households adopt to reduce food insecurity
iv. To identify policies and interventions which can positively impact on food access in rural Tanzania

The above objectives are addressed by answering the following research questions:

i. Is there any linkage between low-income farm households' access to markets and food security?
ii. What are the channels through which rural households sell and access food?
iii. To what extent do rural households depend on the market to access food?
iv. How do rural households cope with inaccessibility of food and markets??
v. Is there any linkage between changes in the cost of diet and households' decisions to consume certain types of foods?
vi. How do households cope with shortage of food and lack of income?
vii. What are the potential policies and interventions that can result in a positive impact on food access and ultimately on nutrition?

1.10 Methodology of the Study

In this sub-section, the description is on the methods used in the study and discusses the area of the study, the population, and the approaches to data collection, and sampling.

1.10.1 Study Area

The research was conducted in two districts, which are economically distinct in rural Tanzania: namely Kishapu District in Shinyanga Region, where households are more dependent on farm income and Mvomero District in Morogoro Region, where households are more dependent on off-farm income. The criteria for selecting these two areas were the high level of nutritional vulnerability, the difference economic activities especially farming as well as the absence of major nutrition interventions.

According to the Tanzania Demographic and Health Survey Report of 2016 and the Comprehensive Food Security and Nutritional Assessment Report 2016, Morogoro and Shinyanga were placed among the regions with high nutritional vulnerability with stunting levels of 30% in Shinyanga and 36.9% in Morogoro (MoHCDGEC et al., 2016; URT, 2011, 2017). The levels of wasting in Morogoro is 6% (MoHCDGEC et al., 2016) which is high and that of Shinyanga are 4.2% (MoHCDGEC et al., 2016). Moreover, Comprehensive Food Security and Nutrition Assessment Report URT (2017) lists Shinyanga as a food deficit region with most of its districts being vulnerable and Morogoro as food self-sufficient but with two vulnerable districts, Morogoro Rural and Mvomero .

Kishapu District recorded a high food deficit according to the national forecast by the Ministry of Agriculture for the year 2012/2013 (ICF and MUCHALI, 2013). The district also ranked highest in food security vulnerability. It has the highest proportion of households involved in agriculture (99.4%) depending on a single rainy season (unimodal rainfall pattern). The majority of these households are involved in both crops and livestock farming (NBS, 2014a).

Morogoro region is considered as food self-sufficient, but Mvomero is a vulnerable district in terms of food security (ICF and MUCHALI, 2013). The District has a total population of 312,109 people with about 56,520 agriculture households and a bimodal rainfall pattern. The District is characterised by a predominance of maize farming as well as high levels of production of pulse (55% of regional production) and horticultural crops (59% of regional production) (NBS, 2014a).

1.10.2 Study Design

Household surveys were conducted in two different periods over the course of one year. The first period was a pre-harvest period, which portrays the situation of food scarcity and the second a post-harvest period, which portrays a situation of food abundance. This approach formed the basis for a semi-longitudinal study design, which helps to provide detailed information on how agriculture impacts on nutrition status. One of the major challenges associated with longitudinal studies was the high attrition rate (UN, 2005), since respondents may change their minds the second time they are visited and may wish not to participate in the study, others may no longer be able to repond, sick, moved to another area or deceased. This was also the case in this study, since this was accounted for during sampling, the final number of respondents after the second phase did not affect the needed sample.

1.10.3 Data Collection Approaches

Two types of data collection were employed, the first is quantitative and the second is qualitative. Quantitative data collection was conducted through household surveys with the aid of structured questionnaires. Discussion with key informants and focus group discussions were employed in qualitative data collection.

1.10.3.1 Household Survey

Before commencement of the major household survey, the questionnaire was developed and pretested in Kiroka village in Morogoro Rural District for two days. This exercise was done in order to ensure that the instrument is reliable and the data that will be collected is valid. As a pilot study area, the village has similar characteristics as the study areas that were selected: it has a large number of farmers, lack of nutritional interventions and large dependence on farming activities. Moreover, the pretesting of the questionnaire was also a way to acquaint researchers and research assistant with the questionnaire itself and the type of responses they would expect. All those questions that needed clarifications were edited before the actual survey in order to fit the actual situations of the study areas. This also helped to estimate the amount of time the questionnaire would take to be filled when collecting data.

The major household surveys collected information on specific household characteristics of the study areas such as demographic characteristics, household economy and agricultural activities for both pre- and post-harvest periods, food consumption and dietary diversity as well as health status of household members. Two major household surveys were conducted within a period of twelve months. The first survey (pre-harvest) took place between January and March 2014 and second survey (post-harvest) took place between August and October 2014 to reflect periods of food shortage and food surplus respectively. During the household surveys, participants spent at least one hour thirty minutes with the researcher to give the information. Consent was sought before each session for each household and participants were informed of their rights not to participate or to withdraw while ensuring anonymity and confidentiality of the information provided.

1.10.3.2 Focus Group Discussions

Focus group discussions were carried out to enable qualitative information to be attained from several individuals in a shorter period of time and to incorporate the perspective of several stakeholders from a range of backgrounds. These discussions helped the researcher to obtain further clarification on issues arising in the community and understand which ones were supported by or were a concern of most people in the community. The nature of questions in these discussions was not personal, so that participants would not withhold information on those grounds. A list of questions guiding the topics discussed were prepared and the facilitators kept the participants focussed on the topic of interest. Three focus group discussions were conducted in each study area, making up six focus group discussions. In each study area, there were one focus group discussion for men only, one for women only and one for both men and women. Each focus group consisted of 8-14 people Table 1-8 and lasted about 90 minutes. These discussions were conducted just before the commencing of the first survey to further inform the study on research questions. They were conducted in a common area accessible for most of the participants (e.g. schools or village centres).

Table 1-8: Focus Group Discussion by Study Area and Season

Group Composition	FGDs Participants (Pre-harvest)		FGDs Participants (Post-harvest)	
	Kishapu	Mvomero	Kishapu	Mvomero
Men Only	8	12	8	14

Women Only	8	11	9	8
Mixed Group	10	11	10	8

1.10.3.3 Interview with Key Informants

Key informant interviews were conducted in the study area with individuals in the community who had first-hand knowledge about local food economies in their community. For the subject matter under study, key informants included market managers, local government officials, representatives of Non-Governmental Organisations (NGOs) and Community Based Organisations (CBOs), village elders and other individuals within the community perceived to be more knowledgeable of the situation as shown in Table 1-9. Potential participants for the interviews were notified beforehand and appointments were made for their convenience. Each interviewee spent at least 45 minutes to 1 hour with the interviewer. Discussions were guided by a pre-determined list of open-ended questions. Follow up questions were used to explore various points emerging from the respondent answers. Note taking was done by either handwriting or tape recording. Informed consent was obtained from the participants.

Table 1-9: Key Informants by Study Area

Category	Kishapu	Mvomero	Total
Agricultural extension officers	2	2	**4**
Village elders	2	2	**4**
Village executive officers	2	2	**4**
Health centre representatives	1	1	**4**
Farm input suppliers (agro-dealers)	3	3	**6**
Total	**10**	**12**	**22**

1.10.3.4 Market Price Survey

Three market price surveys were conducted in 2014. The first survey was conducted in Mhunze market, which serves the whole of Kishapu District. The second and third surveys were conducted in Dakawa and Mvomero markets which serves Milama and Makuyu villages respectively. The surveys were conducted for the 12 months of 2014 and included average prices of three different sellers of commodities commonly consumed in a month by a household, both food and non-food. Inclusion of such commodities depended on the information obtained from the focus group discussions and household questionnaires.

1.10.3.5 Secondary Data

Secondary data from various sources was used at the different stages of this study. First, documents such as policies, official statistics and reports were reviewed to inform the study of the actual situation of agriculture and nutrition in Tanzania. This enabled the selection of the study areas on the basis of the criteria mentioned above. Moreover, secondary data helped in the discussions that follow the findings of this study. Nevertheless, some of the reports and data were not readily available, and therefore the secondary data obtained was only limited to what was publicly available.

1.10.4 Study Population

The study population comprised all agricultural households in Kishapu and Mvomero Districts, Tanzania. Women and children are among the most vulnerable groups to food and nutrition insecurity in most communities. Improving the nutrition status of mothers and children in the first 1000 days of life (conception to 2 years) has the power to determine a child's long-term health, wellbeing and success (UNSCN, 2012).

1.10.5 Sampling Procedure

The study aimed to conduct a multi-stage clustered sample survey in two purposely-selected districts of Tanzania, Kishapu and Mvomero (stage 1). Within each district, two wards were randomly selected (stage 2). Within each ward, two villages were randomly selected (stage 3). At this stage, simple random sampling was conducted, and households were invited to participate in the study. Cluster sampling was appropriate since the study population was difficult to establish or costly to study (Alyahya and Rowe, 2016).

Mvomero (Morogoro) and Kishapu (Shinyanga) are the two districts that were surveyed (stage 1). The criteria for selecting the districts were based on the state of nutritional vulnerability, availability of major farming systems and absence of major intervention in recent years.

Mvomero has a total population of 312,109 people with about 56,520 agricultural households and a bimodal rainfall pattern. The District is characterised by a predominance of maize farming as well as high levels of production of pulse (55% of

regional production) and horticultural crops (59% of regional production) (Morogoro Regional Commissioner's Office, 2007).

Kishapu is a semi-arid area with a population of 272,990 and about 48,258 agricultural households. The district is characterised by unimodal rains. The Tanzania Comprehensive Food Security and Nutritional Assessment Report 2012 ranks Kishapu as the most undernourished (19.3% MUAC) among 40 districts covered by the assessment (Tanzania. PMO and MAFC, 2012). Kishapu has the highest proportion of households involved in agriculture with 99.4%, above the regional proportion of 98%. The majority of these households are involved in both crops and livestock farming (Tanzania. Shinyanga Regional Commissioner's Office, 2007). There are no agricultural households with livestock only in Kishapu.

The sample size (n_0) for the survey were estimated using the following formula obtained from (Alyahya and Rowe, 2016).

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where Z = the abscissa of the normal curve that cuts off an area α at the tails (1 – α equals the desired confidence level, e.g., 95%) at 95% confidence, for a two-tailed distribution, the critical value of Z is 1.96.

p = the estimated proportion of an attribute that is present in the population. In this study the attribute that was used was the level of chronic undernutrition for this case; 44.4% for Kishapu and 43.3% for Mvomero (ICF and MUCHALI, 2013)

q = 1-p (the portion of an attribute not present in the population)

e = the desired level of precision (=0.06 i.e. 94% precision).

For the major survey:

The sample size for Kishapu is: $n = \frac{(1.96)^2(0.444)(0.556)}{0.06^2} = 263$

The sample size for Mvomero is: $n = \frac{(1.96)^2(0.433)(0.557)}{0.06^2} = 262$

The sample for Kishapu was 263 and for Mvomero was 262 making a total of 525 households. A list of all households and members was collected from respective village officials and after random sampling; pre-harvest data collection comprised 554 households (277 from each district). However, a dropout rate of 8.8% in post-harvest survey enabled data collection from a total of 506 households, of which 255 households were in Kishapu and 251 households in Mvomero. Before beginning interviews, respondents were briefed of the study and verbal consent was sought.

1.11 Data Analysis

This study employs both quantitative and qualitative data analysis; one or both methods are applied where appropriate. The Statistical Package for Social Sciences Software (IMB SPSS Version 24) was used to input data from household questionnaires and market price surveys and in performing quantitative analysis. On the other hand, qualitative data from focus group discussions and key informant interviews were transcribed and translated into the English language. The contents of the transcripts were then organised into themes for better understanding of the data.

Chapter 3 presents the study area description and household characteristics as observed from the data. The main method of data analysis in this chapter is descriptive in nature and presents data on household characteristics, household economy: housing, water and sanitation conditions, asset ownership, education level, economic activities and infrastructure, consumption and poverty, and access to markets as well as price survey data. The two chapters that follow, Chapters 4 and 5 are two academic papers submitted to the aforementioned journals. Chapter 4 is titled Low Income Farm Households' Access to Markets and Household Food Security: The Case of Two Economically Distinct Areas in Rural Tanzania and focused on how income and market access affect low-income farm households' food security status and Chapter 5 is titled Seasonality, Food Prices and Dietary Choices of Vulnerable Households: A Case Study of Nutritional Resilience in Tanzania and addressed the effect of diets costs on diet choices for low-income farm households in Kishapu and Mvomero. Chapter 6 complements the results of Chapter 5 as it disaggregates and compares the

linear programming results for the Kishapu and Mvomero Districts and Chapter 7 presents household coping strategies and does a descriptive analysis of the data relating to coping strategies.

1.11.1 Data Analysis on Household Income

Income and economic activities data from household surveys provided information on annual household farm and non-farm income in the year prior the interview (2013). A distribution of net annual household incomes was run in SPSS generating four equal cut-off points (Income Quartiles) of the sampled households. The first income quartile contained the poorest of the households (earning the lowest incomes), the second income quartile contained the lower-middle income earners, the third income quartile contained the upper-middle income earners and the fourth income quartile contained the wealthiest of the sampled households. Detailed analysis of these income quartiles is presented in chapters 4 and 5.

1.11.2 Data Analysis on Farming Systems Determination

To determine which farming system households adopted, both crops and livestock were considered. Considerations on crops were made based on the types of crops cultivated (whether food crops or cash crops), the marketing of crops (the percentage of crop yield that was sold). Also, the percentage of land used for either cash or food crops determined household dependence on that crop. Moreover, with respect to livestock, Tropical Livestock Units (TLU) (Njuki et al., 2011) were used to decide whether households were livestock oriented or not. According to (Njuki et al., 2011), one TLU is equivalent to one mature cow weighing 250 kg in Sub-Saharan Africa as shown in

Table 1-10.

Table 1-10: Conversion Factor of Livestock to Total Livestock Units (TLU)

Livestock species/type	TLU (1TLU=1mature cow of 250kg)
Calve	0.41
Heifer	0.78
Dry Cow	1
Mature Cow	1
Bull	1.2
Oxen	1.42
Goat	0.2
Sheep	0.2
Donkey	0.8
Poultry	0.04

Source: Njuki et al., (2011)

Moreover, the Household Commercialisation Index (HCI), which calculates the ratio between how much of the output was sold and the total produce of the crop, was used to determine whether the crop was a cash crop or not in the household. HCI ranges from 0 to 1 with 1 indicating a completely commercialised/cash crop (Gebremedhin and Jaleta, 2010). For this study, a crop with an HCI value of greater than 0.5 was considered a cash crop and below 0.5 it was considered a food crop.

1.11.3 Data Analysis on Household Food Security Status

In order to determine the food security status of households, Household Food Insecurity Access (HFIA) (Coates et al., 2007) was used. The household questionnaire included a set of nine questions, which were intended to measure feelings of anxiety, feelings of insufficiency of quality food and feelings of insufficiency of food intake in households, 30 days prior the interview. Additionally, Household Dietary Diversity Scores (HDDS) were used to measure the extent to which a household had access to more diverse diets (Swindale and Bilinsky, 2006) using twelve food groups.

1.11.4 Data Analysis on Energy Content of Foods Eaten

To determine energy content of food, food consumption data was used with the Tanzania Food Composition Tables. Because of post-harvest losses that households face, the amounts of food available for consumption from own produce was reduced by the respective post-harvest losses. The final amount of energy consumed in the

household was obtained by a multiplication factor of cooked foods from consumption data of raw foods considering the common cooking and preparation methods in rural Tanzania. Household energy consumption data were converted into individual adult equivalents using adult equivalence units and adjusted for economies of scale in the household.

Seven food groups were used to categorise food items consumed in the household and these were cereals; roots and tubers; vegetables and fruits; meats, poultry and fish; legumes; oils and fats; and miscellaneous items. Lower limits and upper limits of energy from food items and food groups were obtained from a statistical distribution of the data. For food items, the lower limit was the 5^{th} percentile while the upper limit was the 95^{th} percentile of the distribution. For food groups, the lower limit was the 10^{th} percentile and the upper limit was the 90^{th} percentile of the distribution.

1.11.5 Statistical tests

Statistical tests such as the paired sample t-test, chi-square analysis, one-way ANOVA, and binomial regression analysis. For example, paired sample t-tests were used to compare means on the scores of Dietary Diversity and Household Food Insecurity Access Scales (HFIAS) and Prevalence (HFIAP). This was done to test the hypothesis that household food security status does not depend on household incomes. Moreover, analysis of variance (ANOVA) was made on HFIAS and HFIAP variables to determine any statistically significant difference between means within income quartiles and districts.

1.11.6 Post-Harvest Losses

Affognon et al. (2015) reviewed literature on PHL for six sub-Saharan African countries including Tanzania.

Table 1-11 summarises percentages of PHL for some food items in Tanzania.

Table 1-11: Percentage Post-Harvest Losses for Produced Crops in Tanzania

Food Product	PHL ***(%)***
Cereals	15
Sweet Potatoes	32.5
Cassava	52.3
Beans	25
Groundnuts	25
Tomatoes	50
Meat and Fish	20
Chicken	38
Milk	5.66
Fruits and Vegetables	50

Source: Affognon et al. (2015)

Amounts of energy consumed were obtained by a multiplication factor of cooked foods from consumption data of raw foods considering common cooking and preparation methods in rural Tanzania. Household energy consumption data were converted into individual adult equivalents. Adult equivalence units were used in place of household size to account for age and gender differences among household members.

Table 1-12: Adult equivalence Scales: Index of Calorific Requirements by Age and Gender for East Africa

Age Groups (Years)	**Adult Equivalence Units**	
	Male	***Female***
0-2	0.40	0.40
3-4	0.48	0.48
5-6	0.56	0.56
7-8	0.64	0.64
8-10	0.76	0.76
10-12	0.80	0.88
12-14	1.00	1.00
15-18	1.20	1.00
9-59	1.00	0.88
60+	0.88	0.72

Source: National Bureau of Statistics (NBS) [Tanzania] (2014a)

Due to resource sharing within households, adult equivalence units were adjusted for average cost economies of scale since larger households spend less on average compared to smaller households (Newhouse et al., 2016) and reduce wastes in consumption (Browning et al., 2013). Using the economies of scale parameter by $\theta = \frac{-\ln\left(1-\rho+\frac{\rho}{n}\right)}{1-n}$:where n is household size and ρ=0.9 for an equivalent adult (Martin, 2017)

and represents the proportion of household expenditure for goods consumed privately and 1- ρ represents goods consumed publicly in the household. As n increases, ρ decreases. Then household size $n_{adj} = 1 + \big((n-1) \times \theta\big)$. This new adjusted household size was used in place of the actual household size in the analysis.

1.11.7 Linear Programming Approach Used

In this thesis, the linear programming approach is used in Chapter 5 and 6 addressing the effect of diet costs on food choices of individuals in Kishapu and Mvomero districts. This is used to optimise an objective function by minimising total deviation from mean diets subject to a set of constraints including food portion sizes, energy intake from food items and food groups as well as budget constraints. This approach is adopted in order to examine people's choices given the food available and the market conditions (price) (Cobiac et al., 2018; Dooren, 2018).

Linear programming is an optimisation technique in mathematics. The technique involves estimating an objective function which is to be optimised (minimised or maximised) and is subjected to a constraint or a set of constraints. Both the constraints and the objective function contain decision variables (variables whose values give an optimal value for the objective function while satisfying the constraints).

Research to examine the effect of cost of diet and diet choices of individuals given a set of constraints has been done using French data in the year 2000 (Darmon et al., 2002b, 2003, 2006; Darmon and Drewnowski, 2015; Drewnowski and Darmon, 2005). In their research, Darmon et al. 2002 *ibid* constructed a linear programming model to predict food choices of rational individuals while reducing cost and determining the impact on nutrition. Their methodology minimises total deviations from the mean intake TDMI) subject to a set of constraints such as the budget constraint, minimum and maximum energy intake, minimum and maximum energy from food groups, and dietary energy requirements. Deviations from mean intake yield both positive (for those above the mean) and negative (for those below the mean) values. These positive and negative values tend to cancel each other in the equation giving a solution that is not entirely correct. Therefore, to improve this, in this study, both positive and negative values of TDMI were generated and added separately to make sure that excel solver only chooses the absolute values of TDMI. Further, the minimum optimal

budget is compared to what is available as disposable income to the household to analyse whether the individuals can afford such foods. Separately also, the food poverty line of Tanzania is used to compare the results from the sample to the national averages.

The nutrient content of the choice diet is compared with the minimum required intake; as established by WHO and FAO to analyse whether with that diet the individuals do get the desired nutrients and energy.

Hypothesis to be tested:

Null: People's choices of diets are independent of the market price/cost of diet – rather they only choose a diet that satisfies their nutrition needs.

Alternative: People's choices of diets are very much dependent on the market price/cost of diet.

For the purpose of this analysis, decision variables are the portions of food items included in the model. The data obtained from the household survey included 30 food items. For this analysis, all food items (except salt) are included in the model, even if they were consumed in very low amounts.

The objective in this analysis is to minimise the relative deviations from the mean diet in the sample. This is used in order to work with actual data in the communities involved rather than other data, which may be inapplicable or unrealistic for the study areas. The relative deviation from the mean is calculated by subtracting the mean from the decision variable value and then divided by the mean. The sum of absolute values of the relative deviations from the mean is minimised in the objective function subject to budget constraints; dietary requirements; minimum and maximum energy values, maximum portion size.

Minimise: TDMI

Subject to:

i. $\sum_{i=1}^{n} P_i X_i \leq TZS$

ii. $f_i \geq f_i^{min}$

iii. $f_i \leq f_i^{95^{th}}$

iv. $X_i \leq X_i^{75^{th}}$

v. $X_{ic} \geq G_c^{min}$

vi. $X_{ic} \leq G_c^{max}$

vii. $\sum_{i=1}^{n} f_i \geq \sum_{i=1}^{n} e_i^{energyreq}$

viii. $\frac{(m_i - X_i)}{m_i} \leq Z_i \; and \; \left\{-\frac{(m_i - X_i)}{m_i}\right\} \leq Z_i$

Where TDMI = the sum of the absolute values of relative deviations from the mean diet

E(d) = Expenditure on food

P_i = Price per 100kg of food item *"i"*

m_i = mean portion size (g/d) of food *"i"*

f_i = energy amount (kcal) of food *"i"*

Y = the objective function

a = constants

X_i = portion of food item *"i"* g/d *(decision variables)*

i = 1 to n

j = 1 to k

n = the number of food items included in the model

e_i = recommended dietary intake (kcal)

TZS = shilling value of the resulting food consumed

1.11.7.1 Assumptions of the Model

Rationality

The model assumes that the individual is a rational consumer and will only choose a bundle of food items that maximises their utility – for this case – energy intake.

Proportionality

Each decision variable is multiplied by a coefficient that when the variable changes, the result is a proportionate change in that variable to the objective.

Divisibility

The model assumes that all decision variables included – food items – are divisible. Amounts of all food items consumed by the household were collected during the household surveys in both pre-harvest and post-harvest periods. These amounts were from the 30-day consumption recall using the common measuring containers such as buckets, bowls or packets. For example, vegetables were given in bunches, fruits in the average number of say mangoes consumed, number of chickens, buckets of grains or flour. All the food items were converted into metric weights (grams) that enabled divisibility to be applied. Even though realistically a person does not eat a kilogram or half a kilogram of a mango knowingly but converting one mango into its average weight enabled this measurement as accurately as possible.

Additivity

Since the objective function is linear, the value of the objective is the sum of the contributions of each decision variable to the objective function; that is total energy intake is the sum of the energy content of the food items eaten.

Certainty

All coefficients/model parameters are known. The coefficients for this analysis are derived from the data collected in the field.

1.11.7.2 Limitations of the Model

Decision Variables

The decision variables included in this model are limited to the common food items consumed by the sampled individuals in the study areas. This does not mean that other food items are not consumed at all in the societies; rather what is included is most representative of the population.

Palatability

As hard as it is to measure palatability of a food item for a society, it is undeniable that it affects the choice of food items eaten. This is a limitation to this model as palatability was not measured and therefore not included in the model. However, it is expected that, a food item that is more palatable is one that has the highest mean despite its cost.

"Lack of Knowledge on Energy and Nutrient Contents"

Based on the knowledge of the societies that were surveyed, the individuals may have made decisions to eat certain food items without knowledge of their energy or nutrient contents. Knowledge would have influenced choice, however this does not render the model unrealistic because they still make rational decisions based on what is available and the costs involved.

1.11.7.3 Optimisation Problem

$$\boldsymbol{Y = a_0 + \sum_{i=1}^{n} a_i X_i} \quad \ldots\ldots\ldots \quad \textit{Equation 1-1}$$

$$\boldsymbol{Y = a_0 + a_1 X_1 + a_2 X_2 + \cdots + a_n X_n} \quad \ldots\ldots\ldots \quad \textit{Equation 1-2}$$

Let the total departure from the mean diet (TDMI) be the sum of all the absolute values of the difference between each food variable portion size selected from the mean value of diet.

Total Departure from the Mean food Intake

$$\boldsymbol{TDMI} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \frac{|(\boldsymbol{m_i - X_i})|}{\boldsymbol{m_i}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-3}$$

$$\boldsymbol{TDMI} = \frac{|(\boldsymbol{m_1 - X_1})|}{\boldsymbol{m_1}} + \frac{|(\boldsymbol{m_2 - X_2})|}{\boldsymbol{m_2}} + \cdots + \frac{|(\boldsymbol{m_n - X_n})|}{\boldsymbol{m_n}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-4}$$

The division by m_i (mean value of food i) is meant to standardise the differences across food groups. The above function (TDMI) is not linear, and therefore to transform it to a linear function the following was performed:

Assume that Z_i is the new decision variable, which is the absolute value of the standardised deviation from the mean:

Linearising TDMI

$$\boldsymbol{Z_i} \geq \frac{\boldsymbol{(m_i - X_i)}}{\boldsymbol{m_i}} \ \boldsymbol{and}\ \boldsymbol{Z_i} \geq -\frac{\boldsymbol{(m_i - X_i)}}{\boldsymbol{m_i}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-5}$$

$$\boldsymbol{Z_1} \geq \frac{\boldsymbol{(m_1 - X_1)}}{\boldsymbol{m_1}} \ \boldsymbol{and}\ \boldsymbol{Z_1} \geq -\frac{\boldsymbol{(m_1 - X_1)}}{\boldsymbol{m_1}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-6}$$

$$\boldsymbol{Z_2} \geq \frac{\boldsymbol{(m_2 - X_2)}}{\boldsymbol{m_2}} \ \boldsymbol{and}\ \boldsymbol{Z_i} \geq -\frac{\boldsymbol{(m_2 - X_2)}}{\boldsymbol{m_2}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-7}$$

$$\ldots \boldsymbol{Z_n} \geq \frac{\boldsymbol{(m_n - X_n)}}{\boldsymbol{m_n}} \ \boldsymbol{and}\ \boldsymbol{Z_n} \geq -\frac{\boldsymbol{(m_n - X_n)}}{\boldsymbol{m_n}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-8}$$

This is entered into the LP solver in Excel to take care of the absolute value constraint.

Since Z_i is by definition greater or equal to both the standardised value of the difference, this means that the model selects the absolute (positive) value of Z_i. Therefore, below is the form of the model with positive standardised differences.

Then,

$$\boldsymbol{TDMI} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \boldsymbol{Z_i} = \frac{\boldsymbol{(m_1 - X_1)}}{\boldsymbol{m_1}} + \frac{\boldsymbol{(m_2 - X_2)}}{\boldsymbol{m_2}} + \cdots + \frac{\boldsymbol{(m_n - X_n)}}{\boldsymbol{m_n}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-9}$$

$$= \left(\boldsymbol{1} - \frac{\boldsymbol{1}}{\boldsymbol{m_1}}\boldsymbol{X_1}\right) + \left(\boldsymbol{1} - \frac{\boldsymbol{1}}{\boldsymbol{m_2}}\boldsymbol{X_2}\right) + \cdots + \left(\boldsymbol{1} - \frac{\boldsymbol{1}}{\boldsymbol{m_n}}\boldsymbol{X_n}\right) \quad \ldots\ldots\ldots \quad \textit{Equation 1-10}$$

$$= \boldsymbol{n} - \frac{\boldsymbol{1}}{\boldsymbol{m_1}}\boldsymbol{X_1} - \frac{\boldsymbol{1}}{\boldsymbol{m_2}}\boldsymbol{X_2} - \cdots - \frac{\boldsymbol{1}}{\boldsymbol{m_n}}\boldsymbol{X_n} \quad \ldots\ldots\ldots \quad \textit{Equation 1-11}$$

This follows the same format as the linear function $Y = a_0 + a_1X_1 + a_2X_2 + \cdots + a_nX_n$

Where $a_0 = n \; and \; a_i = -\frac{1}{m_i}$

Formulation of constraints

Economic theory suggests that the utility of an individual is constrained by the amount of budget they have which is affected by the costs of items they consume (Daniel, 2016; Salvatore, 2008; Varian, 2014). However, there are society constructed standards that either directly or indirectly guide consumption of the types and amounts of food people consume (Migliore et al., 2015; Salvatore, 2008; Wang et al., 2015). Therefore, the model is constrained by the cost of diet, minimum and maximum amounts of food items and food groups, as well as recommended daily allowance. With regards to the budget, a comparison is later made with the Tanzania Food Poverty Line because using it as it is in the model rendered the model invalid as no solution could be found.

i. Budget Constraint

Since X_i's are the decision variables, the constraint for cost of diet is:

$$\boldsymbol{E_d = \sum_{i=1}^{n} P_i X_i} \qquad \ldots\ldots\ldots \qquad \textit{Equation 1-12}$$

$$\boldsymbol{E_d = P_1X_1 + P_2X_2 + \cdots + P_nX_n} \qquad \ldots\ldots\ldots \qquad \textit{Equation 1-13}$$

The constraint takes the form:

$$\boldsymbol{\sum_{i=1}^{n} P_i X_i \leq TZS} \qquad \ldots\ldots\ldots \qquad \textit{Equation 1-14}$$

$$\boldsymbol{P_1X_1 + P_2X_2 + \cdots + P_nX_n \leq TZS} \qquad \ldots\ldots\ldots \qquad \textit{Equation 1-15}$$

Where TZS is the shilling value of total cost of diet, to be varied by intervals to analyse its effect on diet choice. The budget constraint follows the form of $\beta_1 \boldsymbol{X_1} + ß_2 \boldsymbol{X_2} + \cdots + ß_n \boldsymbol{X_n} \leq \boldsymbol{TZS}$ which is linear. Moreover, the use of mean income or the Tanzania Food Poverty line was not included as the budget limit in this analysis because incomes were highly different between households. For example, the high-income households earned about ten times more than the low-income earners, which makes the analysis impossible for households belonging to the lowest income quartile. Moreover, using the Tanzania Food Poverty line made the analysis unable to obtain a

solution because it is lower than the values in the two study areas. Therefore, the budget limit was obtained by inserting the highest value possible which gave the maximum amount that could be spent on food, above which there were no more changes in food choices (Darmon et al., 2002a). For example, in the initial analysis the number used was TZS 5,000 but the solution gave back TZS 1417 which meant that the highest possible amount a person spent was TZS 1417. Even if TZS 2000 was inserted, the solution only gave the maximum of TZS 1417. Further, after obtaining this amount, the reductions were done to observe the effects of changes in budget.

ii. Total Minimum Energy Intake Constraint:

The energy intake per day is constrained at the daily mean energy intake in the population distribution and is calculated as follows:

If f_i represents energy content of food item *i* in 100g of that food item; then the optimal energy is expressed as:

$$f_i^* \geq \frac{fi \times X_i}{100g} \quad \ldots\ldots\ldots \quad \textit{Equation 1-16}$$

$$\sum_{i=1}^{n} f_i^* \geq \sum_{i=1}^{n} m_i^{energy} \quad \ldots\ldots\ldots \quad \textit{Equation 1-17}$$

$$f_1 + f_2 + \ldots + f_n \geq \sum_{i=1}^{n} e_i^{energy} \quad \ldots\ldots\ldots \quad \textit{Equation 1-18}$$

iii. Daily Energy Constraints

Minimum Food Item – Energy Limit

$$f_i \geq f_i^{min} \quad \ldots\ldots\ldots \quad \textit{Equation 1-19}$$

$$f_1 \geq f_1^{5^{th}}, f_2 \geq f_2^{5^{th}}, \ldots, f_n \geq f_n^{5^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-20}$$

Maximum Food Item – Energy Limit

$$f_i \leq f_i^{max} \quad \ldots\ldots\ldots \quad \textit{Equation 1-21}$$

$$f_1 \leq f_1^{95^{th}}, f_2 \leq f_2^{95^{th}}, \ldots, f_n \leq f_n^{95^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-22}$$

iv. Food Group Constraint

Food items are grouped intro seven major groups (as grouped in the Tanzania Food composition tables) If *"j"* denotes the food group, then X_{ij} is the food item *"i"* belonging to group *"j"*. Where $j = c$ (cereals), r (roots and tubers), v (vegetables and fruits), m (meats, poultry and fish), l (legumes), o (oils and fats), and mc (miscellaneous food items). G_j indicates energy limit of the food group. For the purpose of this analysis only three food groups are constrained in the analysis and these are Cereals; Vegetables and Fruits; and Meats, Fish and Poultry. Only these food groups have been used as constraints because they are frequently used in the daily diets of the sampled households. Moreover, if the model constrained all seven food groups, the solution would be forced to choose at least one food item from each group, this would not yield an entirely true solution since households in the study areas do not eat such balanced diets for them to have food items from each group. Also, the model will be over-constrained such that the solution is not a true representation of the diets on the study areas. Thus,

$$\sum_{i=1}^{n} \boldsymbol{f_{ij}} \geq \sum_{i=1}^{n} \boldsymbol{f_{ij}^{min}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-23}$$

$$\boldsymbol{f_{1c} + f_{2c} + \ldots + f_{nc} \geq G_c^{10th}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-24}$$

and

$$\sum_{i=1}^{n} \boldsymbol{f_{ij}} \leq \sum_{i=1}^{n} \boldsymbol{f_{ij}^{max}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-25}$$

$$\boldsymbol{f_{1c} + f_{2c} + \ldots + f_{nc} \leq G_c^{90th}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-26}$$

v. Food Portions

The food portion size in g/d was constrained at the 75th percentile of the population intake distribution.

Maximum Food Portion Limit

$$\boldsymbol{X_i \leq X_i^{75^{th}}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-27}$$

$$\boldsymbol{X_1 \leq X_1^{75^{th}}, X_2 \leq X_2^{75^{th}}, \ldots, X_n \leq X_n^{75^{th}}} \quad \ldots\ldots\ldots \quad \textit{Equation 1-28}$$

1.11.7.4 Solving the linear programming problem

The following objective function is optimised subject to the constrains below:

$$\boldsymbol{Min\ TDMI} = \sum_{\boldsymbol{i=1}}^{\boldsymbol{n}} \frac{|(\boldsymbol{m_i} - \boldsymbol{X_i})|}{\boldsymbol{m_i}}$$

S. t.:

i. $\boldsymbol{P_1X_1 + P_2X_2 + \cdots + P_nX_n \leq TZS}$

ii. $\boldsymbol{f_1 \geq f_1^{5^{th}}, f_2 \geq f_2^{5^{th}}, \ldots, f_n \geq f_n^{5^{th}}}$

iii. $\boldsymbol{f_1 \leq f_1^{95^{th}}, f_2 \leq f_2^{95^{th}}, \ldots, f_n \leq f_n^{95^{th}}}$

iv. $\boldsymbol{X_1 \leq X_1^{75^{th}}, X_2 \leq X_2^{75^{th}}, \ldots, X_n \leq X_n^{75^{th}}}$

v. $\boldsymbol{X_{1c} + X_{2c} + \ldots + X_{nc} \geq G_c^{min}}$

vi. $\boldsymbol{X_{1c} + X_{2c} + \ldots + X_{nc} \leq G_c^{max}}$

vii. $\boldsymbol{f_1 + f_2 + \ldots + f_n \geq \sum_{i=1}^{n} e_i^{energyreq}}$

viii. $\boldsymbol{\frac{(m_i - X_i)}{m_i} \leq Z_i \ and \ \left\{-\frac{(m_i - X_i)}{m_i}\right\} \leq Z_i}$

All the model constraints are linear in nature. Further information on the analysis of the linear programming approach, the data and results are presented in Chapter 5 of this thesis.

1.11.7.5 Linear Programming Sensitivity Report

Table 1-13 below outlines the sensitivity report generated from the Linear Programming solution of the Post-Harvest Overall Sample. For this report, only the 20 most consumed food items have been included in the Sensitivity Analysis and these are all food items except Irish potatoes, cassava, cabbage, carrots, sardine, honey, tea, ginger, and coconut.

Table 1-13: Sensitivity Outline Report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$C$32:$C$51	*Decision Variable (portions size)*					
$G$32:$G$51	*Objective Function (Total Value of absolute deviations from the mean diet intake)*					

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$C$59:$C$61 <= $E$59:$E$61	*Maximum group Constraint*					
$C$59:$C$61 >= $D$59:$D$61	*Minimum Group Constraint*					
$E$32:$E$51 <= $G$32:$G$51	*Absolute Value of TDMI*					
$F$32:$F$51 <= $G$32:$G$51						
$H$52	*Value of the Budget (TZS)*	1,100.00	-0.01	1,100.00	97.08	0.43
$I$32:$I$51 <= $H$5:$H$24	*Maximum limit on energy intake*					
$I$32:$I$51 >= $G$5:$G$24	*Minimum limit on energy intake (kCal)*					
$I$52	*Total energy consumed*	2,223.56	0.01	2,223.56	0.27	93.77

Because there are many variables and constraints, the report is long, and the detailed report is included in Appendix 7. As an example, below is the outline report, which shows the variables and the constraints in the model. The first part shows the variable cells where cell C32 up to C51 are the decision variables containing the optimal values of food portions generated by the solution. Cells G32 to G51 are the absolute values of the total deviation from the mean intake. The second part shows the constraints where cell H52 is the value of the budget obtained from the analysis. It shows that an additional unit increase in the budget (TZS 1.00) will decrease deviation from the mean diet intake by 0.01 units. That is, with more budget means the person is more likely to consume what they are expected to consume. However, the allowable increase is TZS 97.08, which means it is possible to increase the budget by up to TZS 97.08 and get a decrease in deviation from the mean intake by 1.05 units. Since the allowable decrease is TZS 0.43, it is possible to reduce the budget by that amount and increase deviations from the mean by 0.005 units. A similar analysis applies for the I52 Cell on total energy consumed.

1.12 The Conceptual Framework

This study is based on the assumption that the nutritional status of rural households is related to their local WFP for food economies. The following diagram represents a conceptual framework developed by analysing food and nutrition security.

1.12.1 WFP Framework

The World Food Program in 2009 developed a conceptual framework that would help in identifying at risk areas that would need immediate assistance. The framework is diagrammatically presented in Figure 1-5 below.

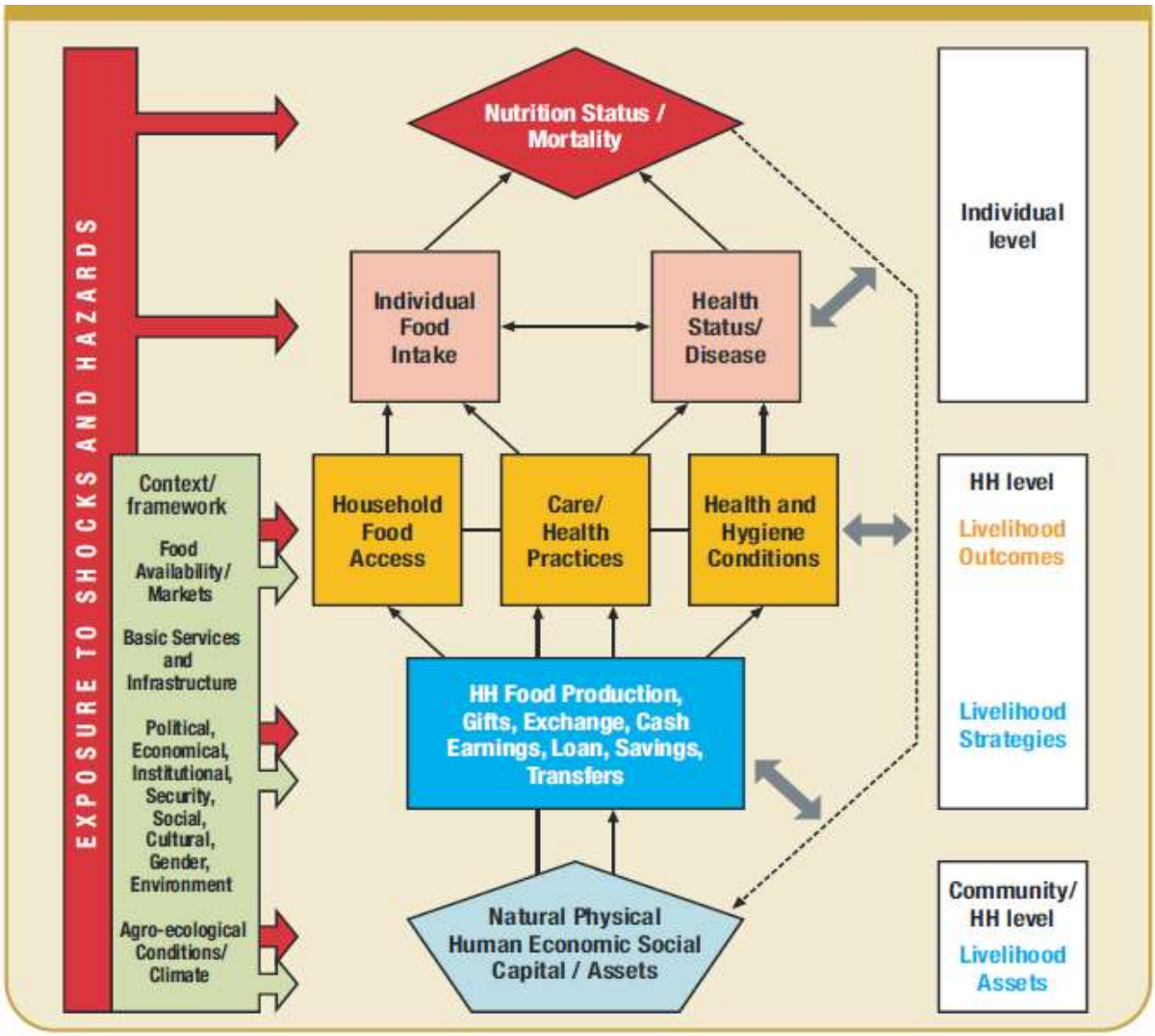


Figure 1-5: WFP Food and Nutrition Security Conceptual Framework

Source: (WFP, 2009)

The conceptual model above as developed by WFP (2009) illustrates the relationships among different indicators that ultimately contribute to nutrition in one way or the other as well as contributing towards overall individual, household and community livelihoods. It shows that there are external shocks and hazards that have a negative influence on the overall food security and nutrition (Béné et al., 2015; Buhaug et al., 2015; Ramankutty et al., 2018). Households are exposed to hazards and shocks such as droughts, floods, crop blight or infestation, economic fluctuations, and conflict. These decrease product yield and hence availability of food. Economic fluctuations may decrease households' ability to purchase food from the market or inputs for their own production (Stifel and Minten, 2017a). This reduces the accessibility of food for the household even if it is already available in the market. More vulnerable households are less able to withstand the shocks and can easily fall into food insecurity in the event that these shocks occur (FAO, IFAD, UNICEF, WFP and WHO, 2017). Vulnerability also differs within the household; this creates different levels of food security at individual level as well (Phalkey et al., 2015). Less vulnerable individuals are less affected by the shocks and hazards even when there is food insecurity in the household.

The framework also presents the environment under which, if appropriate, there is positive influence on household food security. These include the market conditions; political, economic, institutional, environmental and social conditions; as well as the agro-ecological and climatic conditions (McMichael, 2016). If all these conditions and institutions properly operate, they will positively impact on household food security as well as at an individual level. International and local policies and institutions at different levels affect livelihood choices and decisions of poor and food-insecure households (Devereux, 2016; Qureshi et al., 2015).

Access to different kinds of assets such as physical assets, capital assets, social assets and human assets will largely determine the ability of a household to access food. These will serve as inputs into acquisition of food through own production and/or purchases and other means. Own production of food requires access to agricultural inputs such as land, labour, capital, finance and other resources to enable the household to produce (Farnworth et al., 2016; Jost et al., 2016). The ability to acquire these inputs is affected by the factors mentioned above (shocks and institutional

conditions) but also by the knowledge that households have of production and by the services available to them. Moreover, production of own food does not end with access to inputs; the farm households' ability to process these inputs and turn them into a good quality and quantity of output is required. This ability is also affected by shocks and institutional conditions as well as knowledge about production and the farming systems according to the agro-ecology of the area (Devereux, 2016; Qureshi et al., 2015), hence they determine what can be available and what cannot be produced even if it is needed.

Apart from production, the framework presents other ways in which the household can access food. These are through gifts, exchange, cash earnings, loan, savings, and transfers (Banerjee et al., 2015). These may be in the form of cash, food or other things that can then be traded for food. Since it is established that a single household cannot necessarily produce everything it needs for food security (Napoli et al., 2011), such transactions will enable the households to access other foods that it does not produce.

There are other conditions within the household that affect nutrition. These are presented as care/health practices as well as health and hygiene conditions (Mills and Cumming, 2016). Availability of health facilities and health education greatly influence the practices and health conditions in households. The household would also engage in caring for the sick that takes time away from performing productive activities. Health and hygiene conditions affect the quality of food consumed after preparation and these also have to be considered. These conditions in the community or the household will eventually determine food intake and the health status of an individual. In the end, the livelihoods of the people at community, household and individual levels will be enhanced. People would have adequate and sustainable access to income and resources to meet their basic needs. Livelihood assets and strategies will facilitate people to achieve better livelihood outcomes (Serrat, 2017) and these also feed as inputs to household food security and nutrition.

1.12.2 Adaptation of the WFP Framework

Following the discussion of the other dimensions of food and nutrition security discussed from the WFP Framework above, the following figure presents an adapted WFP framework, which serves as a conceptual framework for this study. This

adaptation is done in Figure 1-6 in order to customise the food security framework to the local environment of the study area and the focus of this thesis.

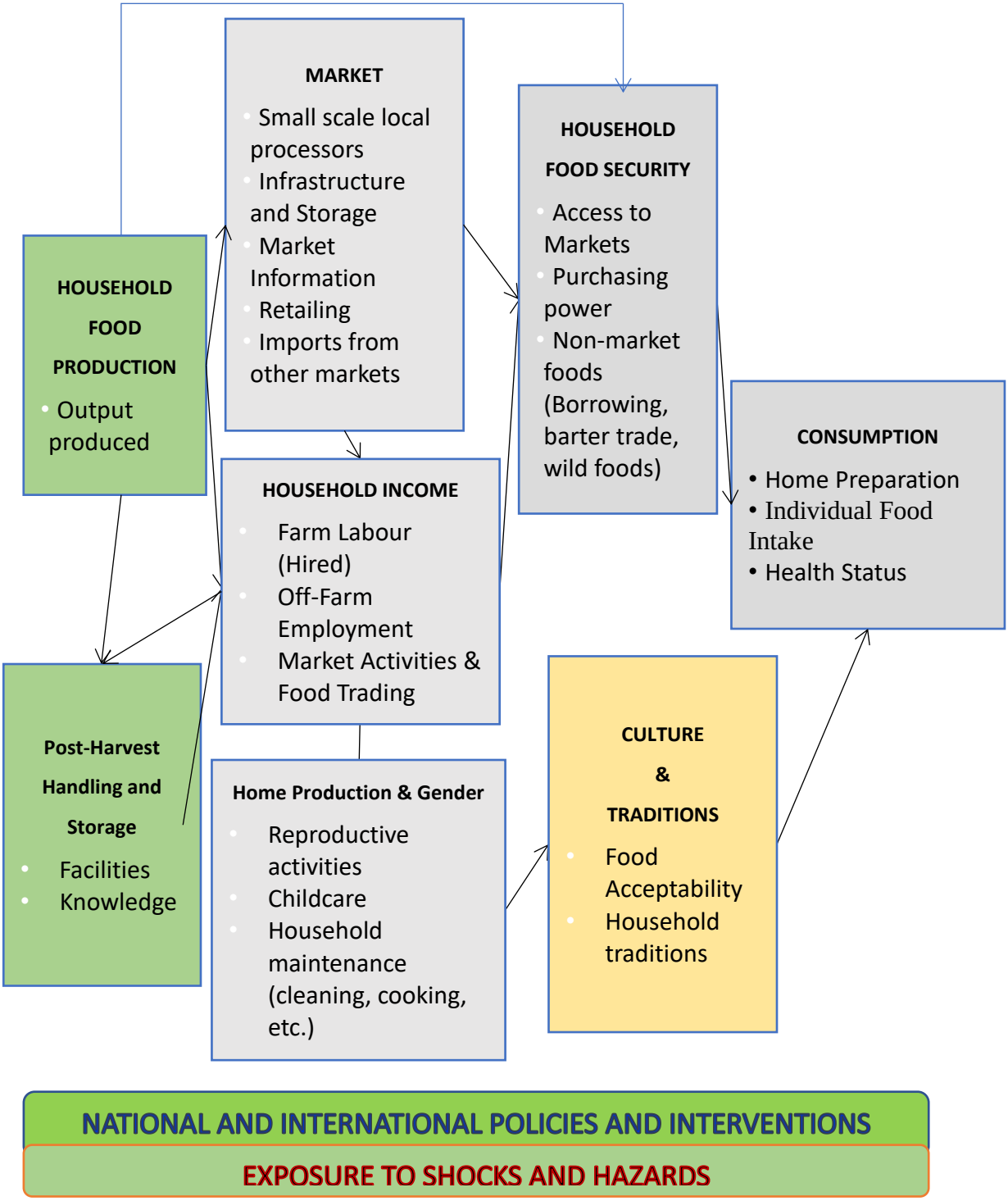


Figure 1-6: Operation of Local Food Economies and Linkages to Nutrition Conceptual Framework
Adapted from WFP, 2009

The above figure shows the interrelationship between variables that may influence the nutritional goals of households. The household consumes foods, which may be

produced within the household or bought from the market. Marketed food goes through a distribution chain with different processes of storage, packaging, transportation and preservation. Farming households get most of their nutrients from their farms and may sell the surplus to obtain other foods from the market. The dependent variable from the above framework is food security, which is explained by production inputs, production processes, the quality and quantity of output, the market process (storage, distribution) and the processing of food by the final consumer or the food processing firms. Moreover, food security is affected by demographic characteristics such as age and gender, also by socio-cultural norms of the society a person belongs to. All these are taken into consideration when analysing linkages between local food economies and nutrition.

A market is a setting through which buyers and sellers exchange goods and/or services (Beckert and Aspers, 2011). With respect to agriculture, an agricultural market is a setting through which buyers and sellers exchange agricultural commodities or services. This kind of interaction between seller (farmers) and buyers (consumers) does not have to be direct or physical. As today's world develops the market develops with it creating complex relationships between different players in the market (FAO, 2013). A chain of intermediaries or middlemen complicates the contact between farmers and consumers in the market. The intermediaries include all those agents within the agricultural market who provide a link between the farmer (producer) and the final consumer; these intermediaries include processors, transporters, wholesalers, and retailers (FAO, 2013). In a setting where there are no complex marketing systems, buyers and sellers have direct contact, but this is not common in today's general setup of the markets. An analysis of such a market setting is therefore important.

The food economy consists of a network of producers, distributors and consumers of food (FAO, 2013). This whole network has a direct and indirect impact on the nutrition of individuals in the households and the community at large. The effect of agriculture on nutrition can be traced through the whole network of production, distribution and consumption (Swenson, 2006, 2008). Women are key players in food economies but they face constraints of income and time in achieving the end goal of nutrition in the food system (Pinstrup-Andersen and Watson, 2011).

As argued by Mlote et al. (2012), there is a cost incurred in value addition on products. These costs might pose some challenges for the producers who might want to fetch a better value for their products. A value chain which has a complex set of participants or distribution system provides little contact between the buyer and the seller (FAO, 2013).

Local food economies benefit the society environmentally, economically and socially by decreasing costs of packaging, increasing health and quality of food, as well as creating jobs for the local people and connectedness between farmers and consumers of food (Irshad, 2010). Hild (2009) argues that there should be linkages between the stages of the food economy in order to ensure that the local food economy is nutritionally efficient. Women are the main producers of food, if they have low nutrition, they will not be able to produce enough food properly for the family and for surplus. Mothers also need proper nutrition if they are nursing for the benefit of their own health and the health of their infant nursing babies. As for the children, they also need good nutrition for their performance in schools and other social activities. Their childhood is the foundation of their performance when they grow up into adults. Malnourished children are found to be less competent in schools, less social and less productive in the production system when (and if) they grow up (FAO, IFAD, UNICEF, WFP and WHO, 2017; Sorhaindo and Feinstein, 2006).

1.13 Ethical Considerations

Research as an activity involves the exercise of data collection, which at times would involve subjects including human beings (Tracy, 2019). Collecting data from human subjects need not be coerced or forced, the subjects need to give data, whether by interviews or observations, which is free from any form of coercion or intimidation so that errors will be minimised as much as possible and the information collected will represent the true nature of the subject at hand (Morris MacLean et al., 2019; Tracy, 2019). At any point in the research – before, during or after – data collection, the research processes should ensure that no harm is inflicted on the subjects (Morris MacLean et al., 2019). This study therefore complied with the ethical considerations and guidelines from every institution of every country that was involved.

Ethical procedures at the University College Dublin guided the whole process of research for this study. Because the data was collected in Tanzania and the partner university in Tanzania, St Augustine University of Tanzania, had given a research approval, the University College Dublin gave an exemption from ethical approval. Moreover, the National Institute for medical Research (NIMR) of Tanzania also gave an approval.

At every administrative level of the local governments, permissions were sought before data collection. Letters were sent to and permission obtained from the Regional Administrative Secretary in Mwanza where the St Augustine University of Tanzania is located, the Regional Administrative Secretaries in Shinyanga and Morogoro Regions as well as the District Administrative Secretaries in Kishapu and Mvomero Districts where the target populations were located. After this level of permissions, introductory letters were written to the respective wards and villages from the district authorities, requesting ward and village level cooperation in data collection. At the ward and village levels, it was made clear what the purpose of the study was and why the data needed to be collected.

At every level of data collection, from the household surveys, focus group discussions, key informant interviews, and market price surveys, the participants were introduced to the purpose of the study and informed consent was sought from them. All participants were assured that their participation was not mandatory, that it is voluntary and if they wish to withdraw from the exercise, they are free to do so. Initially, the research team intended to ask every individual household head in the sample to sign a written consent form. Further discussion with village and hamlet leaders indicated that from their experience, signing any form is not well perceived in the areas since people may refuse to participate just because signing is involved. Therefore, the hamlet leaders signed consent on behalf of the households s/he was leading at the time and then at the household level, verbal consent was sought.

Participants at every point of data collection were assured of the anonymity of their identities and confidentiality of the information provided. All the identifying information was used only to track the individuals for the second round of data collection, at no point in this study were the names or any identifying information used or mentioned. Moreover, the information obtained from the respondents was only used

for academic purposes in completing the study and not for any other reason. Setting up of questions and the language used ensured that no participant would be offended by the questions or think they are too personal to respond, this was minimised by the information given in introducing the study and at any point in the interviews, if a respondent needed clarification as to why a particular question is asked, an explanation was provided. At all times in the data collection process, the respondents were not given any financial or non-financial incentives to attract their participation.

1.14 Utility of the study

The main purpose of the study is to examine the linkages between local food economies and household nutrition in rural Tanzania. As outlined earlier, the study survey was conducted in the year 2014 in two different periods (before harvesting and after harvesting). It was important to capture the situation of the local food economy before and after harvest, in order to gauge the effect on prices and food availability and their impact on food security. This study was conducted in two regions of Tanzania that have different agro-ecological and economic conditions; one region has a unimodal rainfall pattern (one rainy season) while the other has a bimodal rainfall pattern (two rainy seasons). The areas also have different economic activities, one is largely dependent on farm production only and the other is largely dependent on off-farm production and to a lesser extent on farm production. These regions were selected for this study in order to help explain the differences that might exist in the household nutrition status due to operation of food economies in different agro-ecological conditions and economic activities.

It is expected that the study will be able to provide new knowledge and add to literature on the linkages between food economies and food security and nutrition particularly for rural Tanzania. It is also the expectation of this study that the recommendations from this study will benefit the policy and decision makers by taking into consideration nutrition in the context of rural communities. Food economies involve a series of actors and activities and therefore there are various sectors that interlink in the process. So, it is important to identify their various roles and how their policies would ultimately affect household nutrition. It is anticipated that as a result of this study, it may be possible for rural communities to make nutritionally informed decisions on their diets and conduct of daily activities.

1.15 Structure of the Thesis

As outlined earlier, this thesis includes two research articles *(Chapter 4 and Chapter 5 of the thesis)*, which present some of the findings of the research work. The first article in Chapter 4 has been submitted, undergone preliminary review and feedback and returned for further review and is titled: 'Low-Income Farm Households' Access to Food and Markets: The Case of Two Economically Distinct Areas in Rural Tanzania' in the *African Journal of Food, Agriculture, Nutrition and Development*. The second article in Chapter 5 is titled 'Seasonality, Food Prices and Dietary Choices of Vulnerable Households: A Case Study of Nutritional Resilience in Tanzania' and has already been published in the *African Journal of Agricultural and Resource Economics*.

This introductory chapter has discussed the overview and context for this study, the agricultural sector in Tanzania, the policy environment, a statement of the problem, as well as the study objectives and the methodology adopted in this thesis. The literature Review is discussed in Chapter 2; Chapter 3 presents a description of the study area and the household characteristics from the data; Chapters 4 and 5 comprise the aforementioned journal articles, Chapter 6 deepens the analysis contained in Chapter 5 by presenting the disaggregated results of diet costs and food choices for Kishapu and Mvomero; Chapter 7 discusses low-income households' food availability and coping strategies; Chapter 8 comprises a discussion and conclusions related to the study findings and the study recommendations are contained in Chapter 9.

Because the thesis includes two stand-alone research articles, presented in the exact format in which they have been submitted to the journals, there inevitably is an amount of overlap in these chapters in terms of the introductory material, background and some of the theoretical sections. This approach was undertaken in order to keep the integrity of the articles intact and to allow the reader to approach each of them as the stand-alone articles that they represent.

2.0 LITERATURE REVIEW

2.1 Introduction

The key focus of this thesis is to examine linkages between local food economies and household nutrition in rural Tanzania. In doing so therefore, it is important to describe some important concepts that are linked to the local food economy and nutrition at household level. This chapter therefore focuses on key concepts such as the food economy, markets and food security, as well as household economy, poverty and income inequality. These definitions differ from one study to another depending on context and the preference of the researcher. Here they are defined as they are used in this thesis. Furthermore, the subsequent section presents empirical research relevant to the topic as reviewed by this thesis, done by other researchers regarding household incomes, poverty and food security; market access linked to food security; food prices, cost of diet and household food security; agricultural seasons and food security; as well as household coping strategies. Lastly, a summary of this chapter is presented. Further literature is presented in the relevant chapters of the thesis.

2.2 Key Concepts on Food Economy

2.2.1 Food Economy, Markets and Food Security

The food economy comprises a series of activities from before farming to disposal of food (Kinsey, 2001). It consists of a network of producers, processors, distributors and consumers of food. This whole network has a direct and indirect impact on the nutrition of individuals in the households and the community at large.

A formal market is one in which a commodity passes through a recognised authority or institution of the government before it reaches the final consumer (FAO, 1995). While, an informal market is one that consists of direct sales to the final consumer by the producer (FAO, 1995). The informal market includes unrecognized, unrecorded and unregulated small-scale activities such as small enterprises with hired workers, household enterprises using family labour and the self-employed.

Food security encompasses a reliable availability, accessibility and stability of food to an individual or household (Gibson, 2012; Riches, 2016). In 1996, the World Food

Summit recognised freedom from hunger as a basic human right (World Food Summit (1996: Rome), 1996). Though closely related, a freedom from hunger does not directly imply food security, it has to be defined in elements and dimensions which affect food security (Gross et al., 2000).

Over time, the definition has evolved to fit various descriptions of the situation of food at individual and household levels. When at all times, people have physical, social and economic access to sufficient, safe and nutritious foods to meet their dietary needs and food preferences for an active and healthy life, they are deemed to be food secure (Coates et al., 2007; FAO, 2008; Stringer, 2016). This definition has included the aspects of safety, nutrition and preference for an active and healthy life. It has also included the social and economic dimensions of food availability and accessibility.

The United States Department of Agriculture, defines food security as a situation when people have enough food for an active and healthy life (USDA, 2018a); and that food insecurity is when households have limited access to food or are uncertain of whether they can access food (USDA, 2018b).

If combined with household food acquisition and allocation, food security can be used to measure individual and household welfare (Pinstrup-Andersen, 2009). If there is a lack of resources to obtain food at the household, then there is food insecurity (Hunger and Health, 2019).

Other scholars go further to argue that food security definitions should include education, health or other basic capabilities which affect wellbeing (Burchi and De Muro, 2016). However, the focus of this thesis in terms of food security is on the availability and accessibility of food at the household level.

2.2.2 Household Economy, Poverty and Income Inequality

The household economy, poverty and income inequality are concepts that are linked and related as in this study they both affect food security and consequently nutrition. They are also related to local food economy, which is the main focus of this study.

A household economy encompasses the behaviours of households in obtaining incomes, in saving as well as asset or property acquisitions. It also incorporates the

ways in which the household obtains food and non-food needs (Boudreau et al., 2008). Rural societies do not depend only on their own production but other market strategies to obtain food. Using the household economy approach enables the analysis of the kinds of activities households perform and their access to these activities. Even for farming households, the ability to produce food is not the only factor of food security but also their ability to access that food because food access in the household varies from person to person. Food access may be in the form of own production, forest, transfers or purchase (Gross et al., 2000; Rose et al., 2013).

Income is an important factor in the analysis of access to purchased foods. However, incomes are not equal for all households and even for individuals within the households. Income inequality shows the income gap that exists between different individuals or households. There are many measures of income inequality but the most common measure is the Gini coefficient (Jenkins, 2017) which is larger when there is a large gap between the rich and everyone else. Also, the Lorenz Curve can be used to measure inequality (Jenkins, 2017; Ravallion, 2017) and shows higher inequality when there is a large gap between the straight middle line and the curve. When these measure are used, under conditions of similar measurements, it is possible to make comparisons between areas and countries on the levels of income inequality (Ravallion, 2017)

An understanding of the concept of poverty is essential in analysing local food economies because most poor people have low incomes and in this study an analysis of low-income farm households is made. When a household lacks the financial resources to afford the minimum standard of living, it is termed as poor (Joseph Rowntree Foundation et al., 2014; Mack, 2016). In many instances, poverty has been described with the poverty line that distinguishes the poor and the non-poor (World Bank, 2017; World Bank Group, 2015). However, poverty is not just the lack of money, it is wider and multidimensional.

Sen (1982) argues that poverty is not restricted to only an imaginary poverty line. Even though income is a relevant dimension, there are other dimensions that need to be considered. In the essay Poverty and Famines: An Essay on Entitlement and Deprivation, Sen describes entitlements and deprivations as measures of poverty (Sen, 1981). Entitlements could be trade-based, production-based, own-labour or inheritance

and transfer based. He further discusses how food availability does not necessarily eliminate starvation because it all depends on entitlements (Sen, 1982; *ibid*). There are some countries with surplus food production but starving individuals still exist; for example, in Tanzania there are regions with surplus food production, but still there are individuals without food (ICF and MUCHALI, 2013; Ministry of Agriculture, 2017).

Other scholars argue on the multifaceted nature of poverty to include not only income, but also education, health and unemployment (Alkire, 2013). Furthermore, the 2000/2001 Human Development report claimed the inclusion of powerlessness and voicelessness, vulnerability and fear in their poverty definition (Gillis et al., 2001). Nevertheless, poverty with its many claimed dimensions, can differ in definition from one area to another and from one discipline to another (Sindzingre, 1999). The context, under which poverty is used in this thesis, is the lack of income where low-income households are considered to be poor.

2.3 Linking Food Economies, Agricultural Households, Market Access to Household Food Security and Nutrition

As discussed in the previous sections, households operate in their own specific local food economies; they are mainly agricultural households and require access to markets in order to sustain their food and non-food needs. This section, therefore, reviews previous relevant empirical work relating to household incomes and poverty, market access, food prices and their links to household food security and nutrition and lastly household coping strategies.

2.3.1 Household Incomes, Poverty and Household Food Security and Nutrition

Poverty is linked to household nutrition in many studies. Babatunde et al., (2007) found a positive link between household food security status and household income and size among other factors in Nigeria. According to Mazengo et al. (1997) food consumption by households with different economic statuses significantly affects their nutritional status. They conducted their study in rural and urban Tanzania using a 24-hour diet recalls for the rainy and dry seasons. In their study, the authors concluded that poor families consume less foods of animal origin than their rich counterparts.

Households depending solely on farm incomes have less income and the unequal access to non-farm income generating activities leads to income inequalities between households (Reardon et al., 2000). Food insecurity is especially observed among low-income earners in rural areas (Rosen and Shapouri, 2001); access to non-farm income helps to reduce the income inequality gap and improve household welfare indicators (Adams Jr, 2002; Barrett et al., 2001).

Girma and Gerebo (2002) analysed the determination of nutrition status of mothers and children in Ethiopia using data from Demographic and Health Survey 2000. In analysing the 13447 women in the dataset, they used a multivariate logistic regression and found that 25% of the women had chronic energy deficiency and the levels are relatively high for Ethiopia as compared to other Sub-Saharan African countries. The tests showed significant association between malnutrition and very poor families, rural inhabitants and uneducated women. Unmarried women were more likely to be malnourished as compared to married and widowed women. For children, they used a bivariate analysis and found that children born to poor families, single mothers, rural areas and uneducated parents were more likely to be malnourished as compared to their counterparts who have educated parents, live in the urban areas and their parents live together. In their work, they advised formulation of policies, which will empower women so that their generations will not be bequeathed with the malnutrition after them.

Other research done in Tanzania by Weinberger and Swai (2006) investigated the nutritional value of traditional vegetables in Central and North-eastern Tanzania. Using both qualitative and quantitative approaches, they analysed household survey data of 2003 to come up with their results. They found that poor households consume significantly more traditional vegetables than others who are better off in the communities. These traditional vegetables have a contribution to nutrition requirements especially iron and Vitamin A. Considering that traditional vegetables can be marketed, they have a potential to improve not only nutrition, but also incomes of poor households. They can be cultivated all year and they have low input requirements, which may make it easier for the poor households to farm.

Alderman et al. (2006) related the reduction of child malnutrition in Tanzania with income growth and program intervention. They concluded that higher incomes can

help reduce malnutrition but are insufficient if not accompanied by proper interventions.

Despite the important role of the farmers as producers, they do not benefit much from this role mainly because there is little value addition of their produce unless they upgrade by participating in other functions of adding value to the products (Mitchell et al., 2009; Riisgaard et al., 2010). Another reason that farmers do not benefit much in the market is the fact that they are in remote areas and their output is also low; the output fetches a low price in the market and makes them unwilling to sell because of the unfavourable market conditions. The farmer transforms inputs (such as seeds, land, and labour) into agricultural output with little control over the cost of inputs or over the changing environment.

In Bangladesh, research showed that off-farm incomes increase food consumption expenditures and overall household food security (Mishra et al., 2015). A study by Osarfo et al. (2016) on the impact of nonfarm activities on rural farm household income and food security in the upper east and upper west regions of Ghana found a significant positive impact of off-farm income on household income and food security. Furthermore, there is a significant link between income/poverty and the incidence of food insecurity (Magombeyi et al., 2016; Mahadevan and Hoang, 2016; Mailumo et al., 2016). Hence, it is important to consider incomes when analysing food security.

2.3.2 Market Access Linked to Household Food Security and Nutrition

Market access in rural areas is difficult and in many cases controlled by middlemen (Okorie, 2014). Luckett et al. (2015) observed more dietary diversity for households located close to markets compared to those far from the market in Malawi. While analysing drivers of household food availability, Frelat et al. (2016) determined that market access strongly influenced household food availability and hence food security in 17 African countries.

Middlemen are willing to take a risk and invest in a business to transport farm produce from hard-to-reach farmers to potential buyers. Also, Sibhatu et al. (2015) analysed production diversity and dietary diversity in smallholder farm households and found that in some cases dietary diversity is not necessarily due to production diversity and

stress the importance of the market access component in influencing dietary diversity. Similarly, access to market has been linked to access to food and therefore food security (Kalkuhl et al., 2016).

Purchased foods affect food security and diversity in all seasons (Sibhatu and Qaim, 2017). Apart from other factors such as household income, product prices and health, Ahmed et al. (2017) explored the status and determinants of small farming households' food security and role of market access in enhancing food security in rural Pakistan using household survey data and found a significant impact of market access on food security. More remote households are food insecure, as established by (Stifel and Minten, 2017a) who studied market access, well-being and nutrition in Ethiopia. A study on farm production, market access and dietary diversity in Malawi determined a positive association between farm production diversity and dietary diversity (Koppmair et al., 2017). However, it was further established that market access showed more important association with dietary diversity if people can access the market to buy food, sell farm produce and buy fertilisers for their farm production. Even though agricultural diversification is important for food security and nutrition, the role of market access cannot be underplayed (Waha et al., 2018). Thus, access to markets for both buying and selling is an important factor that should be considered when analysing farm households and food security.

2.3.3 Food Prices, Cost of Diet and Household Food Security and Nutrition Status

According to the theory of consumer behaviour, every individual has a goal of maximizing utility but is faced with time-specific budget constraints that limit the achievement of desired utility in each period. Households depend on markets to buy food and sell surplus and therefore the price and purchasing power are important factors. Darmon et al. (2002) modelled diets using a linear programming approach in the French population and established that strengthening cost constraints on diet significantly reduces consumption of nutrient rich food items. Equally, from the same French data, if there existed no cost constraints, people tend to choose diets rich in fish and fruits which are expensive and would not easily be afforded when the cost constraint is included (Darmon et al., 2006). Similarly, due to the high cost of healthy diets, the poor tend to consume energy-dense foods which are cheaper and this results

in obesity and obesity related problems (Drewnowski and Darmon, 2005; Drewnowski and Specter, 2004)

Chastre et al. (2007) modelled the cost of the cheapest diet in Lindi Rural District, Tanzania. The objective was to determine what it would take to ensure that all households are able to afford a quality diet to reduce malnutrition. They sampled children below 24 months and examined the households' ability to feed them adequately. They found that middle and rich families earn income from sales of their economic production while the poorer category of the households would sell their labour to earn income. Most people ate staple foods and stew for their daily diets and supplementary foods were mainly consumed during the post-harvest and not the pre-harvest periods. Diet is influenced by seasonality, age and wealth and is more diverse during the post-harvest period. The authors also determined that diets are affected by culture; as most people would prefer consuming a more expensive variety of food because consuming a less expensive one would make them look poor. Comparing with household annual income, it was established that the better off, the middle and the poor households could manage an adequate diet even in pre-harvest season. Those poorest households and especially those headed by a single old woman could hardly afford an adequate diet even if the number of dependants is small. The poorest households spend most of their income on food and the number of dependants significantly affects the affordability of an adequate diet.

Unnevehr et al. (2010) analysed how prices and income influence demand and the role of nutritious food in health and human capital formation. In their article 'Food and Consumer Economics', they focused on the role of food programs in the economy, particularly on household income, health, hunger, diets and poverty. It is increasingly evident that demand for quality food is becoming more and more important in communities (Unnevehr et al., *ibid*) as food with good attributes (nutritious food) will be priced high according to hedonic pricing (price determined by internal and external factors of the food). The increasing demand for quality food requires an availability of nutritional information on food products so that consumers understand what they are eating, nevertheless, there is no nutrition information provided on the food products.

Lo et al. (2012) established that one of the factors that hinder consumers from having healthy diets is the price of food. They found that healthy diets cost more than

unhealthy diets. They used an observation method of analysing the food choices of students in cafeterias and concluded that when the price of healthy foods was lowered, more people opted for the healthy diet. They recommended for policy interventions to look into the prices of healthy foods so that more people can afford to buy. They advised the use of decision models such as Cost-Benefit Analysis, Cost-Utility Analysis and Cost Effectiveness Analysis to establish links between consumer behaviour in nutrition choice and the cost of nutritious foods.

The purchasing power of households defines the affordability of market goods; that is, how much and of what quality of goods a unit of currency can obtain from the market. A household with low purchasing power might need to forego some of its basic needs for other more pressing needs at that time. People purchase less nutritious foods because they are cheaper (Cochrane and D'Souza, 2015; Darmon and Drewnowski, 2015; Mbegalo and Yu, 2016).

More dietary diversity and food security is experienced during the post-harvest season compared to the pre-harvest season in Kilosa, Tanzania (Ntwenya et al., 2015). Many animal products are expensive and therefore not heavily consumed by Tanzanian households, those who do consume animal products, consume the relatively cheaper animal-source foods (Baker et al., 2016).

It is difficult for lower income groups to comply with dietary guidelines because of the changing costs of diets (Faber and Drimie, 2016); and poorer households are more vulnerable to increasing food prices. For those households that are already food insecure, the cost of nutrient rich foods such as vegetables and fruits tends to limit daily consumption of food items in these groups (Faber et al., 2017). Rural households tend to practice activities in the households that are not beneficial to them nutritionally and financially and women and children especially suffer because they are more vulnerable (Brown et al., 2017; Mbwana et al., 2017).

Cochrane and D'Souza (2015) measured food access in Tanzania using a food basket approach using 15 food groups and 2010/2011 Household Panel Survey Data. They found that nominal prices of foods have risen significantly over three years (2010 to 2013) while real prices did not. Nevertheless, the study revealed that low-income

households are significantly affected by food prices, which makes access to food difficult.

Yu and Shimokawa (2016) reviewed the nutritional impacts of rising food prices in African countries of DR Congo, Ethiopia, Malawi, Nigeria, Tanzania, and Uganda and found that food price increases negatively affects the consumption of nutritious foods especially for Tanzania, Malawi and Uganda where a large part of their diets is a single staple food. Furthermore, using a cost of diet diversity and a cost of nutrient adequacy, Masters et al. (2018) measured the affordability of nutritious diets in Ghana and Tanzania and discovered that there was much more variability in Ghana compared to Tanzania in the choice of a least-cost diet.

2.3.4 Agricultural Seasons and Food Security

About 80 per cent of agriculture in many countries is mostly dependent on rain (Potterton, 2011); and therefore, seasonality plays a role in food production and ultimately food security. In a few countries where weather conditions are favourable and water harvesting technology projects feasible, it has been possible to have all year-round agriculture (Potterton, 2011).

Dietary patterns are worst during the rainy/lean season in Tanzania as suggested by a study on Dietary Patterns and Household Food Insecurity in Rural Populations of Kilosa District (Ntwenya et al., 2015). Additionally, seasons play a significant role in determining the food security status of agriculture-dependent households and towards the end of lean seasons, diets tend to be more diverse (Hirvonen et al., 2016) and households consume fewer calories in the lean season compared to the post-harvest season. However, even with an increase in production in the harvest season, there is still a great influence of purchased foods on household dietary diversity (Sibhatu and Qaim, 2017).

2.3.5 Household Coping Strategies

When households face food insecurity threats, they tend to find ways to get out of the situation. Some of the ways used to cope with food insecurity threats include selling of assets, borrowing, consuming forest foods, or even skipping meals.

Msuya et al. (2010) researched the availability, preferences and consumption of forest foods in the Arc Mountain areas in Tanzania. They used survey data and made a qualitative analysis of the data. They found that indigenous forest foods are heavily consumed when available and that people who consume such types of foods are more food secure. They also concluded that indigenous forest foods could help households in improving incomes if markets for such commodities are developed of if these foods are domesticated. However, they did not look into the nutritional aspect of indigenous forest foods and how they can be used to improve, together with food security, household nutrition.

At the same time, indigenous forest foods can be widely consumed when available and people who consume such foods have dietary diversity and food security. Also arguably, domesticating or improving markets for indigenous forest foods could improve incomes (Ntwenya et al., 2017; Ochieng et al., 2018). In addition, the, seasonality of food crops significantly affects consumption patterns among food secure and food insecure families.

2.4 Summary

There is a significant literature in Tanzania addressing nutrition of either households or women and children (Baker et al., 2016; Chastre et al., 2007; Cochrane and D'Souza, 2015; Hirvonen et al., 2016; Masters et al., 2018; Mbegalo and Yu, 2016; Mbwana et al., 2017; Msuya et al., 2010; Ntwenya et al., 2015, 2017; Ochieng et al., 2018) among others. The literature has explored various aspects of individual and household nutrition in Tanzania such as the analysis of household consumption of a certain food basket, the consumption of forest foods and household incomes.

In this thesis, the focus is further developed on access to markets, household incomes, food costs and diets, seasonality and coping strategies. This is because all these aspects make up the local food economy and do affect nutrition status of households and no study has combined all these aspects. There is a lack of recent literature in Tanzania linking food security/nutrition with the cost of diet or variability in food prices. Very few studies in Tanzania (Cochrane and D'Souza, 2015; Masters et al., 2018; Yu and Shimokawa, 2016) have analysed the impact of food prices on household consumption of nutritious foods.

The following chapters of this thesis present the results on how this study has linked access to markets, household incomes, food costs and diets, seasonality and coping strategies with household nutrition. Chapter Three draws on the study data to give a description of the study areas of Kishapu and Mvomero and to outline the household characteristics and socio-economic characteristics. The two subsequent chapters, Chapters 4 and 5 are two journal articles, namely 'Low-Income Farm Households' Access to Food and Markets: The Case of Two Economically Distinct Areas in Rural Tanzania' which is under review by the African Journal of Food, Agriculture, Nutrition and Development; and 'Seasonality, Food Prices and Dietary Choices of Vulnerable Households: A Case Study of Nutritional Resilience in Tanzania', which has been published by the African Journal of Agricultural and Resource Economics.

3.0 STUDY AREA DESCRIPTION AND HOUSEHOLD CHARACTERISTICS

3.1 Introduction

The main issue addressed in this study is how the operation of local food economies impact on the nutrition status of rural households in Tanzania. It is therefore useful to provide a snapshot of the facilities and resources of both study areas as it serves to understand the rest of the analysis in this thesis. This chapter describes the two study areas, Kishapu and Mvomero and presents the key differences observed from the data in the two districts. It also presents the general household characteristics and the household socio-economic characteristics such as: housing, water and sanitation; sources of energy; asset ownership; economic activities and land ownership; savings and loans; social capital and gender issues. Also, key findings from focus group discussions and key informant interviews are presented in this chapter. Finally, a summary of the chapter is presented.

3.2 Methodology

The methodology used in analysing data in this chapter is descriptive in nature. To present the data, charts, tables and graphs have been used. As part of the analysis, the mean is presented with the standard deviation statistic in brackets. Moreover, the differences between districts or sex of the household head or both have been presented. Statistics such as the analysis of variance and t-statistics are also presented to understand if there are statistically meaningful differences between the areas or between sexes of the household heads.

3.3 Study Areas

A total of 506 households were included in the household surveys: the first-round pre-harvest surveys included 277 households from each district; because of dropout a total of 255 households from Kishapu and 251 households from Mvomero was the final sample. The research recommended both male and female heads of the household be present during the interviews, the success rate for this was 80% because some

households had single heads and in other households one head of the household was present while the other (partner) had travelled.

The respondents included 143 households from Mwakipoya Village (Mwakipoya Ward), 112 from Lubaga Village (Lubaga Ward) in Kishapu and 149 from Makuyu Village (Mvomero Ward) and 102 from Milama Village (Dakawa Ward) in Mvomero District.

3.4 General Household Characteristics

Of those households included in the sample, the following were the numbers of household heads by sex: overall there were 111 female-headed households (62 in Kishapu and 49 in Mvomero) and 395 male-headed households (193 in Kishapu and 202 in Mvomero). Table 3-1 below summarises the household characteristics of the two study areas. The data shows that on average, households are larger in Kishapu than in Mvomero; the average household size in Kishapu was found to be 8 members while in Mvomero it was 5 members. There was no difference between household sizes of males or females in Kishapu, while in Mvomero; female-headed households were one member larger than male-headed households. Also, the number of dependency ratio (calculated from the number of children below the age of 15 and the elderly above 65 years per income earning adult) was observed to be larger in Kishapu (3) than in Mvomero (2).

Table 3-1: Household Characteristics

District	**Kishapu**			**Mvomero**			**Overall**		
Sex of Household Head	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**
Average Households size	8 *((3.689)*	8 *(3.752)*	8 *(3.730)*	6 *2.686*	5 *2.519*	5 *2.547*	7 *3.452*	7 *3.408*	7 *(3.414)*
Average Age (Years) of Household Head	52 *(18)*	45 *(15)*	47 *(16)*	47 *14*	42 *14*	43 *14*	50 *16*	44 *15*	45 *(15)*
Dependency Ratio	3 *(1.554*	2 *(1.040)*	3 *(1.190)*	3 *(1.855)*	2 *(0.809)*	2 *(1.143)*	3 *(1.694)*	2 *(0.934)*	2 *(1.167)*
Average years of Schooling of Households head	3 *(3.373)*	6 *(3.196)*	5 *(3.407)*	4 *3.458*	5 *3.202*	5 *3.273*	4 *3.445*	5 *3.198*	5 *(3.338)*
Average years of Schooling of Other Members	3 *(1.665)*	4 *(1.650)*	4 *(1.654)*	3 *1.870*	3 *1.703*	3 *1.734*	3 *1.750*	4 *1.676*	3 *(1.693)*
Number of Rooms	4 *(2.727)*	4 *(2.761)*	4 *(2.748)*	3 *1.414*	*3* *1.201*	*3* *1.247*	4 *2.302*	4 *2.233*	4 *(2.247)*

Source: Household Survey Data

Most of the household heads in the two areas were married as shown in Figure 3-1. Furthermore, many other members in the household were single as these were children, most of whom were school-age children. In some households, there were other older members that were either married but still living with their parents or divorced/separated and returned home to live with their parents.

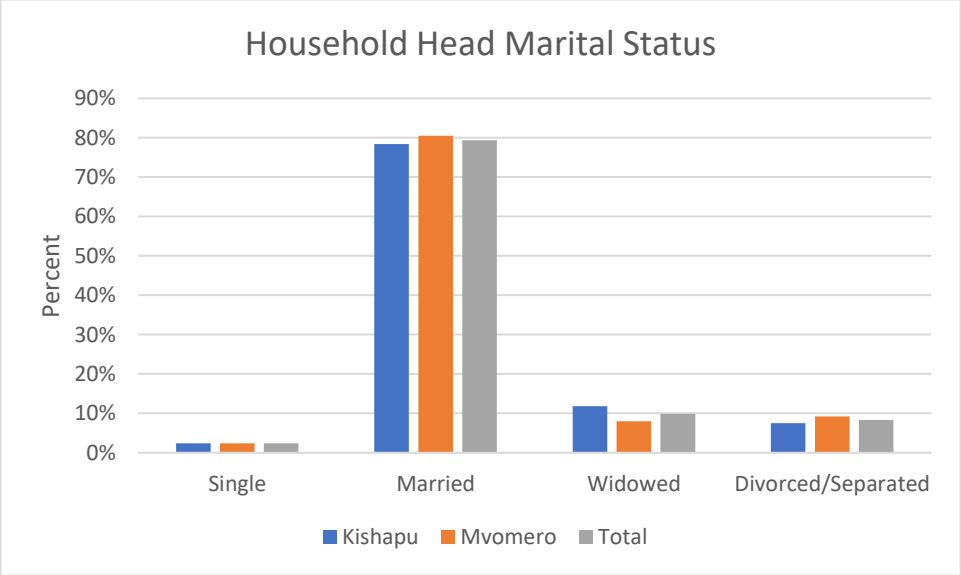


Figure 3-1: Marital Status of Household Heads

Source: Household Survey Data

In some cases, household members that were married but still living with parents were observed in Kishapu because as a tradition, the head of the household pays the bride price (especially cows) on behalf of his son and he is the one to decide when to allow his son to move and start living by himself with his family. It was revealed in the focus group discussions that this sort of tradition is done as a way for the sons to service the bride price that was loaned to them.

3.5 Household Socio-Economic Characteristics

3.5.1 General Welfare Information

When asked to talk about Lubaga village, participants in the FGD said that they are better off since they can practice irrigation during the dry season along river Tungu, an

advantage that other villages do not have. The vegetables they grow helps in home consumption and in selling for income. However, other participants that were not close to the river did not have this advantage. When there is no rain in Kishapu, most households purchase from those who do farm along the river. Participants in Mvomero also stated that the general living standard in their village is not good. Explaining this, they mentioned that the search for money and agriculture is hard. The area does not have enough water and the roads a bad therefore business is not good. Dependence on agriculture is sometimes futile as it all relies on rain. Sometimes rains come at an inopportune time. They do not have rivers to fetch water, so they depend on public standpipes, wells and ground water. It is also difficult to obtain land even for renting.

Comparing life in the village compared to the past twenty years, participants said their life is harder than before. Explaining this, they said that currently even those living close to the river and grow vegetables don't get enough yields hence the income generated is not enough to buy other foods and other needs for the family. In the 1980s and 1990s, life was better because fuel wood was easily available, they did not have to buy fuel wood and food was affordable. In comparison, participants in Mvomero also spoke of difficulties in business activities. Many households in this area are involved in economic activities other than farming and most especially business. Compared to twenty years ago, the unanimous view was that harvests have dramatically declined, there is no enough rain and there are many problems in cultivating as well as high prices for farm implements. They also buy food and non-food stuff at a very high price. Selling things is also a problem, they have to go through middlemen who have their own prices which a mostly unfavourable

Speaking of development projects in Kishapu, there were no projects in recent years except for the school feeding one by WFP. They pointed out that they would prefer access to credit so that they can establish businesses such as tailoring. In Mvomero, several projects were mentioned such as building a health care dispensary and toilets for schools. The government, donors and the citizens conduct these jointly. Some participants pointed out that some projects are not beneficial for them, such as agricultural education, because they get educated but do not have means for implementation. They identified a need for a complete and full functioning health centre especially for the women who need maternal and delivery care.

Ranking poverty levels in their society, participants identified the wealthy being those with livestock herds, owned large land and/or businesses. The poor households do not have these and would have to ask for a piece of land to use in season. There are some households that do keep livestock but not their own, they keep the livestock on behalf of others, and in return they can use or sell the animal products such as milk and manure or the bulls in farming, but they cannot butcher the animals. That household would not be considered well off. If an animal dies, the owner will not ask for any compensation as long as it was not intentional. Since the well off have large farmlands, they sometimes lend pieces of land to the poor and they hire labour to plough and weed. In Mvomero, households are considered wealthy when they have no problems in obtaining all three meals every day; it should also have clean environment around the home and children go to good schools. Moreover, wealthy households have means of earning steady income into the households that is why they have less food worries and other needs. Poorer households have very unsafe. Environments, for example, children may spend a good part of the day without eating and not even knowing when the next meal may be available. They have no sources of income and earn very little in agriculture.

The quality of a homestead in Kishapu is judged by looking at the walls, roofs and floors. Poor homes are those with mud walls, thatch roofs and non-cemented floors, these are also called Matende in the area. On the other hand, good quality homes are those with iron sheet roofs, cemented floors and brick walls, anything in between is moderate quality house. To characterise houses in Mvomero, a good house has to have a toilet, it should be roofed with iron sheets and floored properly. A moderate house may be roofed with iron sheets but not properly cemented on the floor, may have a toilet that is not exactly well built. On the other hand, a poor house is roofed with thatch, the walls are made of mud or reeds, and the toilet is just a pit latrine.

In Kishapu, water is accessed from the seasonal rivers nearby, there are a few wells also where they can access water but in all these sources most households have to walk a fair distance to and from the water sources. This is a duty done by women or female children in the family. Because of the distance, some women to get into misunderstanding with their spouses if a meal is late or they return home late. For those who can, they use ox-pulled carts or bicycles for fetching water. If a person

borrows a cart, they have to pay around TZS 6,000/- (equivalent to EUR 2.6/-) per barrel (approximately 160 litres). On the other hand, in Mvomero, water is mainly bought at TZS 200/- to TZS 500/- (ERU 0.1 to 0.25) per bucket of 20 litres; this makes water in Kishapu much more expensive than in Mvomero.

3.5.2 Community Decision Making Process

In general, in all four villages, it was described that decision making in the villages is through village meetings where proposals are put forwards and votes made. The village council (made up off hamlet leaders, heads of department and other experts such as health workers, social workers, agricultural workers, head teachers and the like) first makes the proposals. Afterwards, the village assembly/meeting will vote for a development project, then the voted ones are taken to the ward and district council for organising implementation processes.

3.5.3 Housing, Water and Sanitation, and Health Conditions

3.5.3.1 Housing, Water and Sanitation

There were few households whose housing conditions were good enough to be termed as good condition houses. To define this, participants in focus group discussions in both villages were asked which houses were considered as good condition, moderate condition and poor condition ones. Their definitions were based on roofing, windows, doors, floors and walls and were almost similar in both districts. Kishapu had the greatest number of poor housing condition since more than 80 per cent of the households were in this category. Moreover, in both districts the heads of the households owned the houses where in Kishapu up to 90 per cent of the premises were owned while in Mvomero there were more rented houses. Many people in Kishapu live either in their farms or close to their farms, that is why most premises were owned, while in Mvomero, most people live close to the village centre while their farms are far from their homes. In the village centre, some people build houses for rent to serve those who do not own plots. The summary for the sampled households' housing, water and sanitation conditions is presented in

Table 3-2.

Table 3-2: Housing, Water and Sanitation

HOUSING, WATER AND SANITATION	KISHAPU	MVOMERO
Percentage of Households with good condition premises	3.9%	15.9%
Percentage of Households with moderate condition premises	12.9%	41.8%
Percentage of Households with poor condition premises	83.1%	42.2%
Percentage of Households with owned houses	92.5%	80.1%
Percentage of Households with rented houses	6.5%	14.7%
Percentage of Households with houses not owned and not rented	2.4%	5.2%
Percentage of Households with electricity	0.0%	6.1%
Percentage of Households with a protected water source	12.3%	96.7%
Percentage of Households using a toilet facility	65.5%	92.8%
Percentage of Households sharing a toilet	18.3%	20.7%

Source: Household Survey Data

The data also shows that no household in Kishapu had electricity connected to their houses while only 6.1 percent of households have electricity in Mvomero. The rest use solar energy, kerosene, charcoal and firewood for cooking and lighting. Fewer households in Kishapu have toilet facilities (65.5 per cent) compared to Mvomero where only 96.7 per cent of households have toilet facilities. The rate of sharing toilet facilities by more than one household is higher in Mvomero than in Kishapu. As explained above, households in Mvomero are in close proximity to one another and because others are rented, more than one family may be staying in the same compound and sharing the same toilet.

The responsibility to fetch water lies with women (92.5% Kishapu and 89.2% Mvomero) and children (42.9% Kishapu and 56.3% Mvomero). Drinking water is either boiled, strained through a cloth or left to settle by a few households. Most households do not treat their drinking water and in Kishapu hand washing is less common compared to Mvomero. Additionally, waste disposal is done within their compounds or farms.

3.5.3.2 Community Health Issues

While interviewing the clinical officer in Lubaga, it was revealed that the main heath issues in the community were diarrhoea, kwashiorkor however is not that much prevalent; they were doing great. Also, pneumonia and worm infections were common, but malaria cases were very rare. Problems associated with caring for people were mainly shortage of medication and reluctance of people to seek medical care. The existing women's or agricultural groups were given health education by the *Tibu*

Homa project (which translates to cure fever) on different health issues. The project also trains local hamlet leaders so that they can easily spread awareness to other community members. The community seemed to receive the project quite well. When villagers attend clinics, they are given nutrition advice on how to balance diets. Health problems associated with diets are reduced when the harvest is good in a certain year. The people may need to walk five to seven kilometres before reaching a health centre; those who live too far away mostly seek traditional medication. The health dispensary did not have electricity but there were plans to budget for solar installation. The centre is understaffed as they have only one clinical officer and one nurse, if one goes for a holiday or has an emergency, the other covers all duties, which is not easy. Village health workers also do not have transport to go around households, which are mostly far apart.

Moreover, in Mwakipoya village, the clinical officer identified more or less the same health issues as in Lubaga village. He pointed out that they educate the society through the village assembly and any opportunity they get when the villagers seek medical services. The centre has a lack of toilets, water and a proper disposal of the biological wastes they have after caring for the sick and the mothers that have delivered. There are a lot of households that are not close to the centre and when they need help, they would travel the distance or seek the help of traditional healers. Problems they face also include lack of health-seeking behaviour among the people and lack of staff at the health dispensary.

With the healthcare worker in Mvomero, the main health problems that were identified in the area health centre were malaria, bilharzia and diarrhoea. The main source of water for domestic purposes is still water from ponds, rivers and unprotected springs. Efforts are made to control these diseases. Also, community health workers attend frequent trainings in order to give appropriate care to the community and sometimes outreach campaigns are conducted for community awareness. The difficulty in reaching remote areas is a challenge in providing healthcare for all. Lack of income prohibits many people from seeking health care in appropriate centres; the government should put forward proper strategies to help seek for a market for farmers' crops to improve their incomes.

In Makuyu health centre, the main health problems facing the community were malaria and water borne diseases such as cholera. The community has improved toilets, which has reduced the number of outbreak cases of such diseases. Health education is provided to nursing mothers when they attend clinics, but also several campaigns are conducted for awareness, such as proper feeding, promoting health seeking behaviour and the use of toilets and hand washing. Availability of medicines is a big challenge and the lack of understanding of proper nutrition.

3.5.4 Sources of Energy for Lighting and Cooking

Like in many rural areas of Tanzania, electricity and gas are rarely accessed and used by the households in Kishapu and Mvomero Districts as sources of energy. The most common source of energy used for lighting in both areas are torches, solar charged lights, kerosene lamps and kerosene chimneys. A few households in Mvomero also use electricity as a source of lighting; these results are summarised in Figure 3-2.

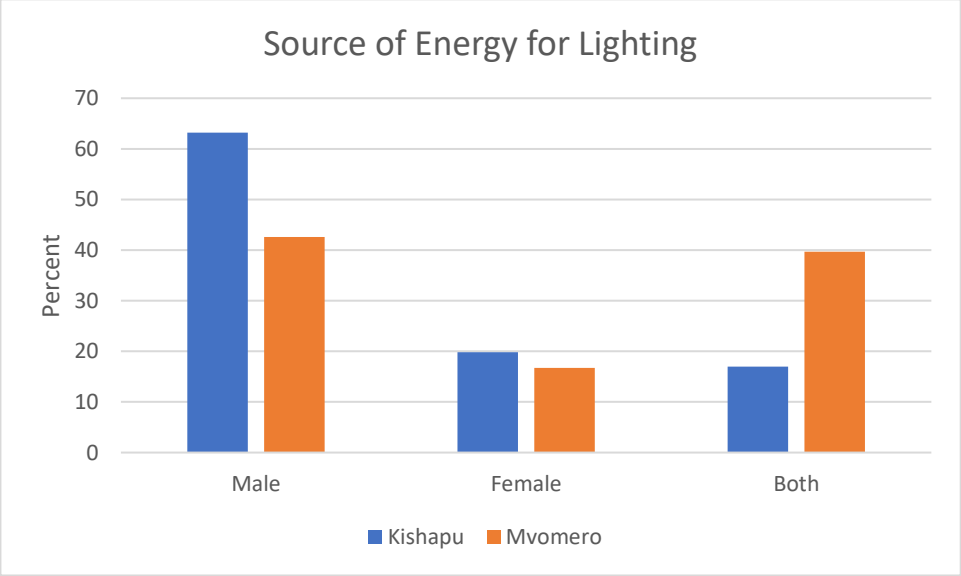


Figure 3-2: Source of Energy for Lighting

Source: Household Survey Data

For cooking, households in both districts use firewood and in some cases charcoal as shown in Figure 3-3 below. Firewood is easily available as many do not have to buy it, it is just picked from the forrest. The business of producind and selling is practiced

more in Mvomero, but also charcoal is consumed more in Mvomero, just like in many semi-urban areas, than in Kishapu.

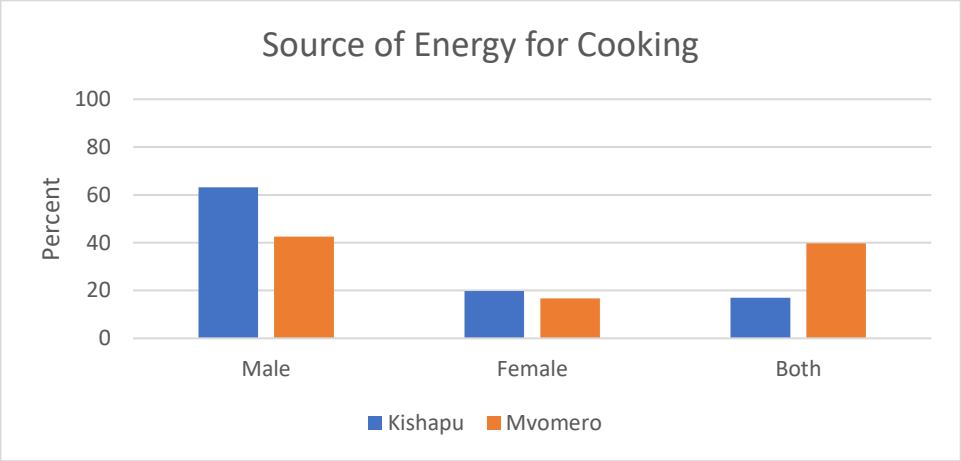


Figure 3-3: Source of Energy for Cooking

Source: Household Survey Data

3.5.5 Asset Ownership

Asset ownership can sometimes approximate a household's welfare. The data in

Table 3-3 indicates that there is low ownership of assets such as motor vehicles, motorcycles, television sets, cupboards, coaches, cookers, and refrigerators. Some of these assets were seen as either not necessary or expensive. For example, even if people could afford refrigerators, with no access to electricity, they would not buy any. Motor vehicle ownership was by a very few households and motorcycles also served as a business for some. Radios, mobile phones, bicycles, beds and chairs are owned by many households in both study areas were deemed as somehow a necessity in the areas. For example, to reach the district centre or the farm for those who do not live close to their farms, one had to have a bicycle. Radios were the only ways to get news as no newspaper is delivered to the village.

Table 3-3: Household Asset Ownership

ASSET OWNERSHIP	KISHAPU	MVOMERO
Percentage of Households owning a radio	52.5%	68.5%
Percentage of Households owning a mobile phone	78.8%	78.9%
Percentage of Households owning a bicycle	65.9%	77.2%
Percentage of Households owning a motor vehicle	1.2%	0.8%
Percentage of Households owning a motorcycle	7.8%	10.4%
Percentage of Households owning a TV	2.0%	3.6%
Percentage of Households owning a bed	82.4%	94.8%
Percentage of Households owning a cupboard	4.3%	6.4%
Percentage of Households owning a chair	90.2%	75.2%
Percentage of Households owning a coach	4.7%	10.0%
Percentage of Households owning an iron	12.2%	10.4%
Percentage of Households owning a cooker	0.0%	0.0%
Percentage of Households owning a refrigerator	0.8%	1.2%
Percentage of Households owning a table	7.5%	28.3%

Source: Household Survey Data

Most households in both study areas own farming assets such as hand hoes and machetes areas as in Table 3-4. There is a large number of households owning hand hoes because they are an important implement in farming, especially during weeding and also for ploughing for those who do not have access to tractors or ox-pulled ploughs. Ploughs are largely owned in Kishapu because they are mostly livestock keepers and use cows to operate the ploughs compared to Mvomero where many of those who do not use hand hoes hire a tractor to farm their land. Tractors are not commonly used in Kishapu, as their availability is scarce. Ownership of axes on the other hand is not common in Kishapu as compared to Mvomero. Axes are used in clearing land or cutting logs for charcoal burning. It was observed that in many households in Mvomero, charcoal making, and trading was more common as compared to Kishapu, making an axe a necessary tool to own.

Table 3-4: Household Farm Asset Ownership

FARM ASSETS	KISHAPU	MVOMERO
Percentage of Households owning a hand hoe	100%	98.4%
Percentage of Households owning a plough	51.8%	1.6%
Percentage of Households owning a pump	3.5%	0.8%
Percentage of Households owning a milling machine	0.8%	0.0%
Percentage of Households owning a machete	87.5%	82.9%
Percentage of Households owning an axe	2.7%	24.8%
Percentage of Households owning a shovel	1.2%	4.0%
Percentage of Households owning a wheelbarrow	1.2%	0.4%

Source: Household Survey Data

3.5.6 Economic Activities, Land and Agricultural Services

3.5.6.1 Economic Activities

Farming is the primary economic activity for over 90 percent of the households in both districts. Other economic activities that households engaged in are small-scale entrepreneurship, civil service, and sale of natural resources such as charcoal and firewood.

As farming is a prevalent type of economic activity, it is also the major source of income into the household. In addition, households earned incomes from self-employment (entrepreneurship), salaries/labour wages and mining among others. Mvomero is an area close to the roads and other towns, therefore, engagement in entrepreneurship (43.4%) activities is a bigger opportunity there than in Kishapu (18.4%). 44.6% of households in Kishapu had no extra sources of income while only 11.8% in Mvomero had no other sources of income presented in Table 3-5.

Table 3-5: Other Sources of Income

OTHER SOURCES OF INCOME	KISHAPU	MVOMERO
Income from self-employment?	18.4%	43.4%
Income from salaries/labour wages?	16.1%	10.4%
Income from small-scale mining?	1.6%	8.8%
Income from charcoal/fuel wood sales?	6.3%	8.0%
Income from people within Tanzania?	4.7%	5.2%
Income from people outside Tanzania?	0.4%	3.2%
Income from pension payments?	0.0%	0.0%
Income from renting-out/leasing of house/land/equipment etc.?	2.4%	3.2%
Income from interest from giving out loans?	5.5%	6.0%
No Extra Source of Income	44.6%	11.8%

Source: Household Survey Data

It is further revealed that; male heads of the household had more sources of income other than farming compared to female heads of the household in both districts as shown in the Figure 3-4 below.

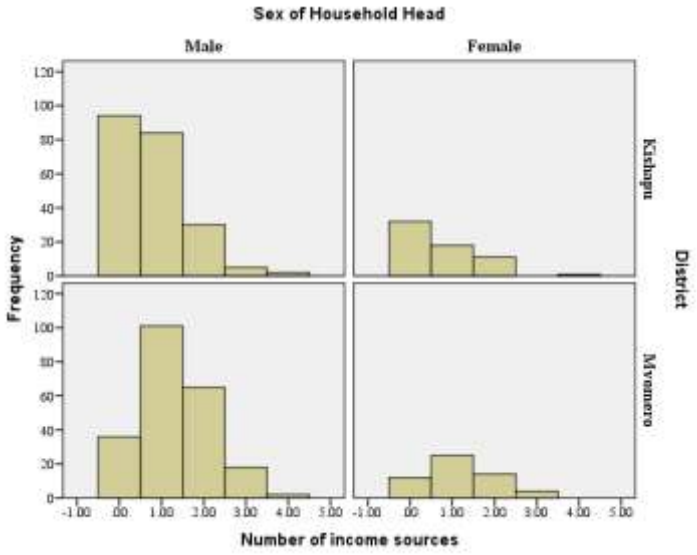


Figure 3-4: Number of Sources of Income

Source: Household Survey Data

The general conduct of earning a living has changed from the past in Kishapu, participants said that the younger generation is not interested in farming; they are interested in securing a job away from the village or doing business. Farming is left for the older generation and a few younger people. “You might buy a cow unfortunately in the following year there might be hunger that forces you to sell the cow and go back to the same situation. So, it is difficult to feel the sense of development. Businessmen are the one that are at least progressing”. “Farming is not profitable, and the wait is long”. They start businesses such as retail shops or livestock trading and not keeping. The villagers grow crops such as maize, rice, cowpeas, groundnuts, millet and sweet potatoes for home consumption and the excess for selling; also, cotton is grown as a cash crop. They also keep livestock like cattle, goats, sheep and chicken. Animals like cattle and goats are used for farming, milking and for saving and some as a custom. For money when you decide to sell your animals you get some money to spend on household needs. In Mvomero, compared to the past, agricultural yield per acre of land has declined because of changes in rain. This leads to the problem of hunger to recur every year. They grow crops such as maize, rice, sunflower, sesame, pigeon peas and mangoes. These crops grow well in the area and are used for food and cash. The main cash crops are sesame and rice. Livestock kept include cattle, goats and chicken, but most especially the smaller livestock for saving and food.

The problem that bothered villagers in Kishapu most in the community was hunger. They resort to labouring in other people's farms so that they can buy food. They lack farm implements because most would use hand hoes, some would hire an ox ploughs and very few can afford to rent a tractor. Since the area is dry, drought reduces their crop yield and sometimes incur losses. On the other hand, in Mvomero, they face problems such as pests and conflicts especially with the pastoralists who feed their herds in the villagers' farms before they had finished harvesting. Sometimes elephants also destroy their farms, the area is close to Mikumi National Park and the elephants may be found wondering in the fields. The village committees solve conflicts with pastoralists and other problems, but in their views the solution is not always fair, and the loss cannot be recovered.

Ukombakomba (shared labour) during farming season is a practice common in Kishapu. During this practice, neighbouring households would join forces and go to plough, weed or harvest in their farms in turns. The host would provide food and drinks and, sometimes, local music. Shared labour is not practiced in Mvomero. Participants in the Focus Group Discussions identified that the practice was common in the past, but as life's hardships overcame people, they concentrated in solving their own problems and not sharing things such as labour. Sometimes, people would not put all their efforts in other people's farms; such unfairness has led to abandonment of the practice.

The most common output market for Kishapu is Mhunze weekly market that operates on Thursdays only. If a person needs to buy or sell something fast, they would have to ask neighbours or go to another village. Prices are not favourable, but they have no alternative. Selling farm produce in Mvomero is mainly though middlemen who regularly visit the village after harvest. The cost of transporting to the nearest market is too high and the farmer is not even sure if all produce may be sold at the market.

After harvest is when livestock are bought in order to save the proceeds. While selling their livestock, villagers have to obtain written clearance from the village government; otherwise they will be caught for breaking the law. Price fluctuations make the situation difficult for local farmers and during the lean season lack of pasture make the livestock thin and fetch a low price in the market, this is when they have to sell most of their livestock to get money for food but they do not get enough.

The village elder in Lubaga stated that he started farming more than 30 years ago and it was his view that there is considerable change in the way people earned their incomes. It is two folds, there are things that are made easier, and others are worse. Irrigation is easier as they can access power generators to easily irrigate along the river, but for the large farms, rains are scarce and the situation worse. Crops have somehow changed as more people are growing rice and green grams as cash crops. The current tendency of people not growing sorghum has also contributed to shortage of food. People now prefer eating maize or rice, growing sorghum slowed down because it was no longer profitable income wise.

In Mwakipoya on the other hand, the village elder pointed out that farming was the most important economic activity in the area. However, farming has changed because people no longer prefer growing sorghum that used to be a great cash crop. There has been a shift towards doing business especially for the youth rather than agriculture.

Village elder in Milama explained that in the past 30 years, the rains were good, and the two rain seasons allowed them to grow crops twice a year. But things have changed, and the second season is not productive. Another elder in Milama had similar views on issues regarding farming practices in the village, that cotton is no longer grown in the area, while maize, sesame and legumes are common crops. Sorghum is not common in the area. These are mainly grown for food and cash. Land is inherited, rented or bought.

An elder in Makuyu village on the other hand pointed out that farming is the most practiced source of income in the households. Cotton is no longer common as a cash crop in the area, people now grow maize, sesame and sunflower as cash cops, sorghum is very rare. Cattle and goats are the most common livestock kept.

3.5.6.2 Community Land issues

Land ownership in the two study areas is shown in Table 3-6 below. On average, households in Kishapu owned larger lands (30.27 acres) compared to Mvomero (5.27 acres). Kishapu is a more remote area than Mvomero; most of the inhabitants there own larger lands for farming and livestock keeping. Since people in Kishapu are traditionally pastoralists, they keep large herds and also need a large land area for

pasture. In Mvomero, most people live away from their farms and many would have to rent land from others in order to farm, this limits the size of land they will be able to farm. Most of the land is male owned (63.2% in Kishapu and 42.6% in Mvomero). Co-ownership of land is observed more in Mvomero than in Kishapu and in both districts, fewer females have sole land ownership.

Table 3-6: Household Land Ownership

Land Ownership	KISHAPU	MVOMERO
Mean area of land owned by rural households (in acres)	30.27	5.27
Land Owned by male head of the household	63.2%	42.6%
Land Owned by female head of the household	19.8%	16.7%
Land Owned by male and female in the household	17%	39.7%

Source: Household Survey Data

Key informant interviews and focus group discussions also highlighted issues of land ownership. Land ownership is an important aspect of the farming communities. In Kishapu, those who do not have land would rent from those who do. Others can acquire land by buying from those who are selling especially if they are moving away from the village or from the village government when they are allocated. In both areas, the village government solves land or any other disputes if hamlet leaders cannot solve them. In Mvomero, land is obtained by request from the village government. Most land is occupied. Most of those who do have land had inherited it. Most farms are located away from the household unlike in Kishpau where some people permanently live in their farms. Many households in Mvomero rent their farmlands rather than owning them, very few do own their land.

In both Lubaga and Mwakipoya villages, land acquisition for the youth has changed, those who have not inherited would mainly rent from others who have large lands or otherwise from those who are in need and want to sell or those who are moving away. Very few people do sell land. Livestock keeping is challenged by pasture availability because livestock keepers need large land areas. Production of local beer and selling food crops affects the availability of food in the area. In Mvomero, on the other hand, land is obtained through leasing and buying from those who do have land. The youth would also inherit land and most farmland is located away from the village. There are some conflicts between crop producers and pastoralists, but not very serious. The conflicts are resolved before it is too late; otherwise they have to go to the authorities.

Land in both villages of Mvomeoro is obtained through leasing and buying from those who do have land. The youth would also inherit land and most farmland is located away from the village. There are some conflicts between crop producers and pastoralists, but not very serious. The conflicts are resolved before it is too late; otherwise they have to go to the authorities.

In Milama conflicts are mainly on issues such as land, there are some large areas of land that have been rented to external investors, but some of them do not do anything on those farms while the villagers are in need of land. Moreover, livestock keepers sometimes graze their animals through the farms even when harvesting is incomplete. The village council is mandated to resolve such conflicts. Land is usually accessed through inheritance. Others would buy or rent land from other farmers, and there are those who buy from the village government.

Mainly Land causes conflict in the village between pastoralists and crop farmers. Pastoralists would graze before harvesting is complete. In the past, there were some cases that resulted to fatalities. However, in many cases the village government will try to resolve before it goes too far. Like in the other villages, land acquisition in Makuyu is through inheritance, renting or buying from other farmers or the village government. The village land-use plan has allocated an area of land for pasture, even though sometimes, the plan is not adhered to.

3.5.6.3 Agricultural Extension Services and Inputs

Villagers in focus group discussions and key informant interviews revealed that they do have some access to agricultural extension services from the ward agricultural officer, but because he operates in a large area, accessing his services is sometimes difficult. Farm implements are available for sale in the district area, but credit services are from own initiatives – borrowing from neighbours. There are informal moneylenders in the area, but they charge very high interest rates. When the villagers have no other option, they would borrow from them regardless for the interest that may go as high as 100%. Agricultural extension services are also available in Mvomero but like in Kishapu, there is one officer serving a large area, hence availability is difficult.

Agricultural extension advise in both districts and villages is given trough the village meetings or groups, where the officer is invited to speak with the villagers especially close to the farm preparation period or when there is a breakout of livestock diseases. On the other hand, in Mvomero, sometimes there are those who receive input vouchers from the government, they contribute some amount because the inputs are subsidised. Marketing for the crops is a big challenge, the middlemen pay very little and there is nothing most farmers can do about it. Agricultural advice is through the ward agricultural extension officer and farmer groups. With respect to credit, farmers have VICOBA and SACCOS groups that help them in time of need. Only a few farmers would opt to access loans from informal moneylenders who charge quite high interest rates. The local money lenders usually loan out to farmers during farm preparation and planting season when farmers are in need of inputs, they usually collect around harvesting time. All agricultural extension officers identified transport as the main challenge in reaching their farmers.

In both districts farm inputs are mostly bought from stores dealing with farm inputs. Most of these stores are privately owned and prices are sometimes high. Three input traders were interviewed in Mhunze, the district centre for Kishapu, since they serve both study villages. During their interviews, they all pointed out that they sold seeds mainly maize, sesame and sorghum seeds and the pesticides to spray on crops. Some farmers would buy fertilisers but not to a large extent and others also frequently buy vegetable seeds such as tomatoes and cabbage. For livestock keepers also, farmers bought medication for washing and treatment of their livestock that were advised by the agricultural officers. Prices of these farm inputs vary according to the prices they also obtain from the wholesalers. Price fluctuations are bad for their business, but they do not have any control over them. There were times that they received bad seeds that failed to germinate, they would recall then as soon as the problem is realised.

With farm input suppliers in Mvomero, the most common inputs sold were fertilisers, pesticides, seeds (maize, *s*orghum and vegetable seeds), and livestock medicines. They face challenges such as receiving expired products from their suppliers, lack of demand of the non-famous brands, improper use of the inputs which may yield unfavourable results and in turn farmers would blame the sellers. Also, they receive goods at high price, their selling price also has to be high and farmers can barely

afford them. Agriculture extension officers do not communicate much the needs of the farmers; it would have helped to supply what is needed if they did. The suppliers do advise farmers on what to use and how to use the products. Another supplier reported to sell similar inputs (fertilisers, seeds, pesticides and livestock medicines). However, most farmers do not use herbicides and the use of improved seeds is slightly catching pace. The farmers do not follow proper use of inputs. They are normally advised on how to use them. Price is a big problem when the wholesalers increase the price and the farmers cannot afford. Agriculture extension officers should work closely with the input suppliers to improve farming in the area.

Moreover, in Dakawa, a similar situation is observed in input selling. Seeds, fertilisers, livestock medicines and pesticides/herbicides/fungicides were sold. There is sometimes low customer demand, which makes them incur losses when goods expire in their stores. Multiplicity of government levies also challenges the business as they are forced to increase price, and high prices also chases away their customers. Farmers have poor knowledge about the proper use of some inputs; and if they do not get good results, they start complaining that the inputs were fake. Farmers also, usually prefer the brand names they are used to, even when told that there is a similar product, they would not buy, and this reduces sales. Input sellers also give input advise to the farmers on how to use them properly.

3.5.7 Saving, Loans and Social Capital

Very few people in both districts have savings accounts; only 3.1% in Kishapu and 2.8% in Mvomero as presented in Figure 3-5. Most saving took the form of buying livestock, keeping the money hidden in the house or buying food stocks. Respondents indicated that they saved money for emergencies and for future basic food and non-food needs of the households.

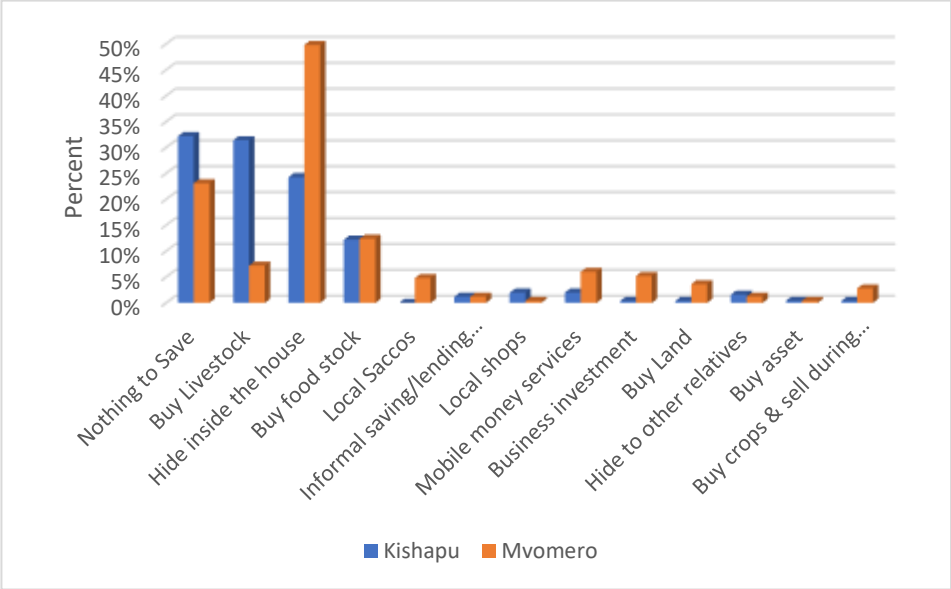


Figure 3-5: Other Means of Saving

Source: Household Survey Data

Moreover, only 3.9% and 9.2% households in Kishapu and Mvomero had taken a loan in the past 12 months and most accessed loans from friends or family and informal moneylenders in their communities. The purposes of loans ranged from medical treatment, farming, to buying for basic needs. Other respondents did not take any loans because of a fear of not being able to pay back and the high interest rate they are charged by the informal moneylenders. From key informant interviews, it was revealed that in both villages in Kishapu, whenever a farmer sells their produce, they would buy livestock in order to save and sometimes they buy rice or just keep the money in the home. Livestock buying is the main method of saving after earning cash from crop farming, or sometimes keep in the home. Saving practices in Mvomero involve buying of assets and farm implements, not much in banks.

In Kishapu credit services are not easily available in the area, there was a time when micro-loans were given trough small groups facilitated by OXFAM International. Some of the groups still exist but others are not functioning. Most of the members in the groups are women and apart from saving and borrowing, they are also involved in farming of sisal or vegetables. Another group was facilitated by Tanzania Social Action Fund (TASAF) and is keeping goats. Due to scarcity of credit services, those in need would usually borrow from the informal moneylenders especially during farm

preparation and refund with large interest during harvesting. Proceeds are usually kept at home or buying livestock, there are very few people with a bank account at Shinyanga; it is a long distance to operate the accounts there.

Many, household heads and other members in Kishapu and Mvomero do not belong to any groups in the community as in Table 3-7. The groups identified by those who do participate in them were either farmers' associations, Savings and Credit Co-Operative Society. (SACCOS), youth groups or women's groups.

Table 3-7: Group Membership

GROUP MEMBERSHIP	KISHAPU	MVOMERO
Any household member belongs to any group in society	8.6%	24.4%
Any household member is a leader in group	45.5%	24.6%

Source: Household Survey Data

3.5.8 Household Gender Issues

Apart from gender differences in land ownership, fetching water and sources of income, there are also differences in decision making within the households. For example, either male or female or both in nearly equal percentages make decisions on the use of incomes from self-employment. But males in Kishapu and both males and females in Mvomero make decisions about the use of income from salaries. Deciding on the use of incomes from other sources largely depends on who earns the income. In cases where decisions were made by both husband and wife, wives indicated to be able to share decision making on how to use income.

Regarding gender differences on decisions about the types of crops and livestock kept, decision-making was shared in many cases, except for cotton and cows where males in both districts largely made decisions. In taking loans and the use of money from loans, decision-making leaned towards male heads of households except for Savings and Credit Co-Operative Societies (SACCOS) where the decision-making was evenly distributed between males, females and together in both districts.

Decisions to purchase farm equipment and the spending of cash from sale of crops in Kishapu are made primarily by males while in Mvomero both decide. The decision

about the type and the amount of foods to feed the family rested with women in both districts.

Moreover, when asked how satisfied women were with time off from household work, the responses showed neutrality and satisfaction. Very few indicated they were very dissatisfied (Figure 3-6).

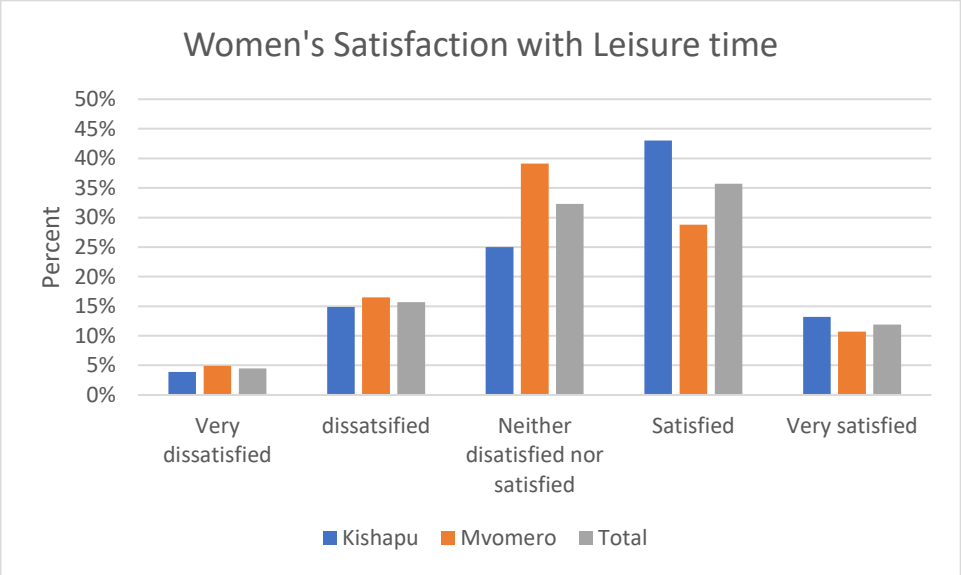


Figure 3-6: Women's Satisfaction with Leisure Time

Source: Household Survey Data

3.5.9 Study Area Price Trends

Data obtained from the monthly market price survey showed variations in prices from one month to another and some differences from one area to another. Mhunze market served the whole of Kishapu District; it is a large market in the area and even traders from areas other than the region visit the weekly market to trade goods. There were two markets serving the Mvomero District, Dakawa and Mvomero Market, residents in Mvomero District would use either of the two markets for buying and selling. Figures below present the trend of prices between January and December 2014.

For most food items, prices of the locally produced showed a much higher variation between months and especially between the lean and plenty seasons. For example, the prices of maize, rice, sorghum and sweet potatoes varied considerable across time and

were lowest in the plentiful months of May to August in Kishapu and July to November in Mvomero as in Figure 3-7 below.

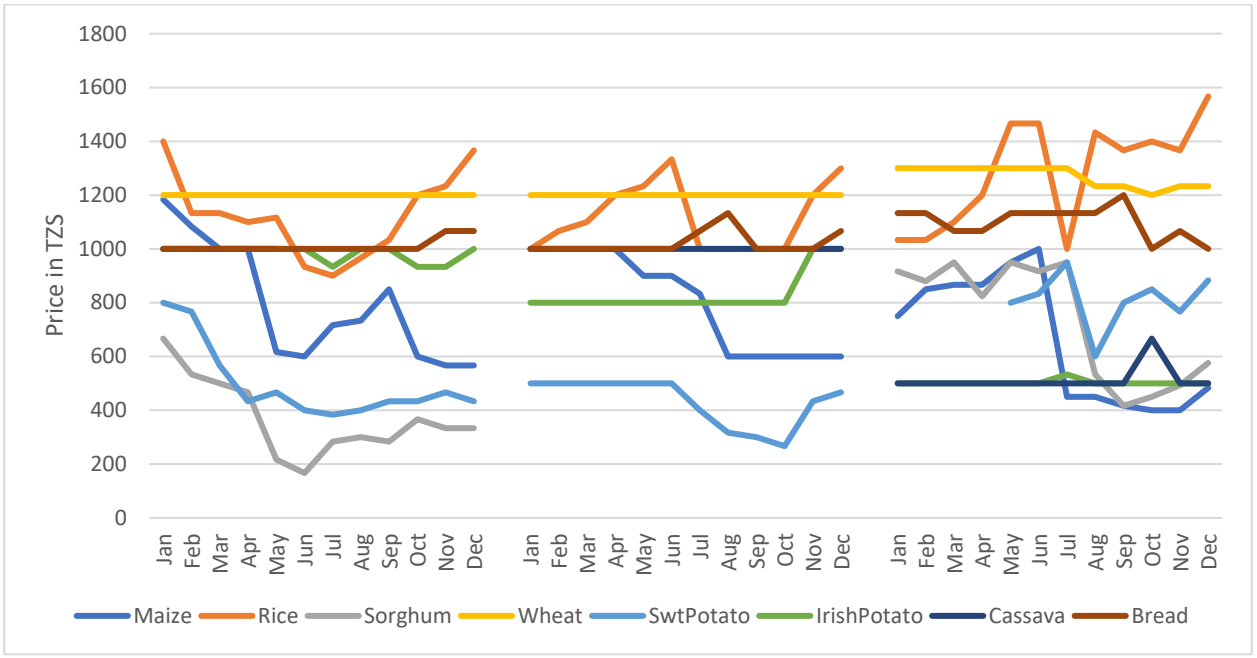


Figure 3-7: Grain and Roots/Tubers Prices in Mhunze, Dakawa and Mvomero Markets

Animal products also showed much variation in the different months except for milk and eggs that were more or less the same price. For example, the prices of a large chicken and small chicken were highest between November and March while one kilogram of beef, goat meat and mutton did not vary much as in Figure 3-8.

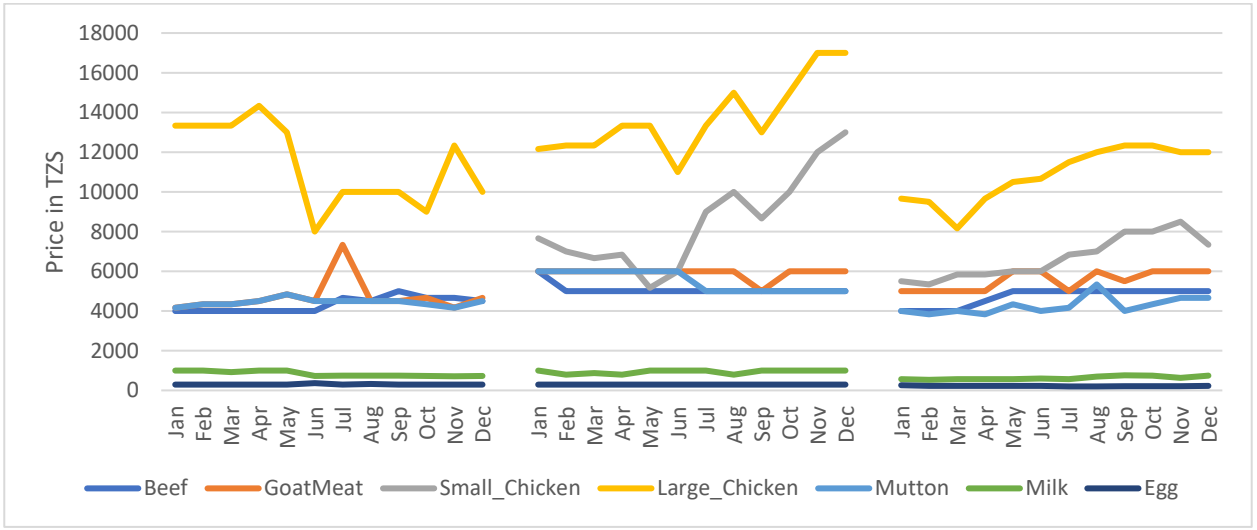


Figure 3-8: Prices of Animal Products in Mhunze, Dakawa and Mvomero Markets

Fruits and vegetables that were largely farmed and available in the local markets were cheaper especially in the rainy months of November to February and March, whereas bananas not at all grown in Mhunze and Mvomero and Onions not grown in Mhunze and Dakawa had constant prices throughout the year (Figure 3-9).

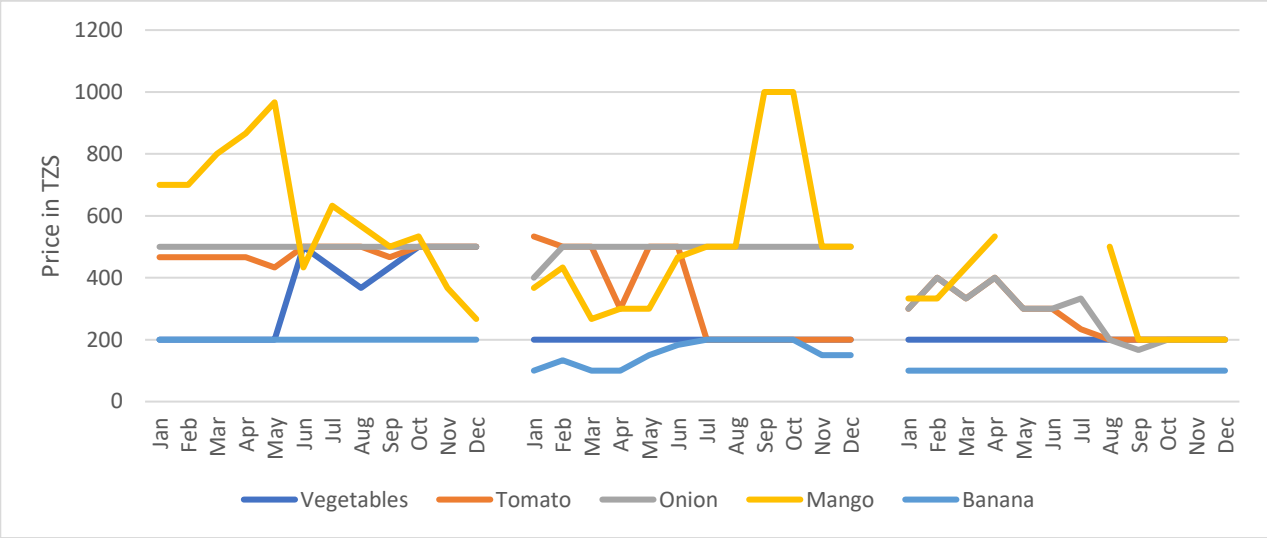


Figure 3-9: Prices of Fruits and Vegetables in Mhunze, Dakawa and Mvomero Markets

Animals in the three markets were sold at relatively similar prices as shown in Figure 3-10 below. Goats and sheep had more or less the same prices in all markets. Prices of most animals were lower in the rainy season as this was the lean season and households would sell some of their livestock in order to satisfy some of their household needs. Since they have little to no alternative incomes, they are forced to accept lower selling prices.

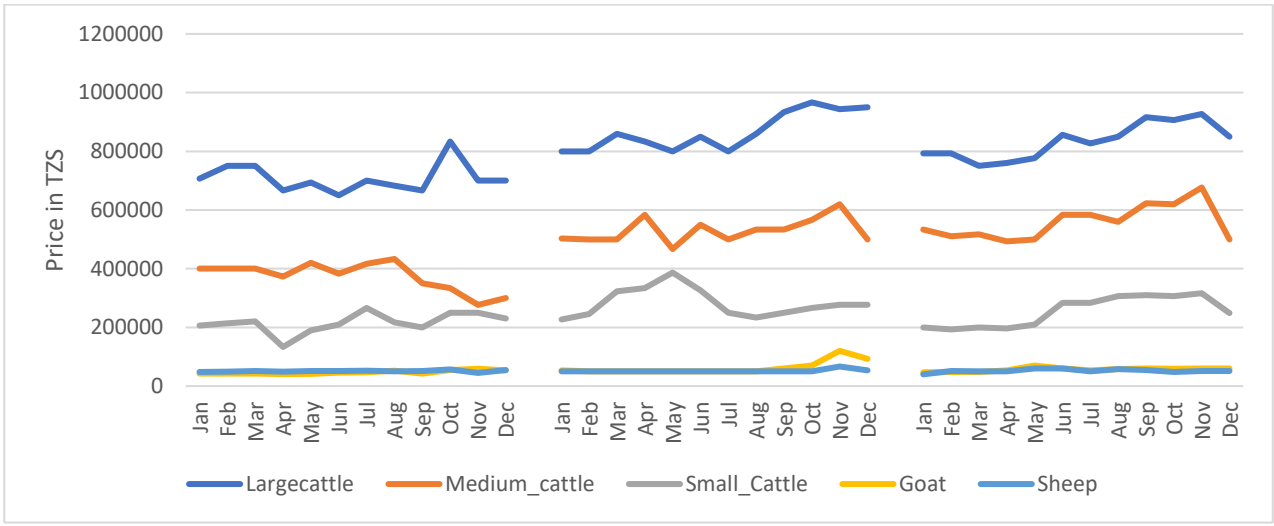


Figure 3-10: Livestock Selling Prices in Mhunze, Dakawa and Mvomero Markets

Figure 3-11 presents the prices for non-food items that are regularly consumed in the households. The trend between January to December shows that a bag of charcoal has more variations in all markets. On the other hand, fuel wood that is popularly used as a source of energy in cooking is more expensive in Dakawa market and is least expensive in Mhunze. There is little to no variations in the prices of a bar of soap, powdered soap and petroleum jelly as these are not locally produced and suppliers regulate their prices.

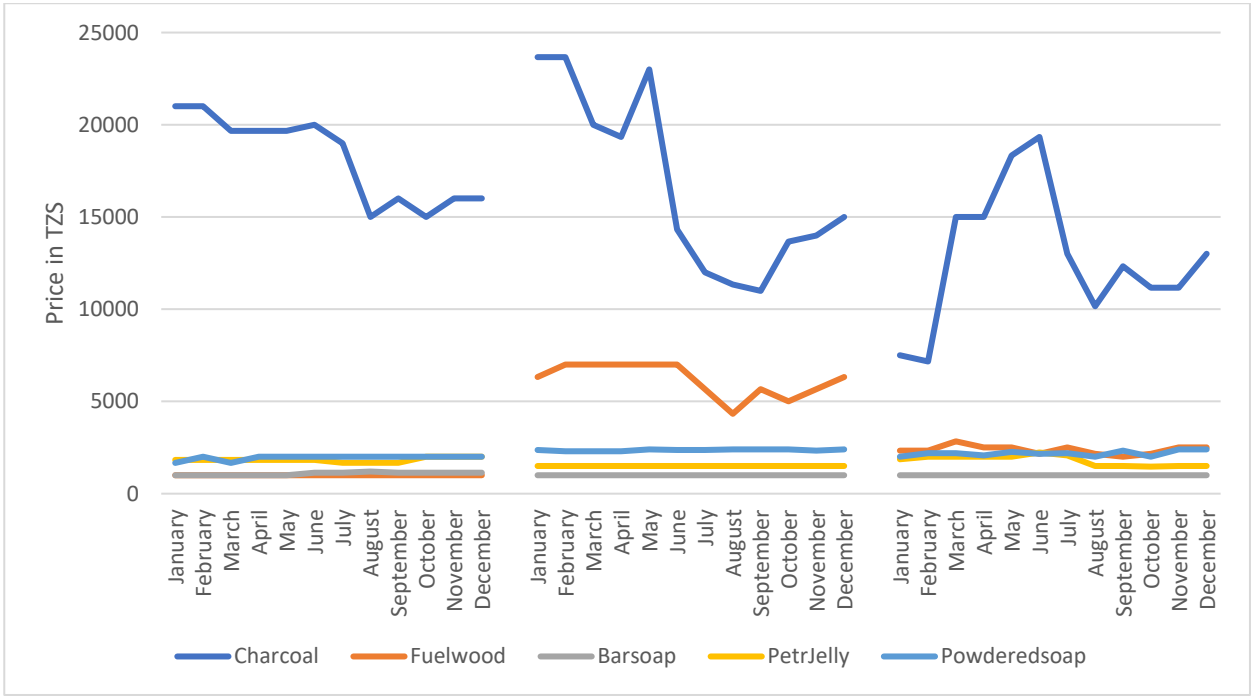


Figure 3-11: Non-Food Prices for Mhunze, Dakawa and Mvomero Markets

Figure 3-12 presents prices of other products such as cooking oil, beans and groundnuts which showed an increasing trend towards ad during the lean season while tea, local salt and packaged salt had little to no variations between months and sugar has some variations independent of the seasons since it is not locally produced and prices of these items are sometimes regulated.

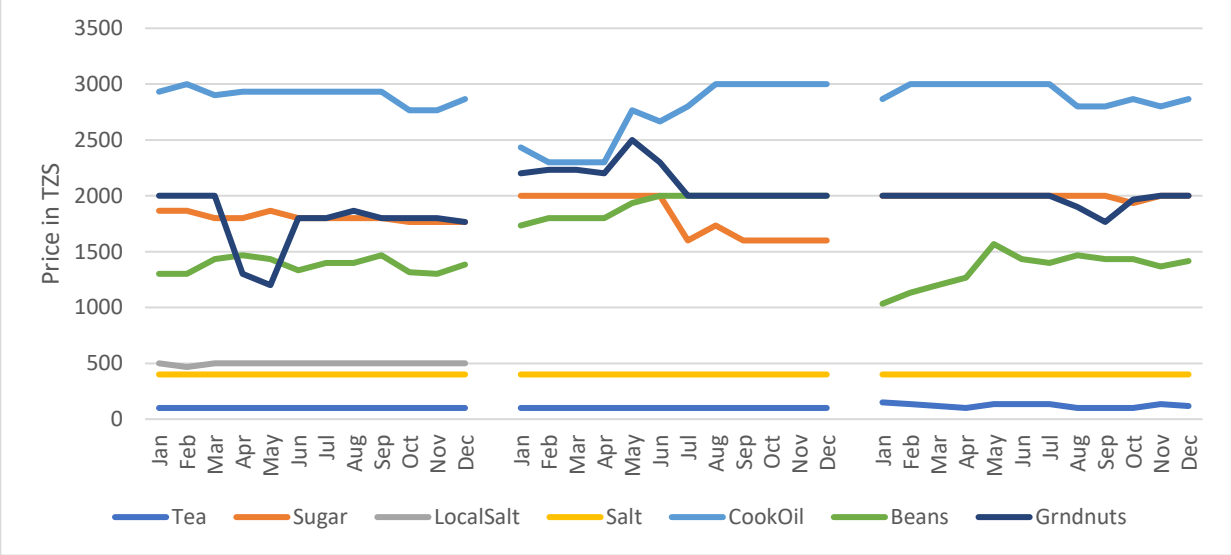


Figure 3-12: Prices of Other Food Items

3.6 Summary

This chapter has described the study area and overall household characteristics and observed from the Household Survey and Market Price Survey data. The key characteristics discussed are the general characteristics of gender, marital status, education and age of household members. Moreover, household socio-economic characteristics of housing, water and sanitation, energy sources, asset ownership, savings, social capital and household gender issues were outlined. While the characteristics presented in this chapter are simple descriptive, it is worthwhile to construct profiles of the study and illustrate the differences between them, as they will serve to understand some of the differences observed in the next chapters. The two chapters that follow are findings chapters in the form of journal articles describing low-income farm households' access to foods and markets and the effect of cost of diet on foods eaten in the study areas.

4.0 LOW INCOME FARM HOUSEHOLDS' ACCESS TO MARKETS AND HOUSEHOLD FOOD SECURITY: THE CASE OF TWO ECONOMICALLY DISTINCT AREAS IN RURAL TANZANIA

Abstract

More than 70 percent of Tanzanians live in rural areas and close to 90 percent of them practice agriculture. Kishapu and Mvomero Districts are highly food insecure, nutritionally vulnerable, lack nutritional interventions and differ in rain patterns, farming practices and economic activities. This study sets out to examine how market access influences the food security status of low-income farm households in rural Tanzania. Both qualitative and quantitative data were collected in 2014: quantitative data comprised structured questionnaires in two phases of household surveys (before and after harvest) and monthly market price surveys. Qualitative data comprised key informant interviews and focus group discussion. SPSS was used to code, clean and analyse the quantitative data while qualitative data was transcribed, coded and organised into themes. Mvomero exhibited significantly better household incomes, food security and market accessibility than Kishapu. Binomial regression was performed on household food security determining variables, which were categorised into food, secure and food insecure, variables in the models explained more than 60 percent of variations in the dependent variables. Results indicated statistical significance in the pre-harvest season such that households close to the market, owning bicycles, in higher income quartiles and with smaller household size were less likely to be food insecure than their counterparts. Post-harvest regressions showed no statistical significance except for the prevalence category of household food insecurity where market access did not have any statistical significance but ownership of a bicycle and having more off-farm income meant households were less likely to go into food insecurity access prevalence. Addressing rural food security issues should consider the differences within the contexts of rural areas. Policies to support the improvement and diversification of farm and off farm incomes and increasing farm output have important implications for low-income farm households. Such initiatives could include improvements in transport infrastructure and access to credit, both of

which would support markets access, augment farm production and improve off-farm income. However, such policies and strategies would be more robust with more tests.

Key words: Markets Access, Food Security, Rural Tanzania, Food Economies

4.1 Introduction

Agriculture plays an important role in the Tanzanian economy, employing about 66 percent of total employed population[1]. About 90 percent of rural Tanzanians are farmers[2] that depend on subsistence agriculture[3] with limited access to both input and output markets[4,5]. The sector has the lowest mean monthly income with very high levels of underemployment[1]. In 2012 the lowest 20 percent of the population earned only 7 percent of national income share[6] and about 44 percent of Tanzanians lived below the international poverty line. More than 9.7 percent of Tanzanians lived in food poverty[7] with majority being in rural areas.

The market provides farm households with access to food and inputs and a means to dispose of their farm outputs. The more remote and underdeveloped the market is, the more difficult it is for farm households to access it[8]. Rural markets of Tanzania are difficult to reach and mostly controlled by middlemen[9] who are willing to take risks and costs of travelling rural roads. Market accessibility influences food security[10–12]. Middlemen control prices, leaving farmers with no choice but to accept selling prices[13,14]; otherwise, they would be left with produce that might get destroyed with time. Even though cereals and legumes, keep longer than perishable crops such as fruits and vegetables, lack of proper storage facilities leave households vulnerable. During wet planting seasons when there is no more food grains left in storage, prices of farm produce are high and farmers are most in need of money and food, however this is also the time they have little to sell, hence, even though selling price is favourable, it does not contribute much in terms of income as most of their product is depleted. During harvest seasons, prices are lower due to high supply and farmers sell raw produce at low price because they lack means to process their output and sell at better price.

The key issue addressed in this paper is how market access and incomes impact on rural households' food security in Tanzania. Entry barriers associated with location and unequal access to non-farm activities, such as small-scale entrepreneurship, small-scale mining and irrigation agriculture, lead to income inequalities between households[15]. Non-farm income reduced income

inequality and improved household welfare indicators[16,17]. Moreover, there is a significant link between income, poverty and incidence of food insecurity[18–20]. Low-income earners were especially food insecure and mostly reside in rural areas[21]. Additionally, seasons play a significant role in determining food security of agriculture-dependent households and towards end of lean seasons, diets are more diverse[22].

Knowledge about these issues is important because rural households depend on agriculture for their livelihoods[2,7], have low incomes and little market access. Therefore, by analysing market access, incomes and food security it is possible to inform households about the best way to achieve better results in daily practices of production, distribution and consumption of food for nutritional benefits. This can also assist policymakers to identify key areas within rural markets that need to be addressed to ensure better operation of rural markets and better financial and nutritional outcomes.

Malnutrition in Tanzania is prominent among majority of rural populace. If this problem is not solved, rural households will continue with practices that are not beneficial to them nutritionally and financially[23]. There is more to be learned about rural food economy and linkages to food security and it is important to distinguish among different rural economies because they vary in many aspects.

The main focus of this paper was to examine linkages between market access, household income and household food security in rural Tanzania with reference to two economically-distinct districts; Kishapu District is more distant from roads and is more dependent on farm income; also, cotton is the main cash crop, Mvomero District on has close proximity to roads, with more off-farm activities such as small-scale entrepreneurship; cash crops are maize and rice. Specifically, the objectives were to analyse income distribution within different farming systems in the study areas; to identify main channels for buying and selling food and challenges faced; and to analyse their linkage with household food security during pre- and post-harvest seasons.

4.2 Materials and Methods

4.2.1 Study Area and Sample

The research was conducted in two economically-distinct districts in rural Tanzania: Kishapu District in Shinyanga Region with about 48,258 (99.4%) agricultural households[24] and Mvomero District in Morogoro Region with about 56,520 (98%) agricultural households[25]; selected based on high criteria below.

Morogoro and Shinyanga were among regions with highest nutritional vulnerability having above national average (42%) stunting[26]. Levels of chronic under-nutrition in Morogoro and Shinyanga were 44.4% and 43.3% respectively[27]. In 2012, Shinyanga had high food deficit; most of its districts were vulnerable and Morogoro was food self-sufficient with two vulnerable districts, Morogoro Rural and Mvomero[27].

A multi-stage clustered sample survey was done in two purposely selected districts of Tanzania, Kishapu and Mvomero because of their food insecurity, nutritionally vulnerability, lack nutritional interventions, and differences in rain patterns, farming practices and economic activities (Stage 1). Within each district, one ward was randomly selected (stage 2) from which two villages were also randomly selected (stage 3), namely Lubaga and Mwakipoya villages from Kishapu and Makuyu and Milama villages from Mvomero. Ethical approval was sought from St Augustine University of Tanzania and University College Dublin and permission to conduct research from relevant administrative offices in the respective regions and districts. Sample size was calculated using the formula $n_0 = \frac{Z^2 pq}{e^2}$; where Z = the abscissa of the normal curve that cuts off an area α at the tails (1 – α equals the desired confidence level, e.g., 95%), p = the estimated proportion of an attribute that is present in the population (levels of chronic under nutrition for this case; 44.4% for Kishapu and 43.3% for Mvomero), q = 1-p and e = the desired level of precision (=0.06 i.e. 94% precision). The sample for Kishapu was 263 and for Mvomero was 262 making a total of 525 households. A list of all households and members was collected from respective village officials and after random sampling; pre-harvest data collection comprised 554 households (277 from each district). However, dropout rate of

8.8% in post-harvest survey enabled data collection from a total of 506 households, of which 255 households were in Kishapu and 251 households in Mvomero. Before beginning interviews, respondents were briefed of the study and verbal consent was sought.

Aim and Research questions

The aim of this study was to examine linkages that exist between market access, household income and household food security in rural Tanzania and specific objectives were: to analyse income distribution within different farming systems in study areas; to identify the main channels used by households for buying and selling food and challenges they faced; and to analyse the linkage between incomes, seasons and market access with household food security. The following research questions were answered:

i. How are incomes distributed within farming systems existing in Kishapu and Mvomero?
ii. What channels do households use to access markets to buy food or sell their produce?
iii. Do seasons influence food security status of households?
iv. Do household incomes affect food security status?
v. Do households' market access affect their food security status?

4.2.2 Data Collection

The data was collected as part of AgriDiet project, which aimed at understanding links between agriculture and nutrition in Ethiopia and Tanzania. Data collection comprised of both qualitative and quantitative data in the year 2014. Qualitative data comprised focus group discussions and key informant interviews while quantitative data was collected by monthly market price surveys and structured questionnaires in two phases of a household survey.

4.2.3 Data Analysis

SPSS was used to code, clean and analyse quantitative data while qualitative data was transcribed, coded and organised into themes. Specifically, for

household incomes, farming systems, food security and market access, the following approaches were used:

4.2.3.1 Household Income Determination

Income and economic activities data from household surveys through respondents' recollections provided information on annual household farm and non-farm income in the year prior the interview (2013). A distribution of net annual household incomes was run in SPSS generating four equal cut-off points (Income Quartiles) of sampled households, the following income ranges were obtained: EUR 0 – 330.35 for poorest households; EUR 330.35 – 665.57 for lower-middle income earners; EUR 665.57 – 1397.46 for upper-middle income earners and the wealthiest received more than EUR 1397.46.

4.2.3.2 Farming Systems Determination

Farming systems were determined based on types of crops cultivated, amount of land devoted to a certain crop – cash/food, marketing of crops and number of livestock units owned by households. If a household cultivated one crop in 70 percent or more of all its land, it was considered dependent on that particular crop. A Household Commercialisation Index (HCI) calculated the ratio of output that was sold and ranged from 0 to 1. A crop with HCI greater than 0.5 was considered a cash crop and below 0.5 it was considered a food crop with 1 indicating a completely commercialised/cash crop[28]. For each household, an average HCI was calculated over the range of crops cultivated. Tropical livestock Units (TLU) were used to decide whether households were livestock oriented or not. One TLU is equivalent to one mature cow weighing 250kg in Sub-Saharan Africa[29].

If a household allocated 70 percent or more of its total cultivated land in 2013 to one crop and that crop had HCI of 0.5 or less, it was considered as practicing Single Food Crop (SFC). A household was categorised as practicing Multiple Food Crops (MFC) if more than 70 percent of its farmland was devoted to more than one food crop and had an HCI of less than 0.5 for each crop. A household qualified as practicing Cash Crop (CC) if more than 70 percent of total

cultivated land was allocated to crops with HCI of more than 0.5. Mixed Crop-Livestock (MCL) contained households that practiced crop cultivation and possessed more than 7.3TLUs (7.3TLUs is the average number of livestock units in the study area generated from collected household farming data).

4.2.3.3 Market Access Determination

In this study, the distance (in minutes) travelled by respondents to or from the common market they use to buy and/sell items is used as a proxy for market access. Other measures of market access such as Rural Access Index (RAI), which estimates the proportion of rural population who live within 2 km of an all-season road, could not be adopted in this study because current indices are not specific to the villages data was collected and current data does not have enough information to formulate a Rural Access Index or an alternative index. From the data, average distance of surveyed households to common output market was 61 minutes in Kishapu and 26 minutes in Mvomero. Binomial logistic regressions were run between Household Dietary Diversity Scores (HDDS), Household Food Insecurity (Access) Scale and Prevalence (HFIAS and HFIAP respectively) as dependent variables and predictor variables were log of market distance in minutes, off-farm and farm income per capita, ownership of bicycle and mobile phone as predictor variables which were statistically significant ($p<0.05$) in explaining the dependent variable. Other variables such as level of education, sex of household head, age, household size, income quartile and farming systems were not statistically significant in explaining the dependent variables.

4.2.3.4 Household Food Security Status

Food security was measured separately in two ways, first using Household Food Insecurity (Access) Scale (HFIAS) and Household Dietary Diversity Scores (HDDS). HFIAS measures the access component of food security at household level[30]. A set of nine questions measured feelings of anxiety, feelings of insufficiency of quality food and feelings of insufficiency of food intake in the household within 30 days prior interview. If respondents answered affirmatively to a higher number of questions, it indicates the household had a more severe

level of food insecurity (access). HDDS measured the extent to which a household had access to more diverse diets[31]. Twelve food groups were used and the lower the HDDS, the less the dietary diversity.

4.2.3.5 Statistical tests

All statistical tests were conducted at 5 percent significance level (Confidence 95 percent). To investigate whether seasons influence food security status of households, a paired sample *t*-Test was performed on Household Dietary Diversity Score (HDDS), Household Food Insecurity (Access) Scale (HFIAS) and Household Food Insecurity (Access) Prevalence (HFIAP) grouped by seasons. To test whether household food security status does not depend on household income, an analysis of variance was performed on HFIAS and HFIAP variables to determine if there was a statistically significant difference between means of these variables according to income quartiles and districts. Moreover, to test whether market access has any influence on food security status, the market access variable above was regressed against HFIAS, HDDS and HFIAP variables in binomial regressions where dependent variables were transformed into binary dummy variables indicating food secure and food insecure.

4.3 Results and Discussion

4.3.1 Household Profile

There were observable differences in household characteristics between Kishapu and Mvomero as outlined in Table 4-1 where on average Kishapu households were larger and their heads older than those in Mvomero. Moreover, in both districts, more than 50 percent of household members were dependants and the percentage of adults earning off-farm incomes was low.

4.3.2 Household Economics Activities, Incomes and Food Security

4.3.2.1 Household Economic Activities

In both districts, farming comprised more than 95 percent of all economic activity and earned more than 60 percent of their total annual income with little non-farm activity. However, non-farm economic activities contributed more to

household income in Mvomero than in Kishapu. In Kishapu more than 45 percent of sampled households did not have any other source of income apart from agriculture and earned more than 80 percent of household income from it; while in Mvomero, more than 45 percent engaged in one extra economic activity other than farming which contributed only 44 percent of all household income. Table 4-2 shows practiced economic activities in the areas.

As shown in Figure 4-1, households practicing Single Food Crop (SFC) farming were poorer than all other households while those practicing Mixed Crop Livestock (MCL) were better off than all other households. This was because in both study districts, middlemen had more control of the market for crops and fluctuations in crop prices left households vulnerable and crop-only agriculture less profitable. Likewise, livestock was used as a means of saving and at times of need they would sell.

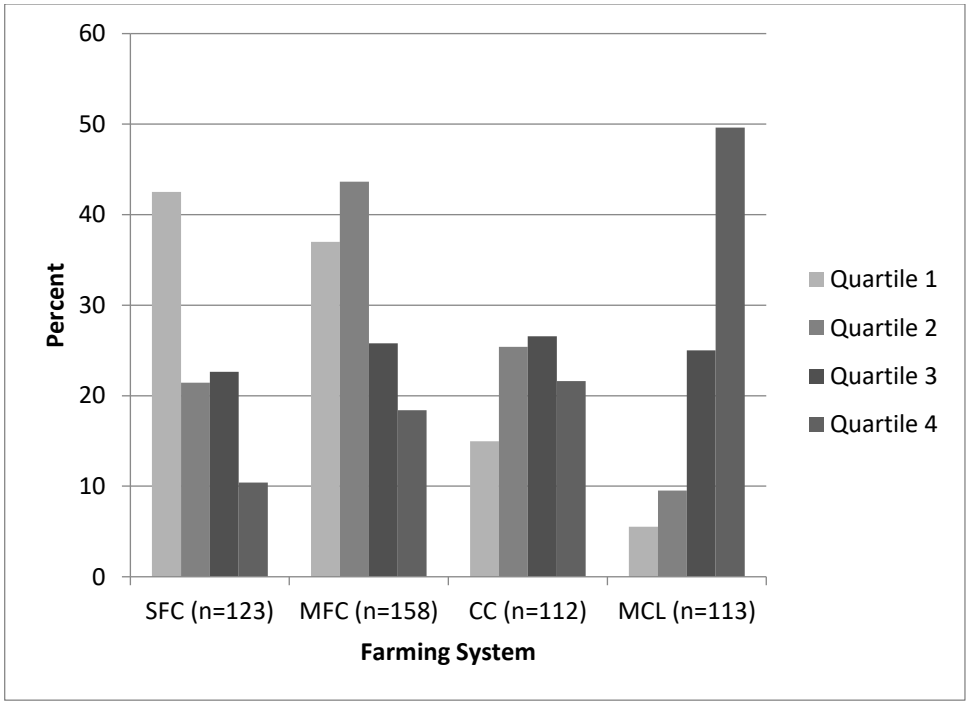
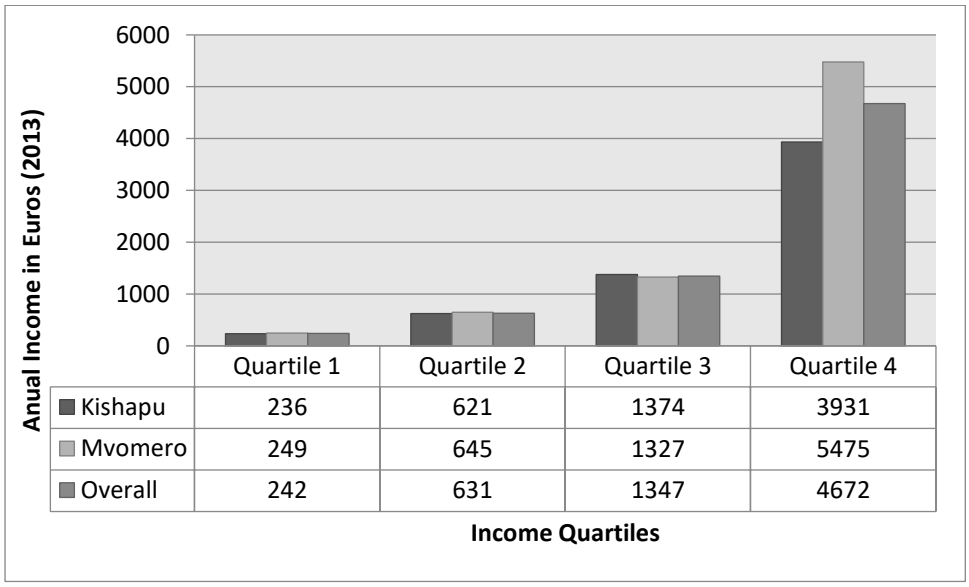


Figure 4-1: Percent of Households Practicing a Farming System

4.3.2.2 Household Income and Income Distribution

The study finds that incomes were not equally distributed in either study area. The Gini coefficients were 0.62 and 0.63 for Kishapu and Mvomero

respectively, indicating a high level of income inequality. Those in Income Quartile 4 received an income about ten times more than that received by Income Quartile 1 and about three times more than the income received by households in Income Quartile 3 (Figure 4-2).



	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Kishapu	236	621	1374	3931
Mvomero	249	645	1327	5475
Overall	242	631	1347	4672

Figure 4-2: Income Levels Categorised by Income Quartiles

Figure 4-3 shows that for each farming system households in Mvomero earned about twice or more than those in Kishapu.

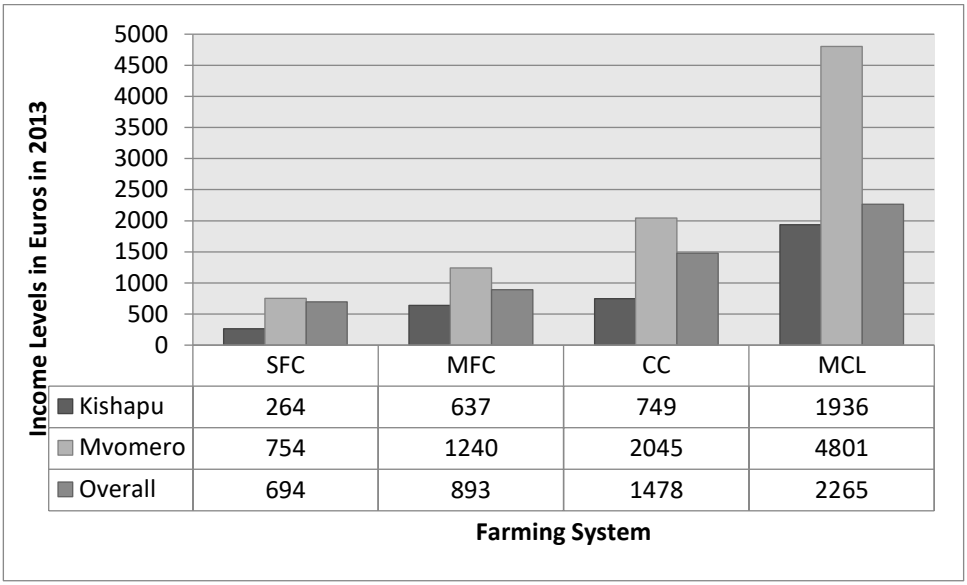


Figure 4-3: Income Levels by Farming System

There were at least three months in Kishapu and at least two months in Mvomero where households had no income coming into the household; these were the same months households faced food shortage.

4.3.2.3 Household Food Security

Household Dietary Diversity Scores (HDDS) were calculated from 12 food groups to measure the extent to which a household has access to more diverse diets as shown in Figure 4-4. The scores range from 0 to 12 and the higher the score the more dietary diversity existed. In both study districts, households consumed about four to six food groups per day. Diets were more diverse in Mvomero than in Kishapu for both seasons, and more diverse in post-harvest than pre-harvest for both areas. In Kishapu, there was an improvement in the diversity of diets from pre-harvest to post-harvest period in all income quartiles. The reason for this was that, in post-harvest households had more food in stock and more income to spend buying other foods. However, in Mvomero, diets were more diverse during pre-harvest compared to post-harvest period because many households had off-farm income, which was not as seasonal as farm income; they could buy a variety of foods in pre-harvest season, but during post-harvest season, even though they had more income, they may have chosen to consume what they had harvested rather than spending their money on buying

foods. Even though there was an improvement in post-harvest diets in Kishapu, households were still no better-off than in Mvomero in pre-harvest because of the nature of rains, types of foods produced and market situation in Kishapu.

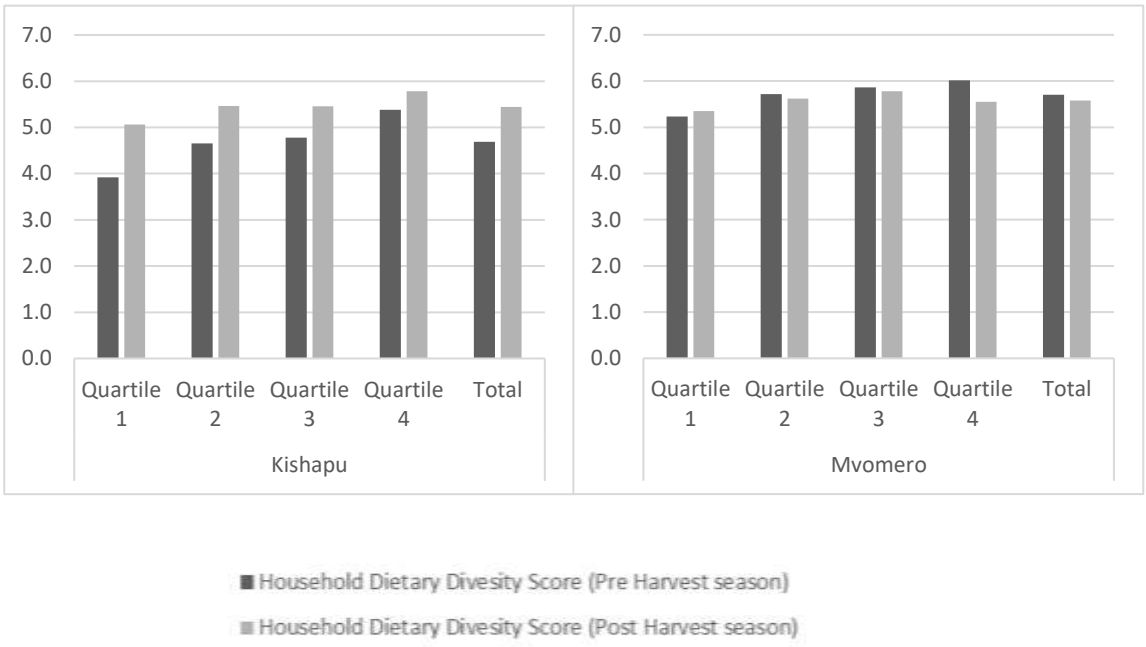


Figure 4-4: Mean Household Dietary Diversity Scores

In both districts, participants in Focus Group Discussions confirmed that their diets were monotonous especially in lean season, others went further to explain they were unable to eat anything the whole day particularly in Kishapu. The self-reported number of months in which households experienced food shortages showed a significant negative statistical correlation (p=0.01) with HDD indicating that when households faced food shortages they consumed less diverse diets.

Results of paired sample *t*-Test for Household Dietary Diversity Scores (HDDS) in pre-harvest and post-harvest periods are presented in Table 4-3. The average difference of mean HDD-Scores in pre- and post-harvest periods for overall sample and for Kishapu are significantly different from zero (p=0.000). This signifies that there was a significant improvement in diet diversity for Kishapu and for overall sample, while results for Mvomero suggest that there was no significant improvement of diets (p=0.203). The seasonal nature of food

insecurity in rural areas suggests that households are very much dependent on what they produce to sustain their dietary needs.

Figure 4-5 presents results for Household Food Insecurity Access Scale Score (HFIAS) as linked to income quartiles. HFIAS measures the access component of food security and a higher score means higher food insecurity (access).

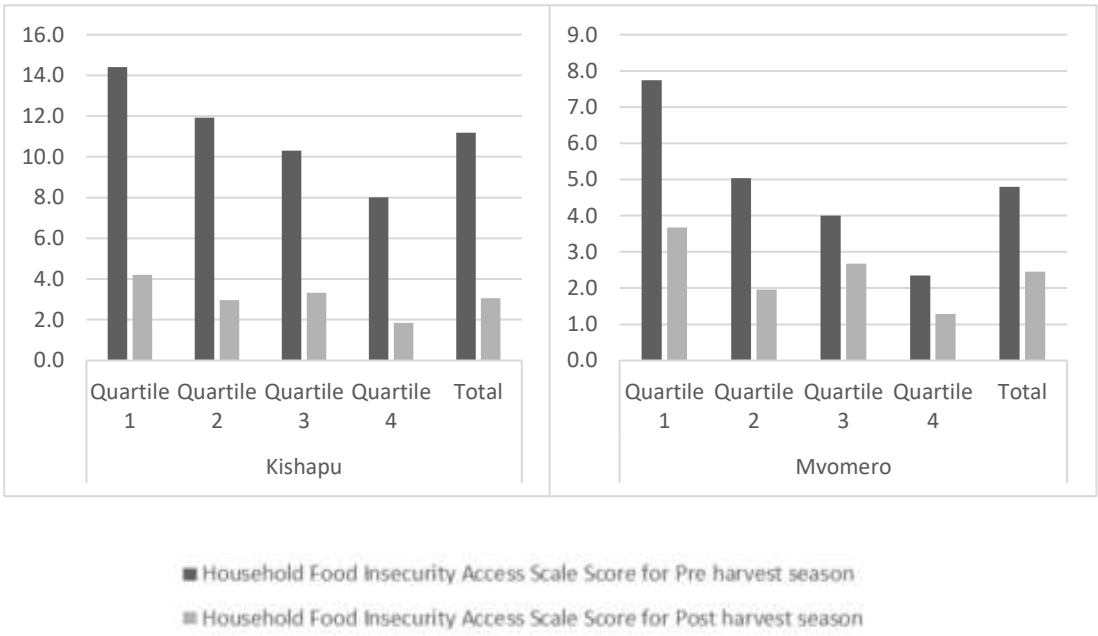


Figure 4-5: Household Food Insecurity Access Scale Scores

For all income groups, households in Kishapu had more food insecurity than Mvomero and poorer households experienced higher food insecurity.

Food insecurity status was significantly different between income quartiles in both seasons (p=0.000) and between Kishapu and Mvomero during pre-harvest season (p=0.000) with Mvomero faring better than Kishapu, while during post-harvest season there were no significant differences (p=0.081) in food insecurity status between the two districts (Table 4-4). Further, Paired Sample *t*-Test statistics (Table 4-5) reveal a significant difference in HFIAS scores between pre-harvest and post-harvest seasons, suggesting significantly better overall food security in post-harvest than in pre-harvest season.

Household Food Insecurity (Access) Prevalence measures the incidence of food access insecurity in terms of four categories ranging from Food Secure to Severely Food

Insecure. A score of 1 represents a food secure household, 2 represents a mildly food insecure household, 3 represents a moderately food insecure household while 4 represents a severely food insecure household.

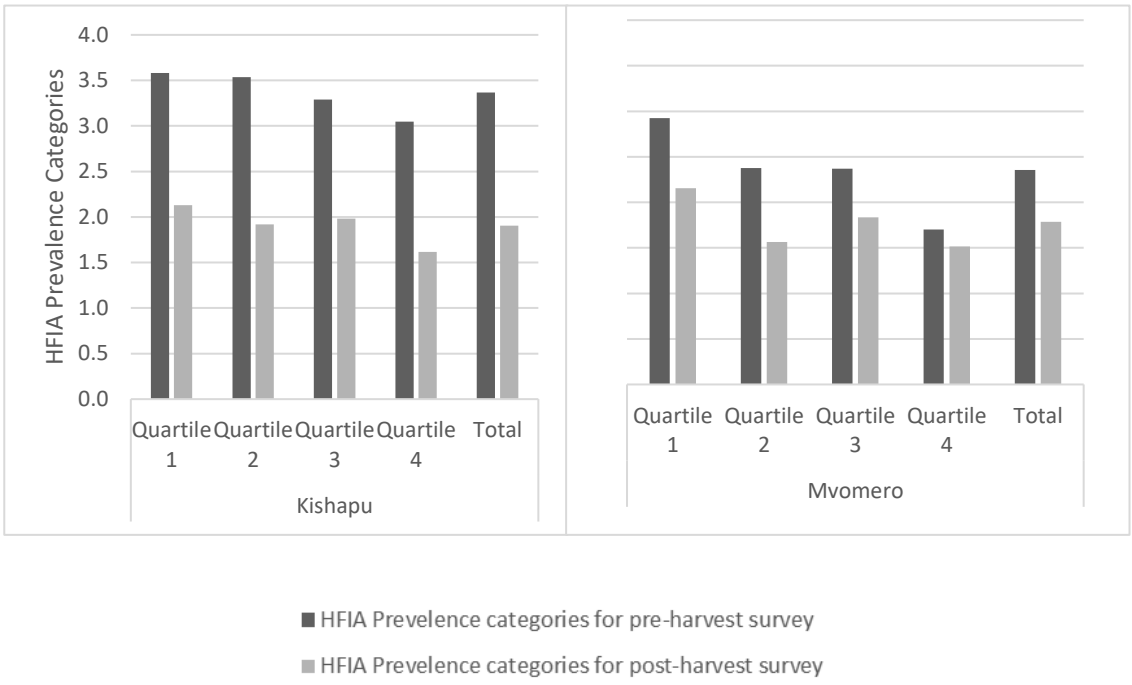


Figure 4-6: Household Food Insecurity Access Prevalence Categories

Much higher levels of food insecurity are observed in Kishapu even in higher income quartiles compared to Mvomero where there was relatively higher food security across all income quartiles (Figure 4-6).

Table 4-6 shows that food insecurity was more prevalent for lower income quartiles than higher income quartiles in both seasons. Thus, from the research question of whether household incomes affect household food security status we can conclude that household food security is affected by household income.

The results of Paired Sample *t*-Test for HFIAP from Table 4-7 show a significant difference in food access insecurity between the two seasons, meaning that household food insecurity (access) was significantly more prevalent during pre-harvest season than post-harvest season. Also, food insecurity (access) was significantly more prevalent in Kishapu than Mvomero during pre-harvest season, while during post-harvest season differences in food insecurity (access) prevalence were not significant between the two districts.

4.3.3 Market access and Food Security

4.3.3.1 Selling Channels and Challenges

In both districts, farm output was sold to middlemen; selling to local village market and neighbouring village market was more common in Kishapu because its roads are bad, and households sold small portions they could transport to the weekly market in the district centre. In Kishapu, cotton farmers sold to cooperative society via contract. They also sold to neighbouring households, but this was not common because most households grew similar crops as their neighbour.

The most common challenge in both districts was low prices for all kinds of farm produce which they would sell anyway for they had no way of dealing with this problem. Some would either bargain or hold their produce to sell later. Poor weighing scale calibration was a common problem for cotton sellers in Kishapu. Farmers complained of having little power in influencing agents to properly calibrate weighing scales. They also lacked means to transport their farm produce to markets and there was an absence of a formal market. During focus group discussions, farmers pointed out local government levies and regulations prohibited them from accessing the market when they wished to sell.

4.3.3.2 Buying Channels and Challenges

Households were highly dependent on the market to access food. Out of all food consumed by households, bought food comprised 73 percent in Kishapu and 90 percent in Mvomero. This dependence on the market made them vulnerable, as they did not have enough reliable income or a daily formal market where they could easily buy what they needed. They obtained food by buying from neighbours or picking forest foods (Figure 4-7).

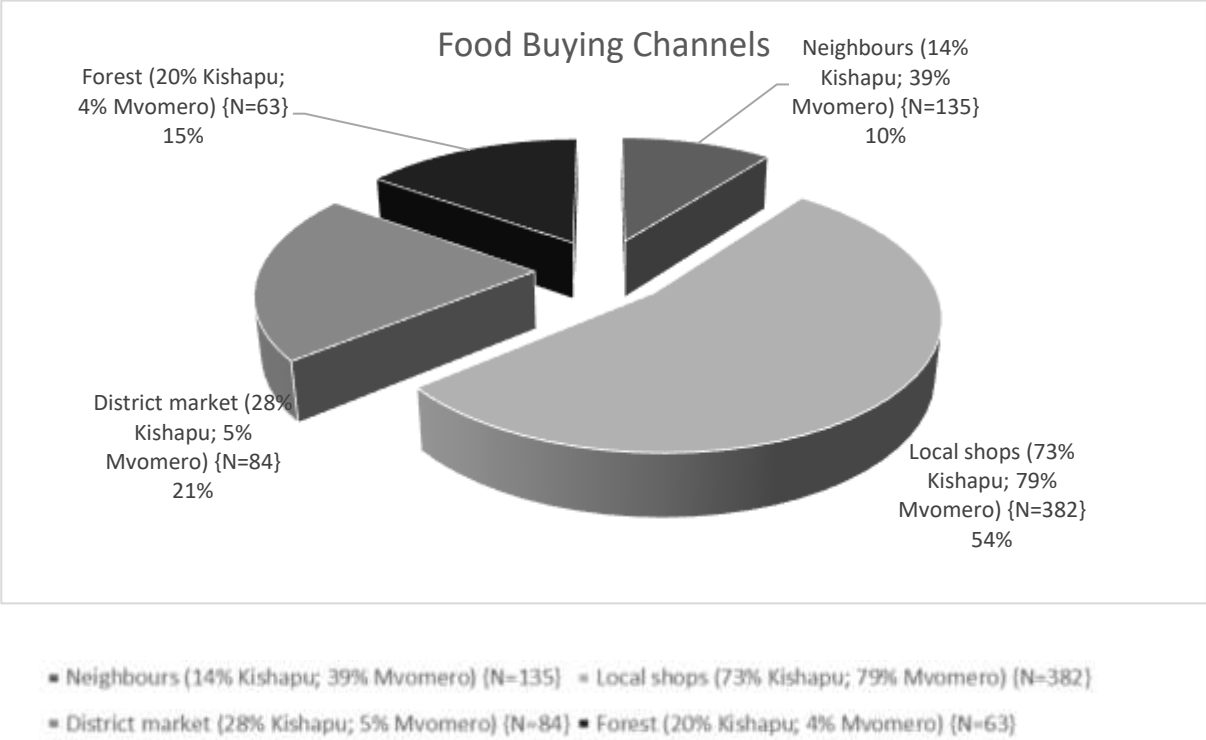


Figure 4-7: Channels used to obtain Foods

When buying foods, households faced a number of challenges. During focus group discussions and in household survey, high prices and their volatility were identified as main challenges in both study areas and households sometimes had to reduce consumption. Additionally, they faced a lack of transport and lack of a formal market.

A set of six logistic regressions were performed to determine the effects of market access, ownership of transport means (bicycle), income quartiles, household size, number of income sources, off-farm income per capita, farming systems, household head sex, age and schooling on the three measures of household food security in pre- and post-harvest periods - HFIAS Preharvest, HFIAS, Postharvest, HFIAP Preharvest, HFIAP Postharvest, HDDS Preharvest, and HDDS Postharvest; results are shown in Table 4-8.

Pre-harvest models were all statistically significant, χ^2=83.67, 132.59 and 109.07 for HFIAS, HFIAP and HDDS pre-harvest ($p<0.001$). The models explained more than 20 percent (Nagelkerke R^2) of variance in household food security measures in pre-harvest period and correctly classified more than 76% of cases. Overall, a one percent increase in market distance meant the household was more likely to be food insecure

in terms of HFIAS, HFIAP and HDDS. Moreover, households owning bicycles were less likely to be food insecure compared to those who did not; while belonging to a higher income quartile and having a smaller family size improved the likelihood of households being food secure.

For post-harvest season, only HFIAP model was statistically significant (χ^2=36.70 and p<0.001) with owning a bicycle, having more off-farm income per capital and the head of the household being older, increased the likelihood of the household falling into food insecurity access prevalence (HFIAP). HFIAS and HDDS post-harvest did not exhibit any statistically significant results and had low χ^2 values. All models explained less than 10 percent of variance in household food security measures in post-harvest and correctly classified more than 69% of cases.

Lack of market access ultimately led to lack of income and food, which contributed to the food insecurity observed in the study areas. It was also observed that on average, more than 83 percent of households in Mvomero are close (45 minutes or less) to the market while in Kishapu only 55 percent of households are close to the market, leading to lower dietary diversity and higher food access insecurity in Kishapu.

4.4 Conclusions AND RECOMMENDATIONS

This study set out to answer five research questions to determine whether incomes, seasons and market access influence household food security. Findings from this study reveal high incomes inequality between farming systems and between districts due to access to off-farm sources of income. Rural households are mostly reliant on farm income, and diversification on-farm and off-farm was minimal. Because of very low incomes and a complete lack of income for some periods of the year, low-income households faced food insecurity (access) threats.

Furthermore, seasons explained a difference in household food insecurity (access) especially within districts, post-harvest was better for both districts. Households with more incomes had significantly less food insecurity. On the other hand, market access is minimal especially in Kishapu and households located far from the common market were more likely to be food insecure.

The rural economy should have diverse and accessible economic activities. Policies and strategies to support improvement and diversification of farm and off-farm incomes and to increasing farm output have important implications for low-income farm households; they should also focus on market access for rural poor; however, such policies and strategies would be more robust with more tests. Such initiatives could include improvements in transport infrastructure and access to credit, supporting market access, augment farm production and improve off-farm income.

TABLES USED IN THE FINDINGS

Table 4-1: Household Characteristics

HOUSEHOLD CHARACTERISTICS	KISHAPU(n=255)	MVOMERO(n=251)
Average Household size	8	5
Percentage of Male members of the household	50.1%	48.5%
Percentage of Female members of the household	49.9%	51.5%
Percentage of Dependants	54.8%	56%
Percentage of Adults earning off-farm income	3	4
Average Age of Household Head (Years)	46.4	42.6
Percentage of female-headed Households	23.5%	20.9%
Average years of Schooling	3.6	3.2
Average number of rooms per household	4	3

Table 4-2: Household Sources of Income

Economic Activity	Kishapu (n=255)	Mvomero (n=251)	Overall (n=206)
Farming	95.7% *(n=244)*	95.6% *(n=240)*	95.7%
Small-Scale Entrepreneur	0.4% *(n=1)*	2.0% *(n=5)*	1.2%
Labourer/Skilled-unskilled	0.0% *(n=0)*	0.4% *(n=1)*	0.2%
Natural Resource Extraction	0.0% *(n=0)*	0.8% *(n=2)*	0.4%
Civil Servant	3.1% *(n=8)*	0.4% *(n=1)*	1.8%
Private Sector/NGO Employee	0.4% *(n=1)*	0.4% *(n=1)*	0.4%
Pensioner	0.0% *(n=0)*	0.4% *(n=1)*	0.2%
Unemployed	0.4% *(n=1)*	0.0% *(n=0)*	0.2%

Table 4-3: Paired Sample t-Test Statistics for HDDS pre- and post-harvest

	Overall		Kishapu		Mvomero	
	Pre	Post	Pre	Post	Pre	Post
Mean	5.194	5.514	4.690	5.447	5.705	5.582
N	506	506	255	255	251	251
Std. Deviation	1.343	1.360	1.434	1.446	1.016	1.267
Std.	0.060	0.060	0.090	0.091	0.064	0.080

	Overall	Kishapu	Mvomero
	Pre& Post	Pre& Post	Pre& Post
N	506	255	251
Corr.	0.213	0.272	0.112
Sig. (2-Tailed)	0.000	0.000	0.077

	Overall		Kishapu		Mvomero	
	Pre	Post	Pre	Post	Pre	Post
Error Mean						

	Overall	Kishapu	Mvomero
	Pre& Post	Pre& Post	Pre& Post

		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Overall	Pre - Post	-0.320	1.696	0.075	-0.468	-0.172	-4.247	505	0.000
Kishapu	Pre - Post	-0.757	1.738	0.109	-0.971	-0.543	-6.955	254	0.000
Mvomero	Pre - Post	0.124	1.533	0.097	-0.067	0.314	1.277	250	0.203

Table 4-4: Analysis of Variance for HFIAS Score pre- and post-harvest

ANOVA - INCOME QUARTILES						
		Sum of Squares	df	Mean Square	F	Sig.
HFIAS_score_pre	Between Groups	2395.655	3	798.552	22.531	0
	Within Groups	17792.273	502	35.443		
	Total	20187.929	505			
HFIAS_score_post	Between Groups	362.056	3	120.685	8.166	0
	Within Groups	7419.044	502	14.779		
	Total	7781.101	505			

ANOVA - DISTRICTS						
		Sum of Squares	df	Mean Square	F	Sig.
HFIAS_score_pre	Between Groups	5161	1	5161	173.099	0
	Within Groups	15026.929	504	29.815		
	Total	20187.929	505			
HFIAS_score_post	Between Groups	46.856	1	46.856	3.053	0.081
	Within Groups	7734.245	504	15.346		
	Total	7781.101	505			

Table 4-5: Paired Sample t-Test Statistics for HFIAS Score pre- and post-harvest

	HFIAS Score - Pre-harvest	HFIAS Score - Post-harvest
Mean	5.194	5.514
N	506	506
Std. Deviation	1.343	1.360
Std. Error Mean	0.060	0.060

	HFIAS Score - Pre and Post-Harvest
N	506
Correlation	0.218
Sig.	0.000

	Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
	Mean	Std. Deviati	Std. Error	Lower	Upper			

		on	Mean					
HFIAS Score - Pre-Harvest and HFIAS Score - Post-Harvest	5.255	6.674	0.297	4.672	5.838	17.712	505	0.000

Table 4-6: Analysis of Variance for HFIA Prevalence Categories pre- and post-harvest

ANOVA-INCOME QUARTILES					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
HFIAP Categories Pre-harvest	61.455	3	15.364	14.763	0
HFIAP Categories Post-harvest	20.858	3	5.214	5.715	0
ANOVA-DISTRICTS					
	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
HFIAP Categories Pre-harvest	130.07	1	130.07	144.781	0
HFIAP Categories Post-harvest	1.853	1	1.853	1.961	0.162

Table 4-7: Paired Sample t-Test Statistics for HFIAP Categories pre- and post-harvest

	HFIAP Categories - Pre-harvest	**HFIAP Categories - Post-harvest**
Mean	2.866	1.846
N	506	506
Std. Deviation	1.074	0.973
Std. Error Mean	0.048	0.043

	HFIAP Categories - Pre and Post-Harvest
N	506
Correlation	0.183
Sig. (2 tailed)	0.000

	Paired Differences			**95% Confidence Interval of the Difference**		**t**	**df**	**Sig. (2-tailed)**
	Mean	**Std. Deviation**	**Std. Error Mean**	**Lower**	**Upper**			
HFIAP Categories - Pre-Harvest and HFIAP Categories - Post-Harvest	1.020	1.311	0.058	0.905	1.134	17.499	505	0.000

Table 4-8: Binomial Regression Results

Explanatory Variables	**HFIAS Preharvest (R^2=0.24)**		**HFIAS Postharvest (R^2=0.09)**		**HFIAP Preharvest (R^2=0.32)**		**HFIAP Postharvest (R^2=0.10)**		**HDDS Preharvest (R^2=0.28)**		**HDDS Postharvest (R^2=0.06)**	
	χ^2=20.05	Sig.=0.00	χ^2=3.51	Sig.=0.43	χ^2=9.70	Sig.=0.00	χ^2=11.40	Sig.=0.00	χ^2=16.81	Sig.=0.00	χ^2=7.24	Sig.=0.24
	Coef.	Std E	Coef.	Std E	Coef.	Std E	Coef.	Std E	Coef.	Std E	Coef.	Std E
Log (mkt-distance)	0.18***	0.073	-0.020	0.162	0.196***	0.060	0.041	0.056	-0.294***	0.067	-0.026	0.600
	(2.466)		*(0.123)*		*(3.267)*		*(0.732)*		*(4.388)*		*(0.043)*	
Bicycle ownership	0.729**	*0.270*	0.502	0.623	0.613*	0.277	0.570**	0.229	-0.465	0.253	-0.361	0.250
	(2.700)		*(0.806)*		*(2.213)*		*(2.489)*		*(1.838)*		*(1.444)*	
Income Quartiles	-0.685***	0.163	-0.524	0.378	-0.596***	0.144	0.052	0.123	0.444***	0.141	0.241	0.130
	(4.202)		*(1.386)*		*(4.139)*		*(0.423)*		*(3.149)*		*(1.854)*	
Household-Size	0.143***	*0.045*	0.142	0.091	0.154*	0.047	0.003	0.037	-0.064	0.039	0.080	0.040
	(3.178)		*(1.560)*		*(3.277)*		*(0.081)*		*(1.641)*		*(2.000)*	
Income sources(no)	0.173	0.151	0.097	0.362	-0.266**	0.131	-0.001	0.122	0.113	0.139	-0.103	0.130
	(1.146)		*(0.268)*		*(2.031)*		*(0.008)*		*(0.813)*		*(0.792)*	
Off-Farm Income/K	-0.003	*0.002*	-0.001	0.002	-0.001**	0.001	-0.002***	0.001	0.004*	0.001	0.000	0.000
	(1.500)		*(0.500)*		*(1.000)*		*(2.000)*		*(4.000)*		*(0.000)*	
Farming system	-0.028	0.152	-0.416	0.369	0.370**	0.131	-0.162	0.119	-0.145	0.138	-0.190	0.130
	(0.184)		*(1.127)*		*(2.824)*		*(1.361)*		*(1.051)*		*(1.462)*	
Sex	-0.355	*0.287*	-0.285	0.663	0.033	0.285	-0.112	0.247	0.032	0.268	-0.094	0.280
	(1.237)		*(0.430)*		*(0.116)*		*(0.453)*		*(0.119)*		*(0.336)*	
Age	0.007	0.009	-0.014	0.022	-0.007	0.008	-0.021**	0.008	-0.007	0.008	-0.011	0.010
	(0.778)		*(0.636)*		*(0.875)*		*(2.625)*		*(0.875)*		*(1.100)*	
Schooling	0.039	*0.043*	-0.004	0.096	0.015	0.036	-0.040	0.033	0.026	0.038	0.062	0.040
	(0.907)		*(0.042)*		*(0.417)*		*(1.212)*		*(0.684)*		*(1.550)*	
Constant	-2.454***	0.861	-2.370	1.886	-0.053	0.782	0.033	0.688	1.864*	0.775	1.540*	0.780
	(2.850)		*(1.257)*		*(0.068)*		*(0.048)*		*(2.405)*		*(1.974)*	

*Robust t-statistics are in parentheses and significance at 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.*

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5.0 SEASONALITY, FOOD PRICES AND DIETARY CHOICES OF VULNERABLE HOUSEHOLDS: A CASE STUDY OF NUTRITIONAL RESILIENCE IN TANZANIA

Abstract

This study examines how food prices and related seasonality factors affect dietary choices of low-income farm households in rural Tanzania. Kishapu and Mvomero districts were selected based on contrasting rainfall patterns, farming practices and economic activities. Data were collected before and after harvest in 2014 using household surveys, focus group discussions, key informant interviews and monthly market-price surveys. A linear-programming solution provides a choice-diet, bundle of food items given model constraints. Cost of choice-diet was compared with household incomes to determine diet affordability. Cheaper, energy-denser foods lacking other nutrients were consumed at lower budgets in both seasons. Policies and strategies to address problems of high cost of nutritious foods should be considered to enable low-income households to obtain affordable but nutritious diets. Moreover, strategies and interventions that can influence behaviour and promote awareness are important for better household nutrition through a suitably balanced diet of available foods.

Keywords

Agriculture, Food Prices, Cost of Diet, Food Security, Rural Tanzania

5.1 Introduction

Tanzania, a low-income country largely dependent on agriculture with its rural population mostly vulnerable, in line with Sustainable Development Goals is aiming for zero hunger and end to all forms of under nutrition. Efforts to increase agricultural productivity and interventions for affected individuals and households are in place. However, seasonality, price and price fluctuations, affect household dietary choices and their resulting nutritional resilience. Women are more affected by climatic and seasonal changes compared to male farmers, while men have more coping strategies then women (Nkengla-Asi et al., 2017; Nube and Van Den Boom, 2003). The poor spend a large part of their income on food and therefore are more vulnerable to price variability (Musgrove and Galindo, 1988) and a linear programming model demonstrated that as income increases, actual proportion spent on nutrition decreases (Silberberg, 1985). There is high variability of food prices across seasons (Gilbert et al., 2017) which also translates to differences in caloric intake (Kaminski et al., 2016). High market prices have been associated with lower dietary diversity (Headey et al., 2019).

Empirical studies have consistently shown price effect on dietary choices, this study revisits these findings in the context of resilience building and seasonality in Africa using a case study of Tanzania. This study uses linear programming approach, comparing two seasons in two economically distinct districts of Tanzania.

5.2 Background

Agriculture has remained a major source of income for most developing countries especially for rural populations (FAO, 2018b). Smallholder agriculture is more common in Tanzania, production is only enough to sustain food and a few basic needs and smallholder farmers provide almost 70 percent of all food consumed in the country (FAO, 2015). As consumers of marketed foods, households are affected by prices of foods they consume (Aschemann-Witzel and Zielke, 2017). It is therefore important to analyse the effect of prices on food choice (Herforth and Ahmed, 2015; Hursh and Roma, 2016; Privitera et al., 2019). Studies indicate that there are post-harvest losses (PHL) on food produced by households. In Tanzania, for most grains, up to 15 per cent

of grain harvest is lost before consumption (Abass et al., 2014). Table 5-1 summarises percentages of PHL for some food items in Tanzania.

Table 5-1: Percentage Post-Harvest Losses for Crops in Tanzania

Food Product	PHL ***(%)***
Cereals	15
Sweet Potatoes	32.5
Cassava	52.3
Beans	25
Groundnuts	25
Tomatoes	50
Meat and Fish	20
Chicken	38
Milk	5.66
Fruits and Vegetables	50

Source: Affognon et al.(2015)

The theory of consumer behaviour postulates that every individual has a goal of maximizing utility but is faced with time-specific budget constraints that limit achievement of desired utility in each period (Alvino et al., 2018). People purchase less nutritious foods because they are cheaper (Cochrane and D'Souza, 2015; Darmon and Drewnowski, 2015; Mbegalo and Yu, 2016). Animal products are not largely consumed by households in Tanzania except for relatively cheaper animal-source foods (Baker et al., 2016). Seasonality of food crops significantly affects consumption patterns among food secure and food insecure families. More dietary diversity and food security was experienced during post-harvest season compared to pre-harvest season in Kilosa (Ntwenya et al., 2015).

Food security has been defined by FAO as a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life(FAO, 2019). Policy makers in Tanzania have put forward several strategies such as provision of nutrition services, nutrients and supplements; promoting dietary interventions and practices, and intensifying awareness and public sensitisation among others (United Nations, 2017b). All these are done to ensure that nutrition and healthy are improved. Additionally, issues such as food shortages, low production of food crops, substandard imports, inadequate knowledge on nutrition, inappropriate food management and vulnerability of households and groups have been identified as challenges to achieving nutritional goals (URT, 2013). To ensure sufficient quantity and quality food is

produced, accessible and utilised for enhanced food security and nutrition, the government intends to concentrate on production of food crops according to agro-ecological zones, to meet domestic demand and surplus for export, ensure food imports are consistent with internationally acceptable safety and quality standards shall be regulated; production and utilization of crops with high nutrient content in areas with nutritional problems and promoting nutritional knowledge and strengthening food storage and stability. However, there is no mention of how food prices affect types and amounts of foods consumed, nutritional vulnerability of the rural poor and seasonal variations in food prices. This paper examines how food prices affect food choices of low-income farm households in rural Tanzania, with respect to their daily diets in two seasons.

The problem of malnutrition in Tanzania is prominent among majority of rural people. If this problem is not addressed, rural households will continue with practices that are not beneficial to them nutritionally and financially and women and children will especially suffer because they are more vulnerable (Brown et al., 2017; Mbwana et al., 2017). There are very few studies in Tanzania (Cochrane and D'Souza, 2015; Masters et al., 2018; Yu and Shimokawa, 2016) that have analysed the impact of food prices on household consumption of nutritious foods. It is therefore important to strengthen literature on linkages between food prices and household nutrition while addressing specific issues of seasonality, household incomes, household size, and location.

The main objective of this paper is to examine the effects food costs on consumption of nutritious food for low-income rural households with the specific question: *How do food costs affect household consumption of nutritious food?* Knowledge about this is important because most households depend on markets to buy foods and are affected by food costs. This analysis helps to understand household food choices and suggest better ways to achieve nutrition benefits.

5.3 Study Area, Data, and Methods of Analysis

5.3.1 Study Area and Sample

The study was conducted in two economically distinct districts in rural Tanzania: Kishapu District in Shinyanga Region, where households are more dependent on farm

income and Mvomero District in Morogoro Region, where households are more dependent on off-farm income. These were selected because of a high level of nutritional vulnerability(ICF Macro, 2011; ICF and MUCHALI, 2013), differences in economic activities (USAID, 2008) and absence of major nutrition interventions (TFNC and REACH, 2015).

Morogoro and Shinyanga had stunting levels 44.4% and 43.3% respectively above national average (42%) (ICF Macro, 2011; ICF and MUCHALI, 2013). Shinyanga was a highly food deficit region with most of its districts being vulnerable and Morogoro was food self-sufficient but with two vulnerable districts, Morogoro Rural and Mvomero (ICF and MUCHALI, 2013).

Multi-stage clustered sampling was done in two purposely-selected districts of Kishapu and Mvomero (stage 1). Within each district, one ward was randomly selected (stage 2) from which two villages were randomly selected (stage 3): Lubaga and Mwakipoya villages from Kishapu and Makuyu and Milama villages from Mvomero. Ethical approval was sought from St Augustine University of Tanzania and University College Dublin; also, permission to conduct research was sought from regional and district administrative offices. A list of all households and its members was collected from village officials and after random sampling data were collected from a total of 506 households, of which 255 were in Kishapu and 251 in Mvomero. Consent was sought from respondents before beginning interviews.

5.3.2 Data Collection

Structured questionnaires were used before and after harvest and monthly market price surveys for regularly consumed food and non-food items in 2014 were used to collect quantitative data while qualitative data comprised focus group discussions and key informant interviews. To understand regular food consumptions of households, a 30-day food consumption recall was collected from households(Troubat and Grünberger, 2017); for respondents whose memory was faint, a 3-day log was collected and estimated to 30 days. Energy and other nutrient contents of food items were obtained from *Tanzania Food Composition Tables* (Lukmanji et al., 2008).

5.3.3 Data Analysis

5.3.3.1 Energy content determination

Amounts of food available in households were reduced by their respective PHL percentages. Amounts of energy consumed were obtained by a multiplication factor of cooked foods from consumption data of raw foods considering common cooking and preparation methods in rural Tanzania(Lukmanji et al., 2008). Household energy consumption data were converted into individual adult equivalents (NBS, 2014b) used in place of household size to account for age and gender differences among household members (Hickey et al., 2016).

Due to resource sharing within households, adult equivalence units were adjusted for average cost economies of scale since larger households spend less on average compared to smaller households (Newhouse et al., 2016). Using economies of scale parameter by $\theta = \frac{-\ln\left(1-\rho+\frac{\rho}{n}\right)}{1-n}$:where n is household size and ρ=0.9 for an equivalent adult (Martin, 2017) and represents proportion of household expenditure for goods consumed privately and 1- ρ represents goods consumed publicly in household. As n increases, ρ decreases. Household size $n_{adj} = 1 + \left((n-1) \times \theta\right)$. This new adjusted household size was used in place of the actual household size in the analysis.

Seven food groups were used: *cereals; roots and tubers; vegetables and fruits; meats, poultry and fish; legumes; oils and fats;* and *miscellaneous items.* These are most common food groups for Tanzania (Lukmanji et al., 2008), also used in this study. Lower limits and upper limits of energy from food items and food groups were obtained from a statistical distribution of data. For food items, lower limit was the 5th percentile while upper limit was the 95th percentile of the distribution. For food groups, lower limit was the 10th percentile and upper limit was the 90th percentile of the distribution.

5.3.3.2 Household Income Determination

Data collected from household survey provided annual farm and non-farm income households received in the year prior the interview (2013). Average exchange rate between EURO and Tanzanian Shilling (TZS) in 2013 was €1=TZS2140.98. A distribution of net annual household incomes was run in SPSS generating four equal cut-off points (Income Quartiles): the poorest earned TZS707,271 (€330.35); lower-

middle earned between TZS707,271 (€330.35) and TZS1,424,969 (€665.57); upper-middle earned between TZS1,424,969 (€665.57) and TZS2,991,930 (€1397.46) and the wealthiest earned more than TZS2,991,930 (€1397.46).

5.3.4 Linear Programming

This study employs an optimisation approach to nutrition using linear programming (a mathematical technique used to optimise an objective function subject to a set of constraints). Decision variables were portions of 29 food items. Nutrient content of target energy level from linear programming solution was compared with minimum required intake of 2,100kcal(WFP, 2017), to analyse whether, with that diet, individuals get desired nutrients and energy.

Methodology by Briend et al.(2003) and (Darmon et al., 2006) was adapted. Briend et al. (2003) do not mention how the absolute value of objective function is considered by linear programming solution in Excel Solver. This poses an effect of negative values of Total Deviation from Mean Intake (TDMI) cancelling out positive values. In this paper, the absolute value of objective function is found by generating positive and negative values of TDMI so that Excel Solver chooses absolute values of TDMI. Optimal budgets were compared to household incomes to analyse affordability.

Hypothesis to be tested:

Null: People's choices of diets were independent of food costs.

Alternative: People's choices of diets were dependent on food costs.

The objective was to minimise relative deviations from mean diet in the population; calculated by subtracting the mean from the decision variable and divided by mean.

Minimise: TDMI

Subject to:

i. $\sum_{i=1}^{n} P_i X_i \leq TZS$

ii. $f_i \geq f_i^{min}$

iii. $f_i \leq f_i^{95^{th}}$

iv. $X_i \leq X_i^{75^{th}}$

v. $X_{ic} \geq G_c^{min}$

vi. $X_{ic} \leq G_c^{max}$

vii. $\sum_{i=1}^{n} f_i \geq \sum_{i=1}^{n} e_i^{energyreq}$

viii. $\frac{(m_i - X_i)}{m_i} \leq Z_i \; and \; \left\{-\frac{(m_i - X_i)}{m_i}\right\} \leq Z_i$

Where TDMI = the sum of the absolute values of relative deviations from the mean diet

E(d) = Expenditure on food

P_i = Price per 100kg of food item *"i"*

m_i = mean portion size (g/d) of food *"i"*

f_i = energy amount (kcal) of food *"i"*

Y = the objective function

a = constants

X_i = portion of food item *"i"* g/d *(decision variables)*

i = 1 to n

j = 1 to k

n = the number of food items included in the model

e_i = recommended dietary intake (kcal)

TZS = shilling value of the resulting food consumed

5.3.4.1 Model Assumptions

i) Individuals were rational and chose a bundle of food items that maximises their utility (energy intake); ii) Proportionality: each decision variable was multiplied by a

coefficient, such that when variables change, the result is a proportionate change in that variable to the objective; iii) Divisibility: all decision variables were divisible – all food items were converted into metric weights enabling divisibility; iv) Additivity: since the objective function is linear, value of objective is the sum of contributions of each decision variable to objective function; iv) Certainty: all coefficients/model parameters were known. Coefficients for this analysis were derived from data collected in field.

5.3.4.2 Model Limitations

Model applicability was limited by: first, decision variables were limited to the common food items consumed by sampled households in the study areas. This does not mean that other food items were not consumed at all; rather what was included was most representative of the population. Second, it is undeniable that palatability affects food choices, however a palatability scale was not measured during quantitative data collection and therefore not included in the model, nevertheless participants in focus group discussions gave their perceptions of which foods were preferred. However, it is expected that, a food item that was more palatable was one that showed the highest mean despite its cost. Third, individuals may have made decisions to eat certain food items without knowledge of their energy or nutrient contents. This however does not render the model unrealistic because they still make rational decisions based on what was available and costs involved.

5.3.4.3 Optimisation Problem

$$\boldsymbol{Y = a_0 + \sum_{i=1}^{n} a_i X_i} \qquad \ldots\ldots\ldots \qquad \textit{Equation 5-1}$$

Let Total Departure from Mean Intake (TDMI) be sum of all absolute values of differences between each food variable portion size selected from mean value of diet.

Total Departure from Mean Intake

$$\boldsymbol{TDMI = \sum_{i=1}^{n} \frac{|(m_i - X_i)|}{m_i}} \qquad \ldots\ldots\ldots \qquad \textit{Equation 5-2}$$

To standardise differences across food groups, the difference is divided by mean and because TDMI function is non-linear, it was linearized with Z_i–absolute value of TDMI:

$$\boldsymbol{Z_i \geq \left|\frac{(m_i - X_i)}{m_i}\right|} \quad \ldots\ldots\ldots \quad \textit{Equation 5-3}$$

Since Z_i is by definition greater or equal to both the standardized values of the difference, this means the model selects the absolute (positive) values of Z_i. Then,

$$\boldsymbol{TDMI = \sum_{i=1}^{n} Z_i = \frac{(m_1 - X_1)}{m_1} + \frac{(m_2 - X_2)}{m_2} + \cdots + \frac{(m_n - X_n)}{m_n}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-4}$$

$$\boldsymbol{= \left(1 - \frac{1}{m_1} X_1\right) + \left(1 - \frac{1}{m_2} X_2\right) + \cdots + \left(1 - \frac{1}{m_n} X_n\right)} \quad \ldots\ldots\ldots \quad \textit{Equation 5-5}$$

$$\boldsymbol{= n - \frac{1}{m_1} X_1 - \frac{1}{m_2} X_2 - \cdots - \frac{1}{m_n} X_n} \quad \ldots\ldots\ldots \quad \textit{Equation 5-6}$$

This follows the same format as the linear function $Y = a_0 + a_1 X_1 + a_2 X_2 + \cdots + a_n X_n$

Where a_0 is a constant $and\ a_i = -\frac{1}{m_i}$

Constraints

vi. Budget Constraint

Since X_i's are decision variables, cost constraint:

$$\boldsymbol{E_d = \sum_{i=1}^{n} P_i X_i \leq TZS} \quad \ldots\ldots\ldots \quad \textit{Equation 5-7}$$

Where TZS is shilling value of total food cost items in the diet.

vii. Total Minimum Energy Intake Constraint:

Energy intake per day is constrained at daily mean energy intake in population distribution and if f_i represents food energy content item i in 100g of that food item; then optimal energy is expressed as:

$$\boldsymbol{\sum_{i=1}^{n} f_i X_i \geq \sum_{i=1}^{n} m_i^{energy}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-8}$$

viii. Daily Energy Constraints

Minimum Food Item – Energy Limit

$$f_i \geq f_i^{5^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-9}$$

Maximum Food Item – Energy Limit

$$f_i \leq f_i^{95^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-10}$$

ix. Food Group Constraint

If *"j"* denoted food group, then X_{ij} was food item *"i"* belonging to group *"j"*. G_j indicated energy limit of food groups. Only three food groups were constrained in this paper: Cereals; Vegetables and Fruits; and Meats, Fish and Poultry because as they were widely consumed in both seasons and survey areas.

Thus,

$$\sum_{i=1}^{n} X_{ij} \geq G_j^{10^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-11}$$

and

$$\sum_{i=1}^{n} X_{ij} \leq G_j^{90^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-12}$$

x. Food Portions

Maximum food portion size in grams per day was constrained at 75th percentile of population intake distribution.

$$X_i \geq X_i^{75^{th}} \quad \ldots\ldots\ldots \quad \textit{Equation 5-13}$$

Linear Programming optimisation results were matched with other nutritional content of portions that were consumed to obtain how much of other nutrients were consumed by household members.

5.4 Results and Discussion

5.4.1 Household Profile

Numerous significant differences ($p < 0.05$) were observed in households between Kishapu and Mvomero as outlined in Table 5-2.

Table 5-2: Household Characteristics

HOUSEHOLD CHARACTERISTICS	KISHAPU	MVOMERO
Average Households size (Number of Members)	7.84	5.43
Average Age of Household Head	46.4	42.6
Percentage of female-headed Households	23.5%	20.9%
Average years of Schooling of Households head	5.08	4.99
Average number of rooms per household	4	3

Source: Survey Data

Households in both study districts were mainly male headed in 78 per cent of households. Analysis of variance on the data above showed statistically significant differences for household size, age of household head and number of rooms per household between districts.

5.4.2 Household Income and Income Distribution

Table 5-3 below shows analysis of variance run on household income data between Kishapu and Mvomero and revealed no statistically significant differences between household incomes in Kishapu and Mvomero, however, there were statistically significant differences in per capita (adult equivalents) household incomes. This could be due to larger household sizes in Kishapu than Mvomero, making per capita incomes smaller in Kishapu than Mvomero. Moreover, there were at least three months with no income at all in Kishapu compared to at least two months in Mvomero; these were the same months that households faced food shortage during rainy season.

Table 5-3: Analysis of Variance – Household Incomes

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Net Annual Household income 2013 in Euros	Between Groups	9332082.858	1	9332082.858	2.532	.112
	Within Groups	1857659297.000	504	3685831.938		
	Total	1866991379.000	505			
Net Annual Household income 2013 per adult equivalent in Euros	Between Groups	3055552.049	1	3055552.049	12.978	.000
	Within Groups	118662141.300	504	235440.757		
	Total	121717693.400	505			

5.4.3 Linear Programming Results

To generate budget points, initially a solution was found from linear programming without constraining the budget equation. The solution gave a choice-diet and energy level that could be consumed and any further increase in budget did not change food choices. Furthermore, budgets were progressively decreased at intervals of TZS100 to assess how food choices varied when a person had less and less money at their

disposal and a minimum budget was reached when any further reductions in budget made the solution non-optimal. Prices were relatively lower in post-harvest season than pre-harvest season in both areas. Solutions were obtained separately for the two seasons.

Apart from energy consumption, other macro and micronutrients are important for the body. According to(WHO, 2019), nutrients are grouped into carbohydrates, fats and fatty acids, proteins, vitamins, minerals and water. Water is not included in this analysis but was consumed independently and also contained in foods eaten.

5.4.3.1 Pre-Harvest Results

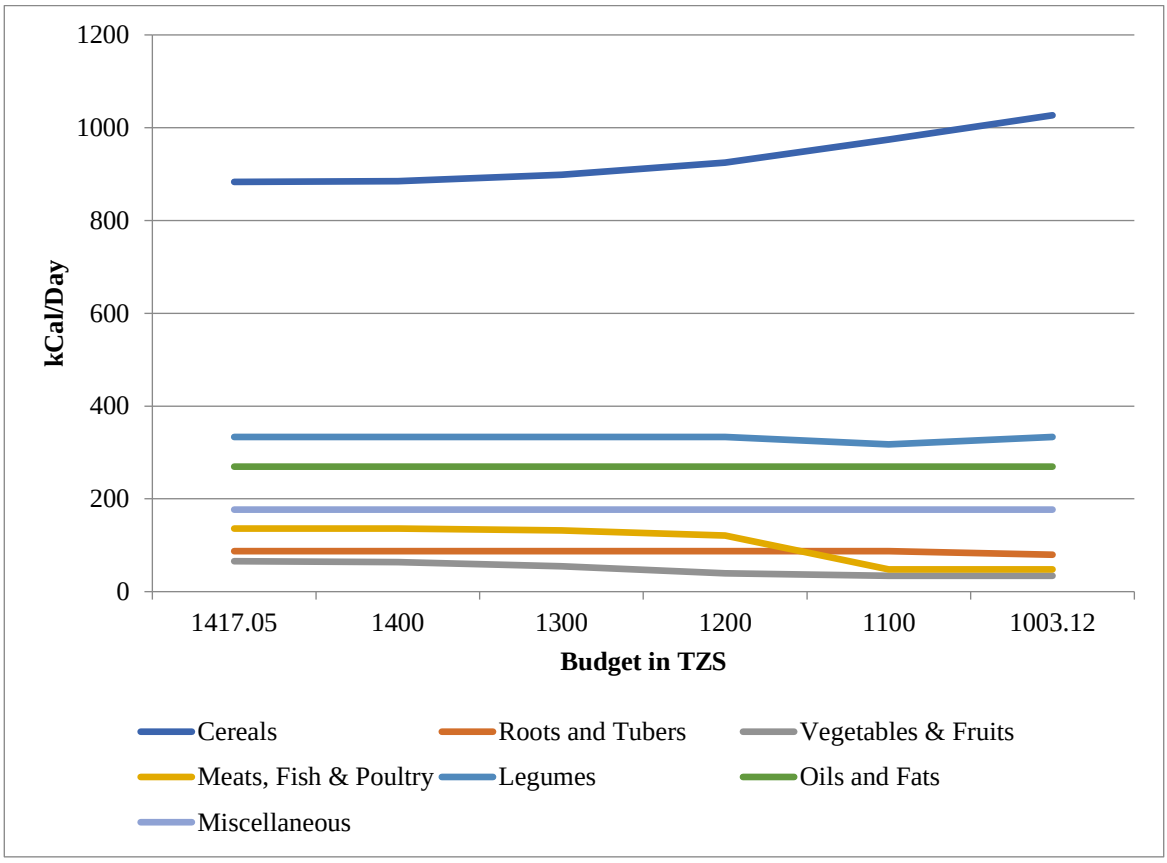
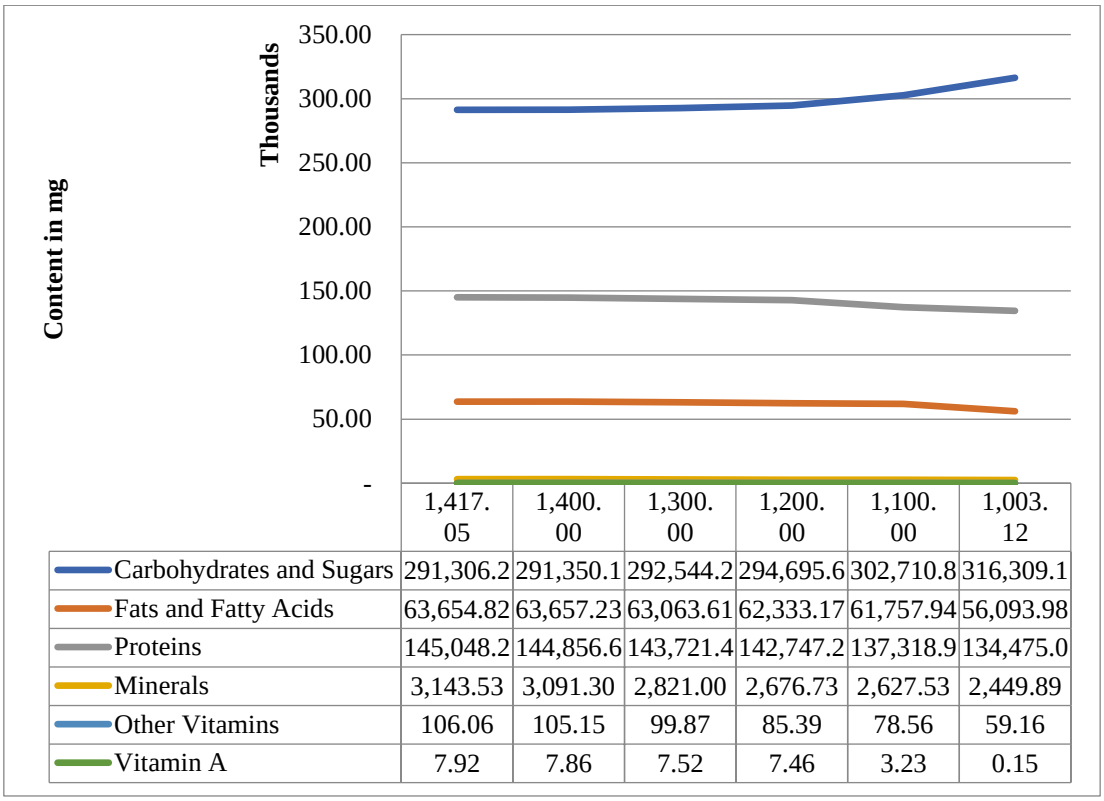


Figure 5-1: Linear Programming Results Pre-Harvest Season

Source: Survey Data

Figure 5-1 presents results for pre-harvest survey diet optimisation problem. An individual may spend a minimum of TZS1003.2 eating required diet while meeting all constraints. When budget was raised above TZS1417.05 no further diet changes occur.

As budget gradually decreased, individuals increased their consumption of energy dense foods such as cereals (especially donuts and rice) and sugar. Consumption of sweet potatoes increased because they were widely available while that of Irish potatoes decreased because these were not grown in the areas and more expensive. Consumption of legumes slightly decreased while that of meats, fish and poultry was notably decreased even with a slight decrease in budget.



	1,417.05	1,400.00	1,300.00	1,200.00	1,100.00	1,003.12
Carbohydrates and Sugars	291,306.2	291,350.1	292,544.2	294,695.6	302,710.8	316,309.1
Fats and Fatty Acids	63,654.82	63,657.23	63,063.61	62,333.17	61,757.94	56,093.98
Proteins	145,048.2	144,856.6	143,721.4	142,747.2	137,318.9	134,475.0
Minerals	3,143.53	3,091.30	2,821.00	2,676.73	2,627.53	2,449.89
Other Vitamins	106.06	105.15	99.87	85.39	78.56	59.16
Vitamin A	7.92	7.86	7.52	7.46	3.23	0.15

Figure 5-2: Post-Harvest Nutrient Consumption

Figure 5-2 represents nutrients consumed from optimal food portion sizes. In pre-harvest, a decrease in budget increased consumption of carbohydrates and sugars with a notable decline in consumption of vitamin A. Further, there is a slight decline in consumption of proteins, fats and fatty acids, minerals and other vitamins.

Daily budget of between TZS1003.12 and 1417.05 per person (adult equivalence) meant that it required a minimum food budget of approximately TZS30,096 and a maximum of TZS42,511.50 per person to meet the target energy level in a 30-day month during lean season. Considering household sizes and household incomes, this diet was difficult to afford for some households.

Table 5-4: Comparison between Feasible Food Budget, Household Size and Household Income for overall sample in Pre-Harvest

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	3.98	1,461,224.84	206.60	2,064,188.39	291.85
2	<1,424,972.06	4.04	1,483,253.36	104.09	2,095,306.81	147.04
3	<2,991,933.91	4.00	1,468,567.68	49.08	2,074,561.20	69.34
4	>2,991,933.91	4.62	1,696,195.67	56.69	2,396,118.19	80.09
Overall Mean	2,755,227.16	4.15	1,523,638.97	55.30	2,152,357.25	78.12

Source: Survey Data

Table 5-4 compares feasible food budget, household size and household income. Even the minimum target energy level is not affordable for poorest and lower-middle households. Even for upper-middle and wealthiest households and overall sample, it still takes a large part of their total annual income; the situation was worse for maximum budget.

Consumption of carbohydrates increased with decrease in budgets while that of proteins and fats and fatty acids slightly decreased with a decrease in budgets, and this is similar for minerals and vitamins.

5.4.3.2 Post-Harvest Results

In post-harvest, budgets were higher as individuals consumed more food varieties even though food costs were lower (Figure 5-3). Consumption of cereals decreased compared to pre-harvest diets whereas maize consumption increased with a decrease in budget. Consumption of roots and tubers increased because fresh sweet potatoes were harvested while items in fruits and vegetables and meats, fish and poultry groups were reduced when budgets were lowered. At minimum budget, there was very little consumption of fruits and vegetables and no consumption of meats, fish and poultry group while legumes (especially groundnuts), oils and sugar increased with budget decreases.

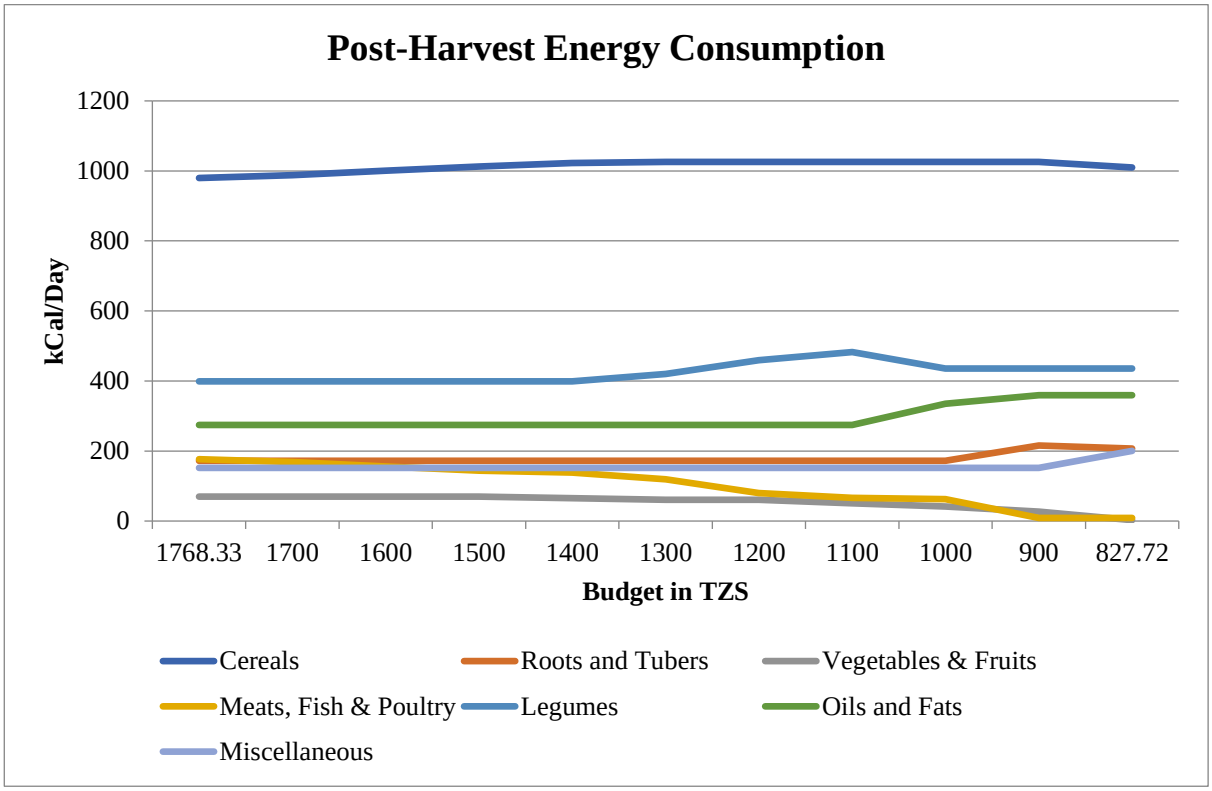
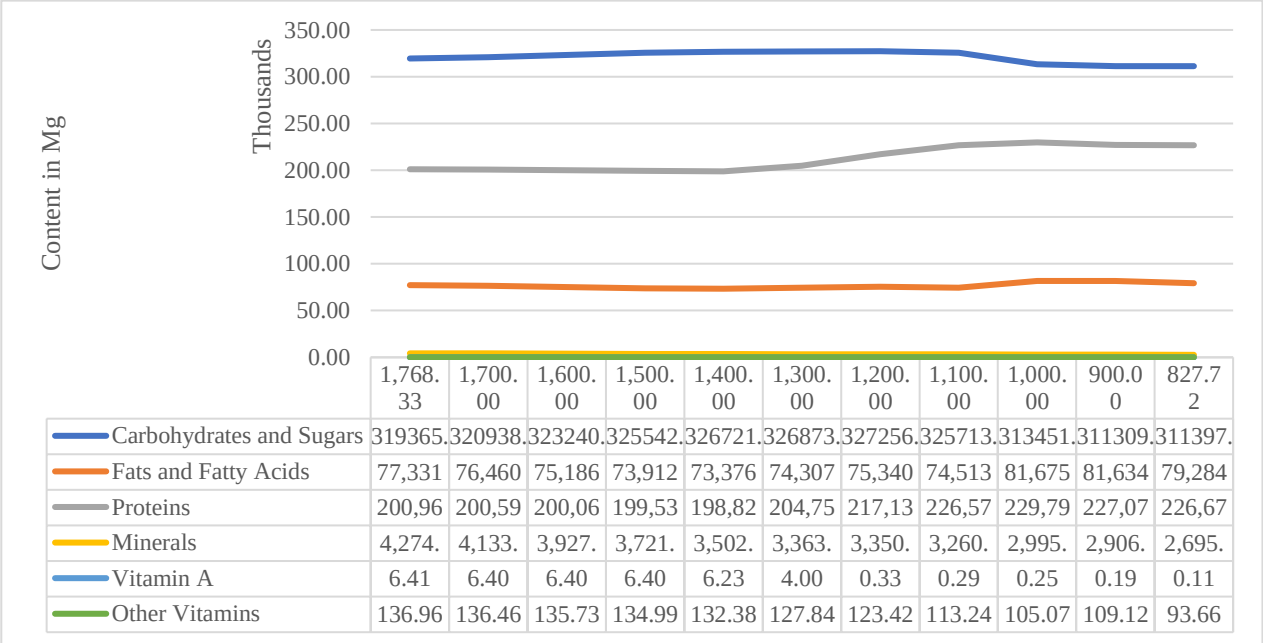


Figure 5-3: Linear Programming Results Post-Harvest Season

Source: Survey Data

From Figure 5-4, consumption of carbohydrates and sugars, other vitamins and minerals only slightly decrease when budget is decreased. However, consumption of vitamin A shows a significant decline while that of proteins and fats and fatty acids increased slightly.



	1,768.33	1,700.00	1,600.00	1,500.00	1,400.00	1,300.00	1,200.00	1,100.00	1,000.00	900.00	827.72
Carbohydrates and Sugars	319365.	320938.	323240.	325542.	326721.	326873.	327256.	325713.	313451.	311309.	311397.
Fats and Fatty Acids	77,331	76,460	75,186	73,912	73,376	74,307	75,340	74,513	81,675	81,634	79,284
Proteins	200,96	200,59	200,06	199,53	198,82	204,75	217,13	226,57	229,79	227,07	226,67
Minerals	4,274.	4,133.	3,927.	3,721.	3,502.	3,363.	3,350.	3,260.	2,995.	2,906.	2,695.
Vitamin A	6.41	6.40	6.40	6.40	6.23	4.00	0.33	0.29	0.25	0.19	0.11
Other Vitamins	136.96	136.46	135.73	134.99	132.38	127.84	123.42	113.24	105.07	109.12	93.66

Figure 5-4: Post-Harvest Nutrient Consumption

One individual needed to spend between TZS827.72 and TZS1,768.33 a day equivalent to TZS24,831.6 and TZS53,049.9 a month in plentiful season.

Table 5-5: Comparison between Food Budget, Household Size and Household Income for overall sample in Post-Harvest

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	3.98	1,205,723.17	2,575,890.94	170.47	364.20
2	<1,424,972.06	4.04	1,223,899.90	2,614,723.47	85.89	183.49
3	<2,991,933.91	4.00	1,211,782.08	2,588,835.12	40.50	86.53
4	>2,991,933.91	4.62	1,399,608.30	2,990,104.56	46.78	99.94
Overall Mean	2,755,227.16	4.15	1,257,223.91	2,685,916.44	45.63	97.48

Source: Survey Data

Table 5-5 shows that even in post-harvest period, when households had harvested and there was more income, the poorest could hardly afford even minimum target energy level. Lower-middle households could afford minimum target diet but not maximum. Upper-middle and wealthiest households could afford both minimum and maximum

target diets, but they would need to spend a large part of their annual income on food alone.

There were limited food choices during pre-harvest compared to post-harvest season. At intervals of TZS100, only six combinations of budget points allowed optimization of objective function while staying within constraints in pre-harvest compared to eleven budget points in post-harvest. Pre-harvest diets were less expensive but also less energy was consumed compared to post-harvest diets. One person consumed up to 1951.95kcal per day in pre-harvest and spent between TZS1417.05 and TZS1003.12 while in post-harvest period, one person consumed up to 2223.56kcal and spent between TZS765.33 and TZS827.72. There was more energy intake in post-harvest season than in pre-harvest season because during pre-harvest season food items were scarce and expensive, limiting food choices compared to post-harvest season. Progressive budget reductions increased consumption of energy dense than nutrient dense foods; because most energy dense foods were cheaper than nutrient dense foods. Consequently, recommended energy intake of 2,100kcal was not met in pre-harvest. Participants in focus group discussions revealed a food consumption pattern consistent with these findings that in pre-harvest many households could not afford energy and nutrient rich food items and sometimes some households skipped meals or go the whole day without eating. Some households consumed maize porridge only, which contains nothing but maize flour and water denying them important nutrients. Other nutrients also showed a decline as budget decreased, except for carbohydrates and sugars in pre-harvest as they were cheaper than other foods and proteins, fats and fatty acids in post-harvest were cheaper than in pre-harvest.

In focus group discussions, participants explained that households consumed less than adequate diet in order to cater for other needs, such as school fees and other school needs for children, rent, medical care and emergencies, and clothing. It was difficult even for those who were considered *well-off* to manage all these needs with the income they earned and little to no alternative sources of income. On average rural Tanzanians spend about 70 percent of their household budget on food (Kassie et al., 2014) as found in this study. Daily food cost poverty line in Tanzania 2012 was TZS858 per adult equivalence (NBS, 2014c). This was below budget requirements found by these linear programming results. However, as the HBS was based on the whole of

Tanzania, food prices and other conditions may differ from this study. Nevertheless, as pre-harvest season is a rainy season and rural households had the option of using forest foods, especially fruits and vegetables, this would lower food burden on their incomes.

During focus group discussions and interviews with leaders and elders, it was revealed that some food items were considered inferior and that only the poor would consume. For example, sorghum rich in calories and cheaper grows well in an area like Kishapu with little rain, but people do not like to grow it and when they do, they would only consume when there was no maize or rice. If sorghum was largely consumed, it could easily satisfy energy needs even in pre-harvest. Linear programming solutions without minimum energy constraint for all samples indicated that individuals could choose a diet that was lower in energy and lower in cost. Consequently, they would end up receiving inadequate nutrients.

These findings are also consistent with findings from other studies such as those by Darmon and Drewnowski (2015) for France; a review of more than 3000 literature by Afshin et al.(2017); and decrease in food cost causes an increase in consumption of nutritious foods (Ball et al., 2015). Moreover, low-income individuals consume higher complex carbohydrate and lower minerals and vitamin A (Si Hassen et al., 2016). However, Kaushal and Muchomba (2015) found that price subsidies intended to reduce food cost did not increase consumption of nutritious foods, rather increased consumption of non-food items for poor households.

5.5 Policy Implications

Food costs and seasonality are important in determining whether or not individuals consume nutritious foods. Therefore, policies to improve household incomes, reduce food costs and reduce seasonal variations in food availability could play an important role in improving dietary choices. Such strategies may include improvement of transport infrastructure and rural markets, increase in off-farm activities such as entrepreneurship education and access to credit.

Cost of diet is an important consideration in policy contexts. While the poor spend most and sometimes more than 100% of income on food alone(Beyer et al., 2016; Kassie et al., 2014; Musgrove and Galindo, 1988), it is important to have specific

price-sensitive policies designed to help the rural poor. Since there are also differences in income among the rural poor, it is important to make considerations on measuring vulnerability for context-specific interventions because no policy is a one-size-fits-all for every household. Policies and strategies to address problems of high cost of nutritious foods should be considered to enable households with lower incomes to obtain affordable but nutritious diets.

Nutrition awareness could be an important approach to changing eating habits of individuals in rural Tanzanian societies but this should be supplemented by other approaches that may enhance food choices(Guthrie et al., 2015). Such policies could invest in strategies that would influence behaviour and perceptions of communities towards nutritious foods(Aunger and Curtis, 2016; Celis-Morales et al., 2016; Ruel et al., 2013). Other researchers find that nutritional education starting with school level for children is more effective(Hawkes et al., 2015), but should also go together with enabling disadvantaged groups to afford nutritious diets(Hirvonen et al., 2017). Higher incomes should be accompanied with interventions such as investments in health, education and access to drinking water for better nutrition(Soriano and Garrido, 2016). Even though individuals in developed countries might be consuming nutrient rich expensive foods because they have enough income to do so, knowledge about nutrient content plays an important role in their decisions(Darmon et al., 2006; Si Hassen et al., 2016). Most foods in rural markets in Tanzania have no nutritional information attached, therefore, even with nutrition awareness, strategies to make sure that nutritional information is available can play a vital role in influencing consumption decision of rural Tanzanians.

Ability to recover from food security shocks caused by factors outside households' control such as seasonality and price changes, will largely influence resilience in household food security and nutrition. There are unique behaviours which make some groups more resilient than others (Aggarwal et al., 2016; Dufour et al., 2014) and should be identified and built upon for the benefit of others. Since indigenous forest foods contribute to dietary diversity and income(Ntwenya et al., 2017; Ochieng et al., 2018), strategies to domesticate and improve markets for such foods could also be important for rural communities.

5.6 Acknowledgements

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6.0 LINEAR PROGRAMMING RESULTS DISAGGREGATED FOR KISHAPU AND MVOMERO SAMPLES SEPARATELY

6.1 Introduction

In the previous chapter, the discussion was based on the overall data from combined samples of Kishapu and Mvomero Districts. However, these two districts differ in many aspects, not just in location and rain patterns, but also the data distributions show differences in consumption patterns, incomes and food prices. This therefore provides the basis for a separate discussion that disaggregates the two sub-samples and analyse the differences observed between them.

In this chapter, a similar methodology was adopted to the one used in Chapter 5. The linear programming approach: assumptions, limitations and optimisation problems are the same. Therefore, the key issue of how food prices affect household consumption of nutritious foods and the impact this has on nutrition status of rural households is addressed with respect to Kishapu and Mvomero rural households.

The research set out to examine the linkages between local food economies and household nutrition in rural Tanzania. In doing so, one of the specific objectives was to examine the effect of cost of diet on choice of food items consumed in the household. This has been addressed in the previous chapter with detailed methodology, findings and discussion from the combined samples of Kishapu and Mvomero Districts.

6.1.1 Farm and Off-Farm Income Sources

More of the households' income comes from farming activities especially in Kishapu where only 15.63 per cent of all income comes from other economic activities. There is more off-farm activity in Mvomero that contributes up to 47.17 per cent of household income. There is observed higher dependence on farm incomes in Kishapu than in Mvomero.

Table 6-1: Percentage of Income from Farm and off-Farm Sources

District		Farm income	Off-Farm Income
Kishapu	**Mean**	84.37%	15.63%
	N	255.00	255.00
	Std. Dev.	24.52	24.52
Mvomero	**Mean**	52.83%	47.17%
	N	251.00	251.00
	Std. Deviation	33.97	33.97
Total	**Mean**	68.72%	31.28%
	N	506.00	506.00
	Std. Deviation	33.51	33.51

6.2 Linear Programming Results

In this chapter, a similar methodology was adopted to that used in the previous chapter. Therefore, the key issue of how food prices affect household consumption of nutritious foods and the impact this has on nutrition status of rural households is addressed with respect to Kishapu and Mvomero rural households.

The following results are categorised into four parts: Kishapu Pre-Harvest, Kishapu Post-Harvest, Mvomero Pre-Harvest and Mvomero Post-Harvest. The discussions below each result are then summarised and compared between districts in the next sub-section.

6.2.1 Kishapu Pre-Harvest

The Kishapu sub-sample pre-harvest results exclude one food item: coconut. This is because it was not consumed in pre-harvest and averaged to zero, making the TDMI invalid. Kishapu, which is a very dry area in most part of the year, has average rains in the pre-harvest season. Figure 6-1 below presents changes in energy contribution from the food groups as the budget changes in Kishapu during the pre harvest season.

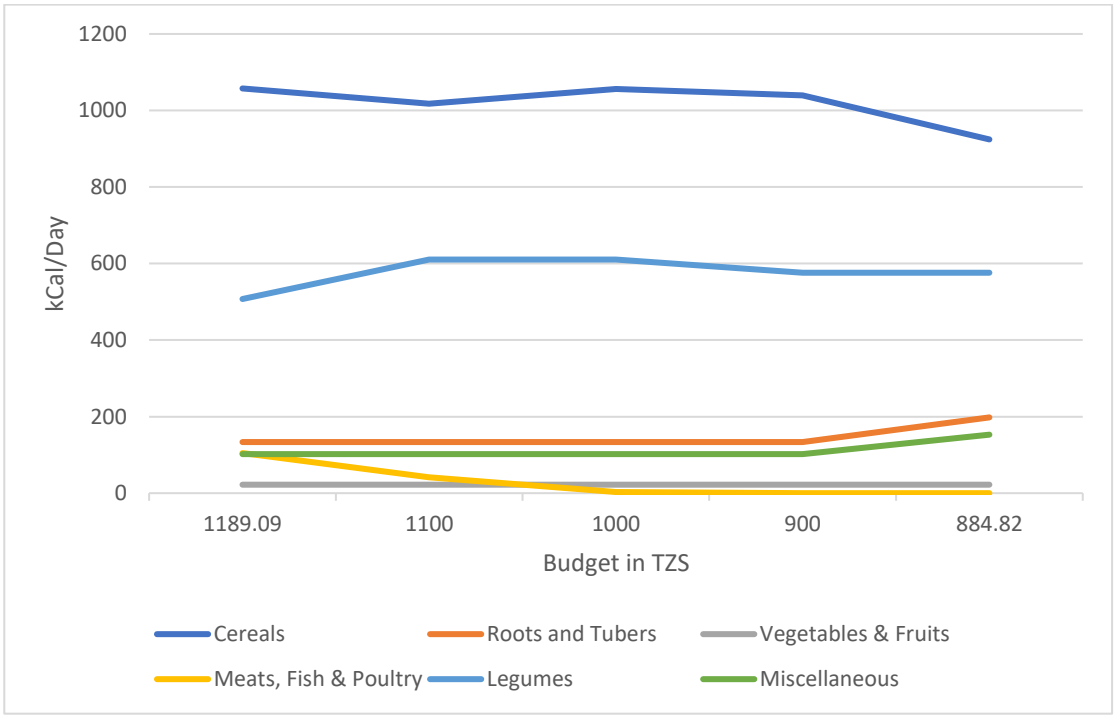


Figure 6-1: Results for Kishapu Pre-Harvest

It is observed that most energy is consumed from cereals followed by legumes. Consumption of vegetables and fruits remains the same. From key informant interviews and focus group discussions, sorghum is considered inferior to maize and individuals would consume sorghum only when they do not have maize. This is also featured in the results above as the budget decreases, consumption of sorghum is progressively increased while that of maize and rice is reduced. Rice, considered superior compared to maize and sorghum, is more expensive and its consumption is reduced to zero.

Sweet potatoes are commonly grown in the rainy season and after harvesting they are dried and produce dried sweet potato wedges/slices they call "*michembe/mapalage*".

These provide some sort of security towards food shortage in the lean season. Consequently, the consumption of sweet potatoes increased with a decrease in budget as these were readily available in the households. Items in the fruits and vegetables group as well as the meats, fish and poultry group were consumed less and less when budgets were progressively lowered, at the minimum budget, there is no consumption of any items in these groups. The consumption of groundnuts, oils and sugar increases with budget decreased especially in the lowest budget.

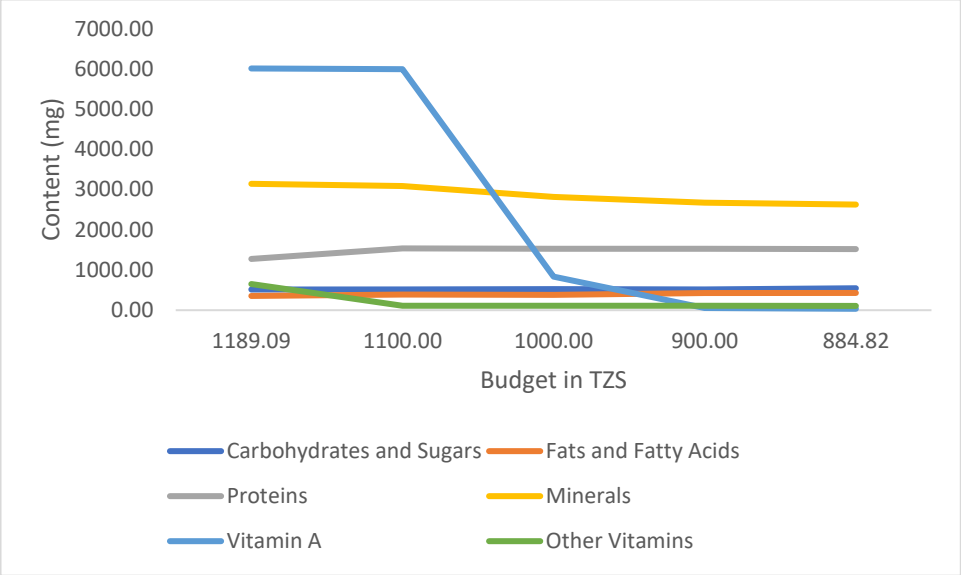


Figure 6-2: Kishapu Pre-Harvest Nutrient Consumption

Figure 6-2 shows nutrients consumed from optimal food portion sizes. In Kishapu pre-harvest, a decrease in budget increased consumption of carbohydrates and sugars with a noted decline in consumption of vitamin A and other vitamins. Further, there is a slight decline in consumption of proteins, fats and fatty acids, and minerals. The linear programming results show that a progressive reduction in budget, given the cost and types of foods available in the lean season, produces feasible diets ranging from TZS 801.55 and TZS 1189.09 a day equivalent to TZS 24,046.5 and TZS 35,672.70 in a 30-day month.

Table 6-2: Comparison between Choice Diet, Household Size and Household Income for Kishapu in Pre-Harvest

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	4.56	1,337,754.89	189.14	1,984,543.65	280.59
2	<1,424,972.06	4.51	1,323,086.52	92.85	1,962,783.30	137.74
3	<2,991,933.91	4.97	1,458,035.48	48.73	2,162,978.49	72.29
4	>2,991,933.91	5.12	1,502,040.58	50.20	2,228,259.53	74.48
Overall Mean	2,755,227.16	4.75	1,393,494.68	50.58	2,067,232.97	75.03

From

Table 6-2, results indicate that households in the first income quartile could not afford even the minimum feasible diet because it is more than 180% of their annual income, much more for the maximum feasible diet. However, those in the second income quartile could barely afford the minimum diet but not the maximum diet. Households in the third- and fourth-income quartiles were better off because even the maximum feasible diet is not more than three quarters of their annual incomes.

6.2.2 Kishapu Post-Harvest

The Kishapu sub-sample post-harvest results exclude one food item: cassava. This is because it was not consumed in post-harvest and averaged to zero, making the TDMI invalid. Overall, energy contribution from cereals was highest and increasing similar to pre-harvest season. The second contributor to energy consumption was legumes, while consumption of oils and fats as well as vegetables and fruits showed no change with respect to budget changes as shown in Figure 6-3.

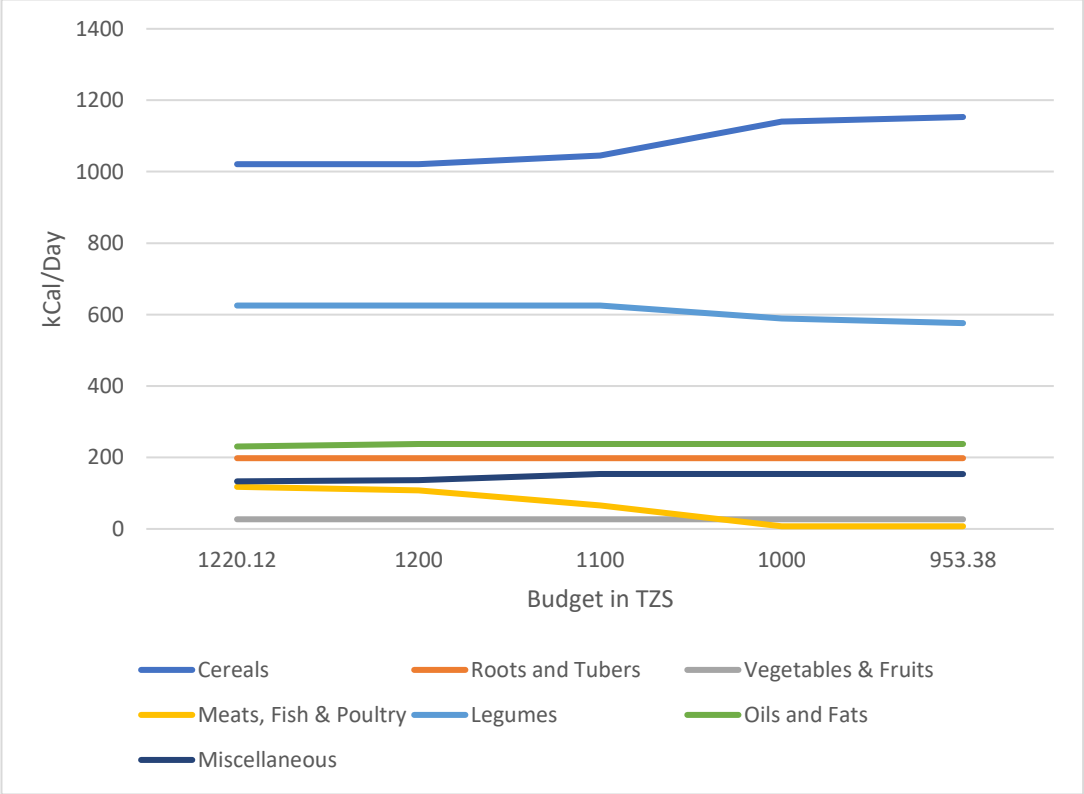


Figure 6-3: Results for Kishapu Post-Harvest

There is less consumption of sorghum in post-harvest period; and with a further reduction in budget its consumption falls to zero. While consumption of rice was much

less in pre-harvest, in post-harvest there is more consumption of rice but still a further budget reduction reduces it to zero. Wheat, which was not consumed in pre-harvest, was now consumed and even though it is bought, its consumption increases as this is the time people have income flowing into the household. Consumption of maize is also reduced as budget decreases, but at the very minimum, it is again increased.

Consumption of cassava decreased while that of sweet potatoes increased with budget reductions. In the fruits and vegetables category, fruits were consumed in the household but at minimum budget there is no consumption of any items in this group. Consumption of meats, fish and poultry was also lowered to zero except for milk. Consumption of groundnuts and oils increased with budget reduction while that of sugar was reduced. These consumption changes are also reflected in consumption of other nutrients as shown in Figure 6-4 below.

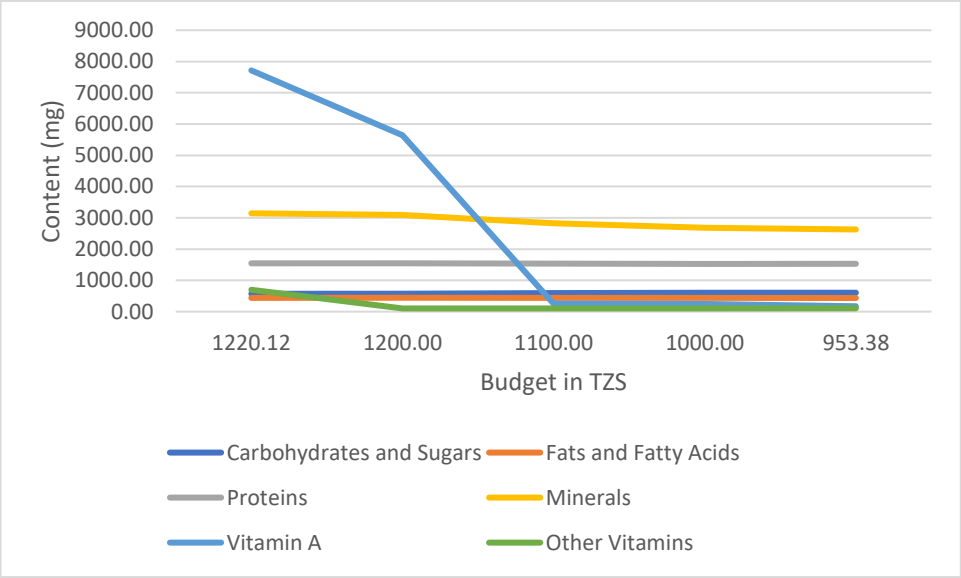


Figure 6-4: Kishapu Post-Harvest Nutrient Consumption

During the post-harvest season, a similar trend is observed, where consumption of vitamin A significantly declines with budget decreases with that of other vitamins also declining. Consumption of carbohydrates, minerals, fats and fatty acids also remains more or less the same.

To attain a choice diet, an adult person would spend between TZS 887.50 and TZS 1147.17 per day which; equivalent to TZS 26,625.00 and TZS 34,415.10 a month respectively.

Table 6-3: Comparison between Choice diet, Household Size and Household Income for Kishapu in Post-Harvest

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	4.56	1,481,202.00	209.42	1,914,580.84	270.70
2	<1,424,972.06	4.51	1,464,960.75	102.81	1,893,587.63	132.89
3	<2,991,933.91	4.97	1,614,380.25	53.96	2,086,725.17	69.75
4	>2,991,933.91	5.12	1,663,104.00	55.59	2,149,704.81	71.85
Overall Mean	2,755,227.16	4.75	1,542,918.75	56.00	1,994,355.05	72.38

The post-harvest choice diets from Table 6-3 were more expensive for households and much less affordable for those in income quartiles 1 and 2 in Kishapu. Those in quartiles 3 and 4 could still afford choice diets for the post-harvest period in Kishapu even though they have relatively larger households compared to the poorer households.

6.2.3 Mvomero Pre-Harvest

In Mvomero on the other hand, total energy contributed by each group remained the same for cereals, roots and tubers, as well as vegetables & fruits groups. There was slight decrease in energy contributed by meats, fish and poultry group as shown in Figure 6-5.

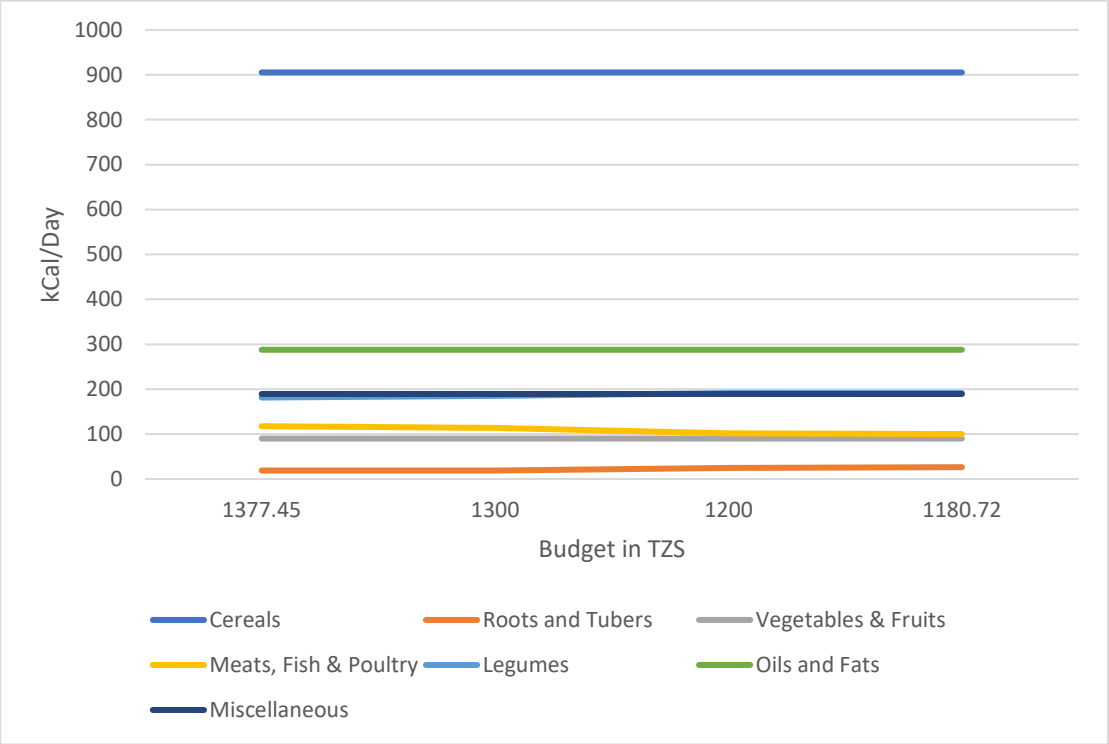


Figure 6-5: Results for Mvomero Pre-Harvest

On the other hand, regarding nutrient consumption in Mvomero, a different picture emerges with the consumption of vitamin A showing an increase while other nutrients showing some slight changes as in Figure 6-6 below.

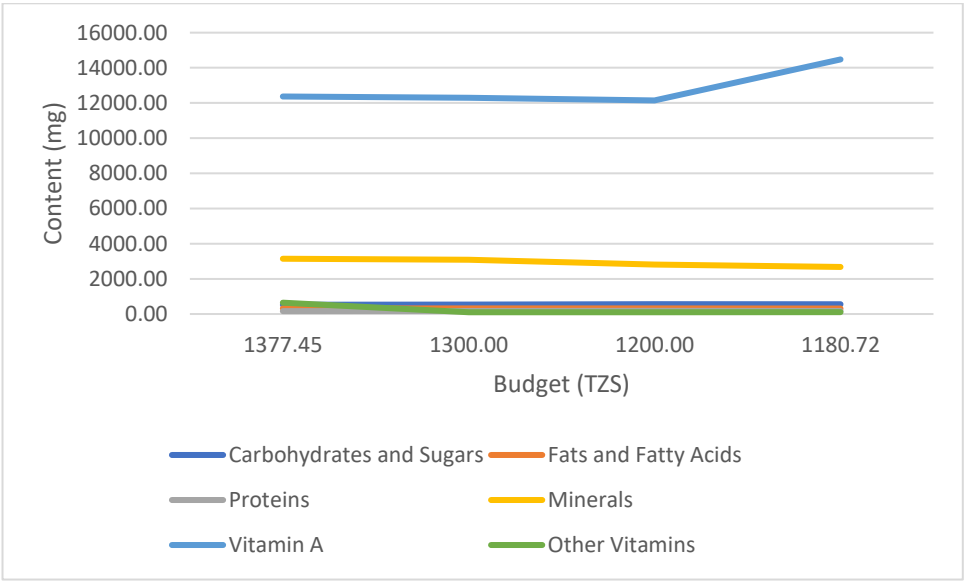


Figure 6-6: Mvomero Pre-Harvest Nutrient Consumption

An adult person in Mvomero consumed between TZS141.15 and TZS 935.98 on food per day this is similar to TZS 28,079.40 and TZS 42,528.00 a month respectively in the pre-harvest period. Consumption of items in the cereals and roots and tubers groups increased with budget reductions. Vegetables and fruits as well as meats, fish and poultry consumption were reduced when budget decreased. On the other hands, beans, oils and sugar were increased when budget is reduced.

Table 6-4: Comparison between Choice diet, Household Size and Household Income for Mvomero in Pre-Harvest

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	3.42	1,171,584.89	165.65	1,774,438.27	250.88
2	<1,424,972.06	3.39	1,161,307.83	81.50	1,758,873.02	123.43
3	<2,991,933.91	3.41	1,168,159.20	39.04	1,769,249.86	59.13
4	>2,991,933.91	4	1,370,274.72	45.80	2,075,366.40	69.37
Overall Mean	2,755,227.16	3.55	1,216,118.81	44.14	1,841,887.68	66.85

From Table 6-4, the poorest households in quartile 1 and 2 were less able to consume even the minimum feasible diet while those in the second quartile could at least consumer the minimum diet. Those is the third and fourth quartiles were more able to afford both the minimum and maximum choice-diets from their annual incomes.

6.2.4 Mvomero Post-Harvest

During the post-harvest season in Mvomero, observable changes emerge in the energy contribution from all groups. While in pre-harvest most groups showed no change, in this season energy contribution from cereals increases with budget decrease, while from fats and oils slightly decreases. Other groups also show a similar trend as in Figure 6-7.

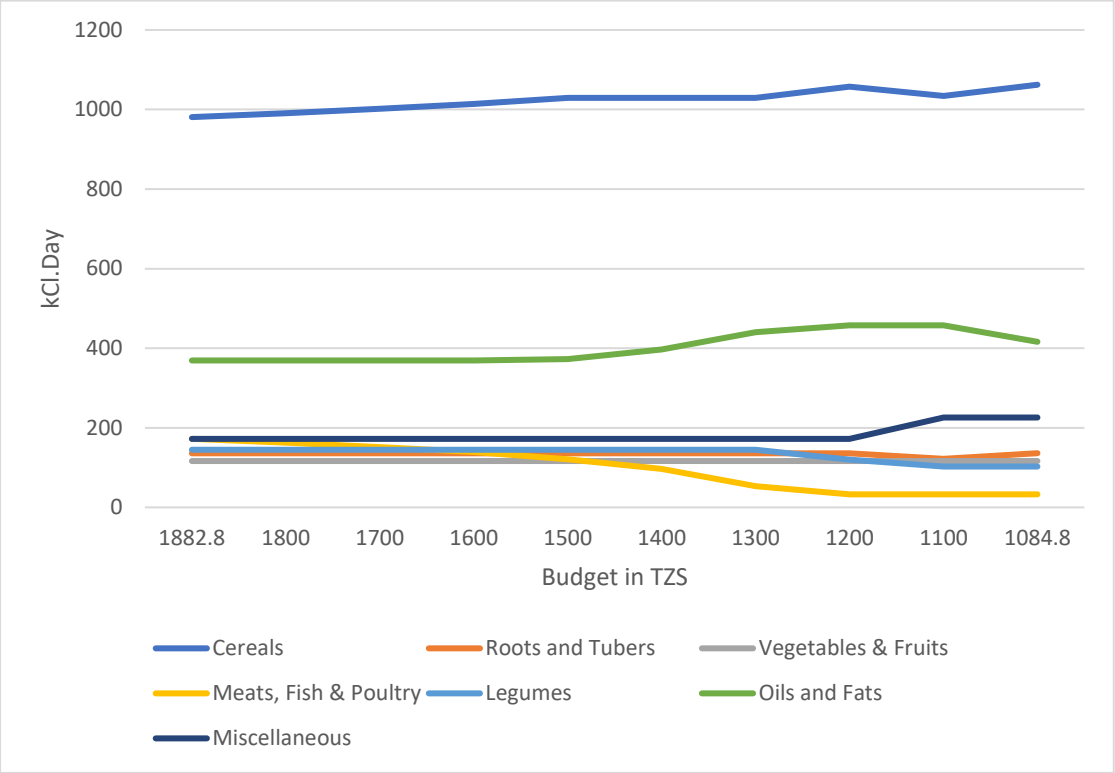


Figure 6-7: Results for Mvomero Post-Harvest

Consumption of specific food items in the cereals group increased with budget reductions as well as in the roots and tubers group. On the other hand, consumption of vegetables and fruits and well as meats, fish and poultry is reduced except for milk whose consumption is similar throughout. Moreover, the consumption of oils, sugar and groundnuts was increased with budget reduction.

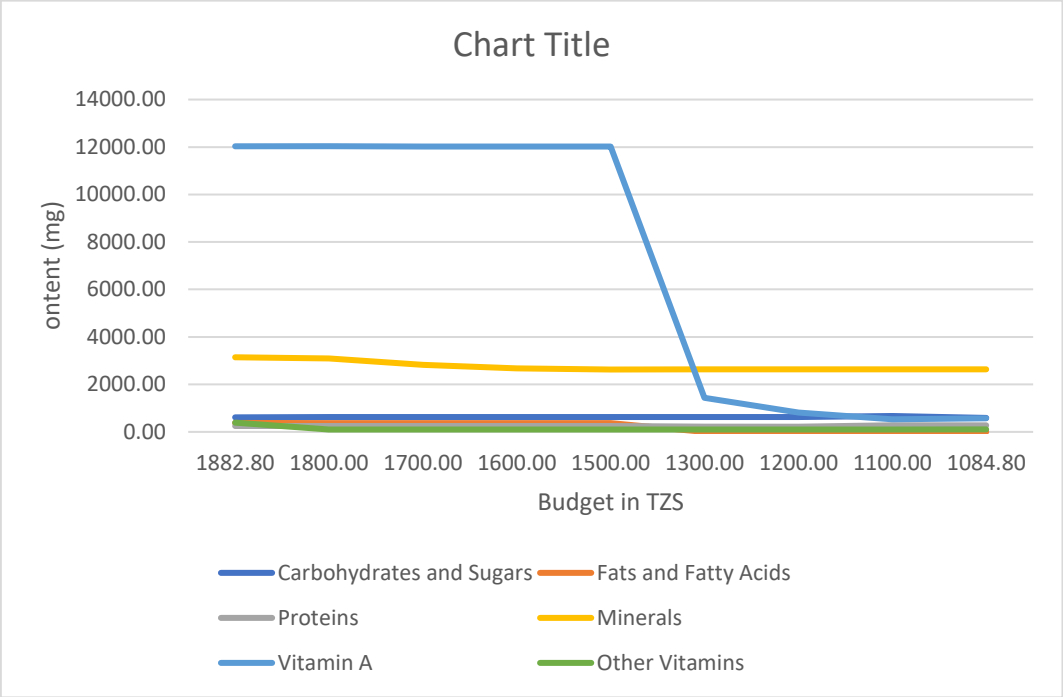


Figure 6-8: *Mvomero Post-Harvest Nutrient Consumption*

Also, in the post-harvest season, consumption of all nutrients falls with the decrease in budget. Vitamin A also show a major decline as presented in Figure 6-8 above.

The budget for choice diet ranged from TZS 936.37 to TZS 1919.63 per day or monthly from TZS 28,091.10 and TZS 57,588.90 in a 30-day month.

Table 6-5: *Comparison between Choice diet, Household Size and Household Income for Mvomero in Post-Harvest*

Quartile	Annual Average Household Income (TZS)	Average Household Size	Amount needed to attain target energy level per year			
			Minimum		Maximum	
			TZS	% on household income	TZS	% on household income
1	<707,272.74	3.42	1,172,073.06	165.72	2,402,839.26	339.73
2	<1,424,972.06	3.39	1,161,791.71	81.53	2,381,761.73	167.14
3	<2,991,933.91	3.41	1,168,645.94	39.06	2,395,813.42	80.08
4	>2,991,933.91	4	1,370,845.68	45.82	2,810,338.32	93.93
Overall Mean	2,755,227.16	3.55	1,216,625.54	44.16	2,494,175.26	90.53

Table 6-5 shows that households belonging to the first income quartile could not afford both minimum and maximum choice-diets while those in the second income

quartile could only afford the minimum diet even though it takes a large part of their annual income. Households in the third- and fourth-income quartiles were better able to afford both the minimum and maximum choice diets, but the maximum diet takes much more from their incomes.

6.3 Summary Results and Discussion

The linear programming results indicate that the pre-harvest diets are less expensive but also less energy is consumed compared to the post-harvest diets. For the overall sample, one person consumed up to 1951.95kcal per day in pre-harvest and spent between TZS 1417.05 and TZS 1003.12 while in the post-harvest period, one person can consume up to 2223.56kccal and spend between TZS 1768.33 and TZS 827.72. For the Kishapu sample, one adult consumed up to 2111.36kcal in pre-harvest while spending between TZS 884.84 and TZS 1189.09 whereas during the post-harvest period, the same individual consumed up to 2353.12kcal and spent between TZS 1220.12 and TZS 953.38 on food. On the other hand, in Mvomero, an adult person spent between TZS 1180.72 and TZS 1377.45 while consuming 1790.01kcal in pre-harvest; and during the post-harvest an adult person spent between TZS 1882.80 and TZS 1084.80 while consuming 2091.96kcal.

It is observed that there is more energy intake in the post-harvest season than in the pre-harvest season for both the combined sample and disaggregated samples. This could be attributed to the fact that during the pre-harvest season, food items are scarce and expensive, limiting choices and hence total energy intake than in the post-harvest season. The findings also show that, overall, a person reduces the consumption of nutrient dense foods and moves towards the consumption of energy dense foods as the budget is decreased. This is because most of the energy dense foods are cheaper than their nutrient dense counterparts. Consequently, in the pre-harvest season, an adult person does not consume the recommended energy intake of 2100kcal as suggested by (WFP, n.d.).

Further, consumption of other nutrients shows the same trend as the consumption of energy. At lower budget points, individuals in both study areas consume less vitamin A and more carbohydrates, except for the Mvomero sample in pre-harvest period.

Food items rich in vitamin A and other vitamins are also expensive for the households to consume.

A study on the economic lives of the poor, included 13 countries of which one was Tanzania, found that the rural poor spend about 58 to 76 per cent of their budgets on food alone (Banerjee and Duflo, 2007); this concurs with the results from this study where more than 90 percent of all monthly household expenditure is on food and more than 70 percent of total annual income is spent on bought food in Mvomero and more than 90 percent in Kishapu. The Tanzania Household Budget Survey 2012 for a food basket of 2,200 kilocalories reports the daily cost of TZS 858 per adult equivalent. This budget is below the minimum choice diet found by these liner programming results. When the model was constrained with the food poverty line of Tanzania of TZS 858, no feasible solution was obtained. The most minimum budget yielding a feasible solution was TZS 884.84 in Kishapu and TZS 953.38 in Mvomero, which are above the TZS 858 line. Therefore, with TZS 858, an individual in these two study areas will not be able to achieve any choice diet while fulfilling the linear programming constraints. However, the HBS was based on the whole of Tanzania, where food prices and other conditions may differ from the study area. Nevertheless, it should be remembered that the pre-harvest season is a rainy season, and during this season rural households have the option of using forest foods especially fruits and vegetables, this would lower their burden on the little income they have.

For both districts, the mean target energies were higher in Kishapu than in Mvomero in both seasons. Nevertheless, the budget range for these diets were lower in Kishapu than in Mvomero for both seasons. This could be attributed to the fact that, people in Kishapu consumed sorghum, which is cheaper, and more energy dense than other cereals considering that cereals contribute more to a person's diet than other food groups in the study areas.

In both seasons, the target energy for Kishapu met the recommended daily intake of 2100kcal. Whereas, the target energy for Mvomero for both seasons did not meet the recommended amount. In pre- and post-harvest Kishapu, at intervals of TZS 100, there were 5 combinations of diet bundles and budget points for each that allowed an individual to meet the objective function while staying within the constraints. While, in Mvomero there were four combinations in pre-harvest and ten combinations in post-

harvest. Pre-harvest choice diets were less expensive in both districts compared to their respective post-harvest diets.

In semi-arid areas like Kishapu, some crops grow better than others because of their resilience on the harsh conditions of the areas. Sorghum for example, grows well in Kishapu but households do not prefer to cultivate this crop as it is considered inferior. Both focus group discussions and key informant interviews gave information on how disliked sorghum is. This dislike is also translated in lower consumption even though it contains more energy than many other cereals consumed in the households.

As informed by focus group discussions and interviews with leaders and elders, most foods are eaten as a custom and in the community some foods are such as sorghum are not preferred and are deemed inferior. Also, many poor households can hardly afford a single meal, which makes it even more difficult for them to afford the vitamin rich foods. Linear programming solutions without minimum energy constraint for all samples indicated that individuals can choose a diet that was lower in energy and lower in cost. Consequently, they would end up receiving inadequate nutrients.

Findings from this chapter are similar to the findings by other researchers that examined the effect of diet costs on food choices in France (Darmon et al., 2006). Moreover Afshin et al.(2017) reviewed more than 3000 literature and found the same results. A decrease in food cost caused an increase in consumption of nutritious foods (Ball et al., 2015). Low-income individuals consume higher complex carbohydrate and lower minerals and vitamin A (Si Hassen et al., 2016). However, even when subsidies are intended to make nutritious diets more affordable so that low-income individuals could consume them, Kaushal and Muchomba (2015) found that these subsidies instead increased consumption of non-food items for poor households.

It is important for governments, non-governmental organisations and other institutions either directly or indirectly concerned about individual and household nutrition to provide nutritional education to the population so that everyone makes an informed choice when consuming food. Most of the choices they make so far are not informed on the nutritional value of the foods they consume and the benefits these foods have to their bodies. Moreover, traditions play a role in the food choices of people because, traditionally, the main staple of Tanzanians is *Ugly* (maize meal) or rice which always

takes a large portion of the daily diet. Education will help them compliment their main staple with appropriate food items from other food groups.

Because poor people spend a large part of their household income on food(Beyer et al., 2016; Kassie et al., 2014; Musgrove and Galindo, 1988) (as observed in this study); they need nutritional education supplemented with other approaches (Guthrie et al., 2015) and strategies such as government policy that necessitates food producers/suppliers to provide nutritional information so that it can influence consumption decisions of Tanzanians may have more meaningful results. Also, strategies to influence behaviour and perceptions of communities towards nutritious foods (Aunger and Curtis, 2016; Celis-Morales et al., 2016; Ruel et al., 2013) are necessary. These strategies should also target other more vulnerable groups is societies such as children and disadvantaged groups (Hawkes et al., 2015; Hirvonen et al., 2017).

If there existed no cost constraints, people tend to choose diets rich in fish and fruits which are expensive and would not easily be afforded when the cost constraint is included (Darmon et al., 2006). However, even with higher incomes, if health is not improved, people will spend their money in medical care instead, therefore investments in health, education and access to drinking water for better nutrition are necessary (Soriano and Garrido, 2016).

7.0 LOW-INCOME HOUSEHOLDS' FOOD AVAILABILITY AND COPING STRATEGIES IN TANZANIA: THE CASE OF KISHAPU AND MVOMERO DISTRICTS

7.1 Introduction

The main research problem addressed in this thesis is how local food economies impact household nutrition in rural Tanzania. In addressing this problem, the study set out to examine factors within the local food economy as they are linked to household food security and nutrition. The previous chapters have discussed the linkage between household incomes, market access and food security as well as cost of diet and food security in rural Tanzania. This chapter explores the coping strategies of low-income farm households when they are faced with threats relating to food security.

Tanzania is a developing country whose economy is dominated by dependence on agriculture and agriculture related activities. Since its birth, Tanzania as a nation has derived a good part of its income from agriculture even though its value added as percentage of GDP has been declining with the rise of other sectors (World Bank, 2018j). A large majority of Tanzanian citizens are employed in agriculture especially in the rural areas (NBS, 2013, 2014d, 2015).

7.2 State of Food and Income Availability

Many of the sampled households accessed most of the food consumed from purchases. During the pre-harvest period, Kishapu household bought about 73.66 percent of all foods consumed in the household, while in the post-harvest period bought food declined to 64.97 percent but still more than any other source of food. On the other hand, in Mvomero bought food comprised 90.23 percent and 88.95 percent in pre-harvest and post-harvest periods respectively (

Table 7-1). All this shows a high dependence on the market.

Table 7-1: Percent of bought foods

District	Percent of Food Bought	
	Pre-Harvest	Post-Harvest
Kishapu	73.66	64.97
Mvomero	90.23	88.95
Total	81.88	76.86

Source: Household Survey Data

Food items such as maize and sorghum were consumed from own harvest both in pre- and post-harvest periods in both districts. In the post-harvest period, the percentage of bought food decreased because of availability of own production.

In line with this high dependence on bought foods, a large share of monthly household expenditure is on food rather than non-food items. More than 45 per cent of households in Kishapu had to walk more than 45 minutes to the weekly market. Whereas, in Mvomero only about 17 per cent of the households lived far from the market. The food was bought either from the local shops in the village or the weekly district markets which are far.

The months of December, January, February and March were identified as the common months that households lacked income coming into the household in Kishapu, Similarly in Mvomero they faced the same months lacking income with an additional month of April. On average there were 3 and 2 months of no income in Kishapu and Mvomero respectively. This lack of income during these months was accompanied by a shortage of food in the households. Again, during these months, there are no harvests and therefore food prices are higher than they were at other times. The market price survey data tool also indicated higher prices between the months of October to February. This makes households more vulnerable in terms of food security. Food expenditure comprised more than 90 percent of all monthly expenditure in a household in all study districts (

Table 7-2).

Table 7-2: Monthly Food and Non-Food Expenditures

Monthly Household Consumption		Pre-Harvest	Post-Harvest
Kishapu	Non-Food	2.54%	5.02%
	Food	97.46%	94.98%
Mvomero	Non-Food	4.94%	5.96%
	Food	95.06%	94.04%

Source: Household Survey Data

Meal frequencies slightly improved in the post-harvest season compared to the pre-harvest season in both districts and individual groups (children below the age of 5, female children between 6 and 18, male children between 6 and 18, lactating mothers, pregnant women, other adult women and adult men) in the household. For example, children less than five years of age ate up to 3.5 meals a day in the post-harvest period, while in the pre-harvest period they ate 3.2 meals in Kishapu. For Mvomero, children less than five years old ate 3.2 meals a day in pre-harvest and 3.4 meals in post-harvest as presented in Figure 7-1.

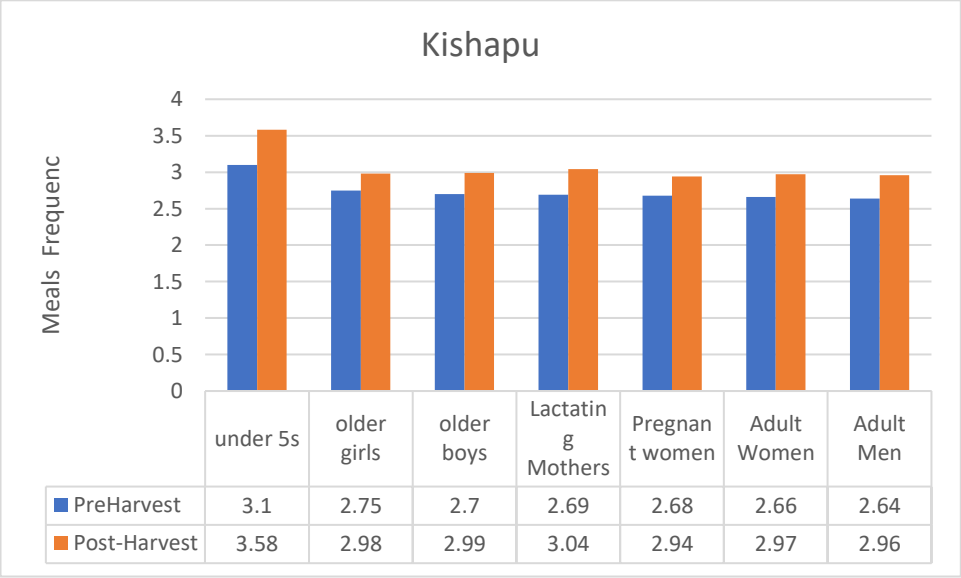
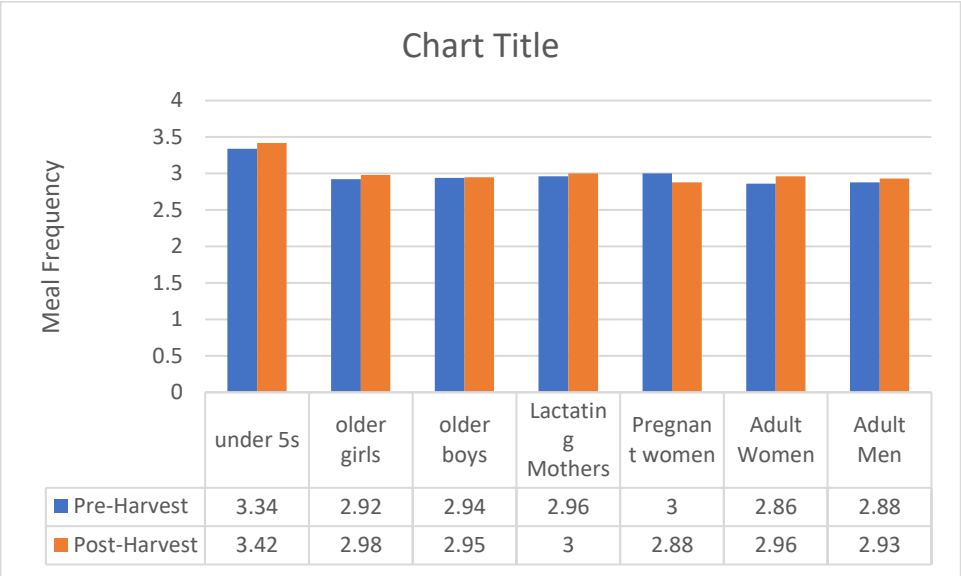


Figure 7-1: Meal Frequencies for the various individual Groups in the Household in Kishapu

Source: Household Survey Data

For Mvomero, children less than five years old ate 3.2 meals a day in pre-harvest and 3.4 meals in post-harvest. In both districts it is observed that other groups in the households ate fewer meals than children below the age of five (Figure 7-2).



	under 5s	older girls	older boys	Lactating Mothers	Pregnant women	Adult Women	Adult Men
Pre-Harvest	3.34	2.92	2.94	2.96	3	2.86	2.88
Post-Harvest	3.42	2.98	2.95	3	2.88	2.96	2.93

Figure 7-2: Meal Frequencies for the various individual Groups in the Household in Mvomero

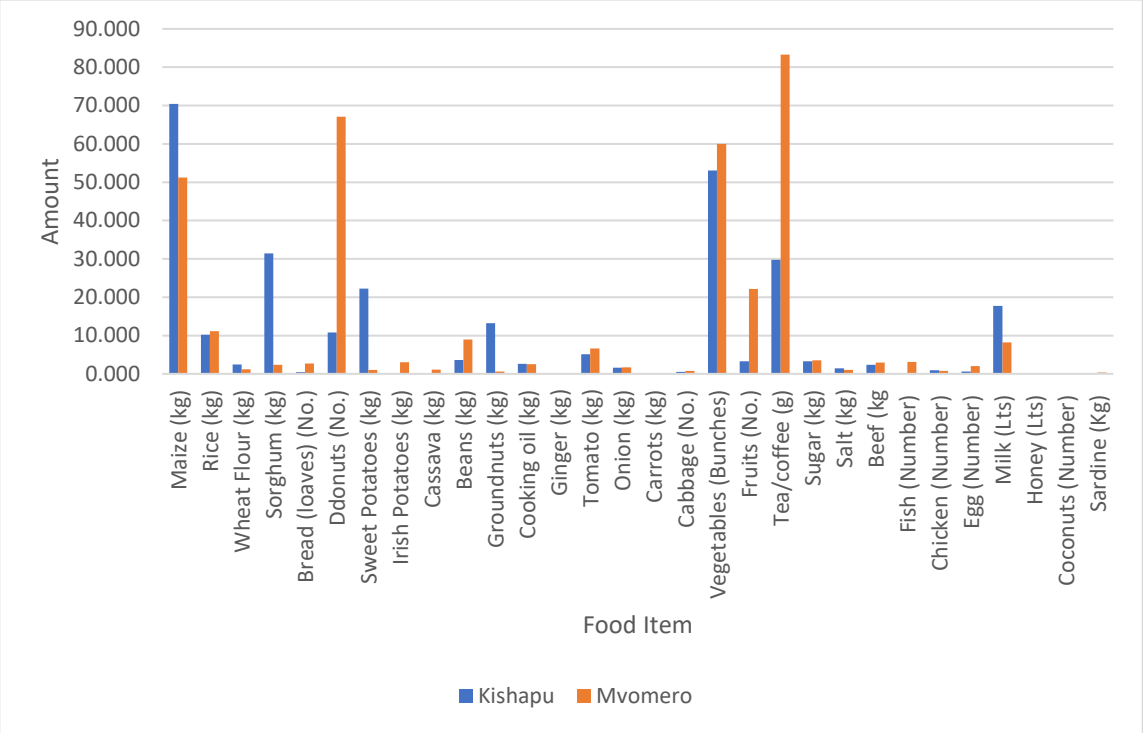
Source: Household Survey Data

7.2.1 Consumption Patterns

In both Kishapu and Mvomero, the staple foods consumed were cereals and most importantly maize followed by sorghum and rice, in both areas vegetables accompanied these as the side dishes in both areas. Consumption of meat, fish, chicken was very low in both areas and most especially in Kishapu. Households also consumed more tea and donuts as these were common breakfast items in both areas, together with sweet potatoes in Kishapu. Foods eaten in the households are mainly due to custom and availability. As discussed in focus group discussions, the usual breakfast item in Kishapu is soft maize porridge or sweet potatoes, locally named as *michembe*/*mapalage*, they cut the potatoes in wedges or slices then dry them after harvest, the dry potatoes can stay for a long time. When preparing as food, the dry potatoes are boiled and mashed and eaten with tea. In Mvomero breakfast is usually tea with leftover rice, donuts or bread, and sometimes, soft maize porridge. For lunch and dinner, they are used to eating the hard-maize porridge with vegetables or meat

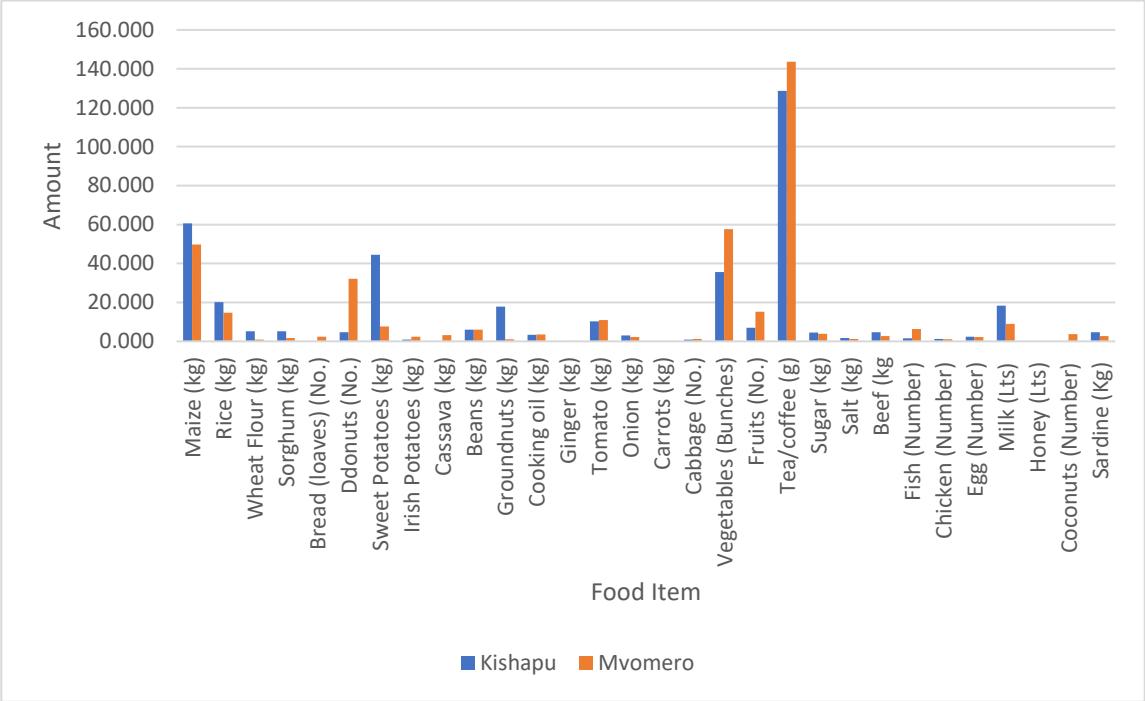
when available. But the main staple is the hard-maize porridge in both areas. Rice is also common but not for every household because it is more expensive than maize. *Makande* (a mix of maize and beans in one pot) is also largely consumed in both areas.

Table 7-3: 30-day Household Food Consumption in Pre-Harvest Period



A similar trend is observed in the post- harvest season of the common foods consumed. However, in the cereals group, consumption of maize and sorghum declined while that of maize and wheat flour increased. There was more consumption of milk in Kishapu than in Mvomero in both seasons and the consumption of vegetables decreased in both areas. In both seasons also, fruit consumption was greater in Mvomero than in Kishapu. There was an increase in the consumption of beef in Kishapu while in Mvomero there was a slight decrease. With the availability of fresh sweet potatoes in post-harvest, households shifted from consuming bread towards more sweet potatoes, these are both breakfast items.

Table 7-4: 30-day Household Food Consumption in Pre-Harvest Period



7.2.2 Food Security Status by Sex of Household Head

The table below (Table 7-5) presents the results of the paired sample t-test of food security and sex of the household head. The results indicate that female-headed households are more food insecure in terms of both household dietary diversity, household food insecurity access scale and household food insecurity access prevalence in both pre- and post-harvest seasons. The results are statistically significant as all results have a significance of 0.000.

Table 7-5: Paired Sample t-test Results according to Food Security and Sex of Household Head

Paired Samples Statistics							
	Sex of Household Head	HFIAS Pre-Harvest	HFIAS Post-Harvest	HFIAP Pre-Harvest	HFIAP Post-Harvest	HDDS Pre Harvest	HDDS Post Harvest
Mean	0.790	8.012	2.757	2.866	1.846	5.194	5.514
N	506	506	506	506	506	506	506
Std. Deviation	0.406	6.323	3.925	1.074	0.973	1.343	1.360
Std. Error Mean	0.018	0.281	0.175	0.048	0.043	0.060	0.060

Paired Samples Correlations						
	Sex & HFIAS Pre-Harvest	Sex & HFIAS Post-Harvest	Sex & HFIAP Pre-Harvest	Sex & HFIAP Post-Harvest	Sex & HDDS Pre-Harvest	Sex & HDDS Post-Harvest
N	506	506	506	506	506	506
Correlation	-0.141	-0.089	-0.109	-0.076	0.107	0.039
Sig.	0.001	0.046	0.014	0.087	0.017	0.378

Paired Samples Test								
	Paired Differences				Paired Differences	t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	95% Confidence Interval of the Difference			
				Lower	Upper			
Sex - HFIAS Pre-Harvest	-7.219	6.393	0.284	-7.778	-6.661	-25.404	505	0.000
Sex - HFIAS Post-Harvest	-1.964	3.982	0.177	-2.312	-1.617	-11.097	505	0.000
Sex - HFIAP Pre-Harvest	-2.073	1.189	0.053	-2.177	-1.969	-39.211	505	0.000
Sex - HFIAP Post-Harvest	-1.053	1.082	0.048	-1.148	-0.959	-21.893	505	0.000
Sex - HDDS Pre-Harvest	-4.401	1.361	0.061	-4.520	-4.282	-72.737	505	0.000
Sex - HDDS Post-Harvest	-4.721	1.404	0.062	-4.844	-4.599	-75.635	505	0.000

7.3 Causes of Food Shortage

In order to analyse coping strategies of households, it is important to first analyse the causes of food shortages in the household. To understand households' perceptions of what caused the shortage of food in the households, respondents were asked this question and the responses indicated that it was due to low harvest in the previous agricultural year. For Kishapu and Mvomero households, they grow crops once in one agricultural year, and the production the receive does not last them the whole year. Because of a lack of other sources of income, they find themselves selling food when in need of money for other household needs.

Furthermore, the high dependence on farming for income, leaves them with no food and no money to buy food even when it is available in the market. Therefore, apart from other reasons such as lack of land, lack of jobs and selling land for emergencies; a lack of money was another cause of food shortage in the households (Table 7-6).

Table 7-6: Causes of Food Shortage

Cause	Kishapu	Mvomero
Low harvest in the previous production season	96.2%	84.3%
Lack of Money	11.8%	13.8%
No Job/Means to get money	0.0%	2.5%
Lack of land	3.4%	8.2%
Large family	0.8%	2.5%
Did not farm	0.0%	0.6%
Sold for family emergency	0.0%	9.0%

Source: Household Survey Data

Additionally, societies in Mvomero and Kishapu engaged in socio-cultural activities that consumed a significant part of their food supply. For example, in Kishapu, weddings and *Ukombakomba* (joint farming of several household sin one farm) were indicated as major food draining activities while in Mvomero traditional dances were indicated as depleting food.

In Kishapu, problems of food shortage are common in the area as revealed in focus group discussions and key informant interviews. Drought is the main problem causing food shortage and some people would do irrigation farming if they have land close to the river and food would be bought from villages that had better food supply. On the other hand, Mvomero participants identified food shortage as a common problem and that to overcome, they have to sell their labour to earn income to buy food. Others would concentrate on business so as to earn extra income for their family needs. Such shortages have led to poor nutrition as one member was quoted “in short, our health in general is poor. Nutrition is poor, we do not have good nutrition. Everyone eats *ugali* (hard maize meal) and *mlenda* (vegetable side dish containing Corchorus leaves only), how will you get good health? You cannot”. They have little access to markets because of the bad roads in the area.

Moreover, in Kishapu there are practices such as wedding ceremonies and Ukombakomba (shared labour), which consume a considerable amount of food in the household. Weddings usually happen after harvest in the months between June and October, and Ukombakomba happens during farming, weeding and harvesting. In Mvomero, after harvesting in the months following August, up to November, is the time when most ceremonies such as weddings and celebrating the youths coming of age happen. Rainfalls have decreased compared to the past years and when things are

very bad, traditional rituals are done to call rain. Social activities such as weddings, and sometimes, traditional dances spend a good amount of food in the society leaving those involved with food shortage.

In the past the village had a practice where village elders would perform a ritual before anyone can start consuming their harvest, during this ritual meant part of the food is consumed. But nowadays, no one cares about performing such rituals. Also, Bambara Groundnuts are not allowed in the area and a majority farming cash crops instead of food crops mainly causes food shortage. Some people sell all their harvests and do not keep enough for future use. As in Milama, growing Bambara groundnuts is prohibited in Makuyu for the same reason.

7.4 Coping with Shortages of Food

In the face of these difficult conditions related to obtaining food for the household, members resort to finding means of dealing with the situation in order to provide for their families. In both districts, the most common method of dealing with shortages was to engage in casual labour so that they could earn a wage and be able to buy food. At the time of shortages, when crops have not ripened in the farms and there are those who need labour to weed their farms, there is a chance that a low-income household can earn a little income (Table 7-7). Fewer households indicated that they would sell livestock, especially in Kishapu, as livestock for them is a means of saving.

Table 7-7: How Households Deal with Food Shortage

Dealing with Food Shortages	Kishapu	Mvomero
Get food from the forest	4.7%	1.8%
Did not take any measure	0.4%	0.0%
Sell livestock to buy food	27.1%	5.3%
Borrow from neighbours and relatives	19.6%	20.7%
Engage in casual labour	63.1%	71.0%
Seek help from hamlet/village leader	3.1%	1.2%
Let the children eat first	1.6%	0.0%
Eat fewer meals	7.8%	4.7%
Do petty business (selling charcoal, *mikeka*, milk...)	5.1%	6.5%
Irrigation Agriculture for cash	1.2%	0.0%

Source: Household Survey Data

Another way of dealing with the scarcity of food was borrowing of either food or money from neighbours or relatives. In some instances, households ate fewer meals, as also revealed in focus group discussions where participants in both districts said they sometimes ate only one meal when conditions were really bad.

In some instances, households also sought foods from the forest, especially vegetables that grow well during the rainy pre-harvest period. These ease the burden of food shortages as they are available for free and were picked by women and female children. Furthermore, barter trade was practiced by a relatively small number of households in both districts, with common items given or received being maize, rice and groundnuts. There was no indication that they practiced barter trade between food and non-food items. This was a difficult trade as sometimes the giver might not have what the receiver needs, and therefore money would have to be involved. A small number of households worked for food, and for those who did, the foods received were mainly cereals (rice and maize).

In focus group discussions and key informant interviews it was revealed that, in Kishapu, when people run out of food, they resort to labour and purchase. Moreover, to earn extra income, some would sell charcoal and fuel wood. The tendency in the household at times of food shortage is to reduce meal frequencies except for the very young babies. In such situations, there are families that can only get one meal per day, even if it is not enough, it is shared within the family. Other families would cook only forest picked vegetables as they cannot afford even one kilogram of maize flour the main staple. Food is available in the market, the only problem they face is money to access that food from the market; thus, whose who can find day labour would do so to earn a little for food. During the time of food shortage, people would sell livestock or seek for day labour where they can earn a little income to cover for family meals.

Elders would go to the bushes and perform some rain rituals at times of drought. If there is food shortage, the only option available is for a person to work as labourer in other peoples' farms. Other people engage in the burning and selling of charcoal. It was noted that in the past, land acquisition was only one's ability to clear the unoccupied areas.

Food shortage was mainly associated with drought and laziness in farming, also sometimes overselling what was produced. At times of food shortage, most people would borrow from others who had enough reserve or government would assist at very severe shortage. Rain rituals are common when there is persistent insufficient rain and savings are just within the home.

7.5 Summary

This chapter presented the key challenges in relation to food availability and income in the study area, the reasons for these challenges and the coping strategies that households adopt to somehow survive through the challenges. Households in the study areas buy most of their non-cereal foods both during the pre- and post-harvest period, they are dependent on the market to obtain their food and non-food needs. Moreover, these rural households faced low production in the previous agricultural year and a lack of income strengthened their challenges in obtaining food. To cope with these challenges, households resorted to seeking casual labour, consuming forest vegetables, borrowing food or money, or eating fewer meals.

8.0 DISCUSSION AND CONCLUSION

8.1 Introduction

The key issue addressed in this study is how the operation of local food economies impact on the nutrition status of rural households in Tanzania. Knowledge about this is important because most rural households depend on agriculture for their income and food. Therefore, by analysing the local food economy it is possible to inform the households about the best way to achieve the best results in their daily practices of production, distribution and consumption of food for nutritional benefits. This can also help policymakers to identify key areas within food economies that need to be addressed in order to ensure better operation of the food economy and better nutritional outcomes.

To address this, the study set out to examine the linkages between local food economies and household nutrition in rural Tanzania by addressing the following specific objectives: to assess the linkage between low-income farm households' access to markets and food security; to examine the effect of cost of diet on choice of food items consumed in the household; and to identify policies and interventions which can positively impact on food access in rural Tanzania. The study was conducted in two distinctly different agro-ecological zones of Tanzania, namely Kishapu and Mvomero Districts. Data were collected during both pre- and post-harvest seasons in 2014 from 506 farm households through interviews, the use of household survey questionnaires, supplemented with monthly market price surveys, focus group discussions and key informant interviews. The study identified income groups (quartiles) and farming systems, and also calculated food security using Household Food Insecurity Access Scale (HFIAS) and Household Dietary Diversity Score (HDDS). In this chapter, theoretical, practical and methodological reflections of the study are done and followed by conclusions deduced from the specific objectives of this study.

8.2 Discussion

While linking local food economies with household nutrition, the factors explored in this study are household income, access to markets, farming systems, the cost of food,

how these factors affect food security at the household level together with the coping strategies that households adopt.

8.2.1 Insights from Relevant Theory and Literature

The various theories on food security and household poverty presented in Section 2.2 of this study generated a background from which an analysis of local food economies is made. These theories guided by the conceptual framework in section 1.12 have helped to set the scene from which to analyse the household food security status of low-income farm households. The findings indicate that low-income farm households have little to no access to markets, which results in food insecurity, while households are left with little to no means of coming out of this situation.

It is important to recognise that household food security for low-income farm households in rural Tanzania is not a new phenomenon, and that this is already known as depending on factors described in this thesis such as market access, cost of diet and farming systems. However, a combination of methods used in this thesis provides a more comprehensive and wide-ranging view of the farm households' local food economies and provide a better basis for exploring this topic.

8.2.2 Insights Which Have Practical Implications

Analysis of local food economies and their links to household food security and nutrition, enables the understanding of households' practices in accessing markets, food choices and coping strategies. Findings from this study help to explain how low-income farm household in rural Tanzania are affected by market access, access to income and diet costs both economically and in terms of food security. The findings of this study and recommendations arising from it, if properly implemented, may influence the Government of Tanzania in policy formulation and the setting up of institutional frameworks that can help low-income rural households to achieving better market conditions and market outcomes, but also improved food security and diet choices. Both local and national policies, when guided and informed by comprehensive research findings, will help create a better environment for low-income farm households to farm and market their products. Improvement in market conditions will also serve to reduce income insecurity and food insecurity.

8.2.3 Insight from the Methodological Approaches Adopted in this Study

The comprehensiveness of the methodology adopted in this research allowed a thorough analysis to be made of household food security linked with local food economies. Before the actual survey data collection was attempted, a scoping study was conducted in a similar village to the study areas and a focus group discussion in each study area was also undertaken. Monthly market price surveys for both areas and two phases of household surveys in pre-harvest and post-harvest periods served as tools to collect data. Furthermore, focus group discussions and key informant interviews, again in both areas, strengthened the methodology of this study.

The quantitative data obtained from household surveys and market price surveys was complemented by the qualitative data from focus group discussions and key informant interviews. The qualitative data represented a rich source of information that supplemented information obtained from the survey tools. Nevertheless, the multiplicity of methods of data collection posed a challenge in terms of cost, logistics and time; researchers and their assistants had to find a balance so that the information obtained was not compromised.

In terms of the data analysis, the methodologies used were also comprehensive as the study used a mix of descriptive, statistical and mathematical approaches (linear programming) to analyse data. The linear programming approach provided a way of analysing food choices from mathematical point of view.

8.3 Conclusions

The findings from Chapters 4, 5, 6 and 7 and the discussion in section 8.2 above provide a basis for the following conclusions, which relate directly to the research objectives, to be drawn from of the study.

8.3.1 Low-Income Farm Households' Access to Markets and Food Security

High income inequality was observed both within a district and between the two study areas, there were clear differences regarding income groups, market access and food security. Households in Kishapu live in more remote rural areas, which are far from the road and the market. These households lack the opportunities to diversify incomes

off the farm and face difficulties in buying food and selling produce. This was evident from the study findings showing the lower incomes these households received into the household throughout the year, which translated into lower levels of food security observed in Kishapu compared to Mvomero.

Mvomero households on the other hand, were closer to the roads and markets and had more diverse sources of income and more engagement in economic activities off the farm. Market access difficulties, both for buying and selling, were still observed in Mvomero but were at least better because they were not far from the roads and markets. Consequently, households in Mvomero had higher incomes than those in Kishapu for any category of income identified in this study. This resulted in higher food security in Mvomero, compared to Kishapu.

Furthermore, economic activities in both areas were largely farming activities and in farming, four farming systems were identified as follows: Single Food Crop (SFC), Multiple Food Crops (MFC), Cash Crop (CC) and Mixed Crop-Livestock (MCL) f In terms of income, households practicing Single Food Crop (SFC) farming received the least income of all households while those practicing Mixed Crop Livestock (MCL) were better-off than all other households. This was because in both study districts, middlemen had more control of the market for crops and fluctuations in crop prices left households vulnerable and crop-only agriculture less profitable.

8.3.2 Cost of Diet and Choice of Food Items Consumed in the Household

It was determined in the findings that a large percent of monthly food consumption in the households in both districts comes from food purchases, and therefore price has a major impact on food choices of households. Volatility of food prices was observed from the price data collected from monthly market price surveys and impacted on food choices of the rural households. Findings from the overall sample revealed diet choices were compromised when the budget constraint was strengthened; diets richer in energy and poorer in vitamins, proteins and other micronutrients were chosen when budgets were lower. When the choice diets were compared to household incomes, it was revealed that nutrient rich diets were not affordable for lower income households, and coupled with other needs in the households, even lower nutrient diets were barely affordable.

Additionally, the disaggregated results painted a picture of the differences that exist between Kishapu and Mvomero. Even though diets were less expensive in pre-harvest than in post-harvest for both districts, the situation was better in Mvomero than in Kishapu. Kishapu households consumed more energy dense diets than in Mvomero because of the higher prices and the lower incomes these households have compared to Mvomero.

8.3.3 Low-Income Farm Households' Coping Strategies

Households in both study districts faced shortages of income, shortages of food and a lack of access to markets. Faced with these difficulties in the market, incomes and food access security, households adopted various strategies in order to cope with the situation. A lack of means to save money forced households to adopt non-conventional means of saving such as buying livestock and hiding money inside the home. Moreover, households lacking savings are forced to borrow from family and friends to sustain their needs, or in some cases sell household property. Among other reasons, buying food is one of the reasons households had to use saving, sell livestock, borrow or sell household properties.

Some households eat naturally growing green leafy vegetables from the forest, especially in the rainy season in order to have something on the table. The non-conventional means of dealing with food shortage was not to deal with it, as some households just opted to eat fewer meals instead. Other means that these societies might have adopted, were not as common because the barter trade was observed to occur between two food items and sometimes food for work was adopted.

In summary, low-income farm households in rural areas of Tanzania, similar to Kishapu and Mvomero, have little opportunities for off-farm economic activities, lack access to markets, face food price volatility and food shortages. All these contribute to food and income insecurities in these areas and without the help of relevant authorities such as the government with policies and strategies, or other institutions from both central and local governments as well as non-governmental organisations, these conditions will continue to exist, and households will continue to suffer.

9.0 RECOMMENDATIONS

9.1 Introduction

Various recommendations are made from the discussion and conclusions made in this thesis. These recommendations aim to contribute in the improvement of local food economies for low-income farm households in rural Tanzania. Recommendations are categorised into government policy recommendation, recommendations for the study areas, recommendations for the households, and finally recommended areas for further study.

9.2 Government Policy Recommendations

i. In areas such as Kishapu, which have fewer off-farm economic activities and sources of income, the government should put in place policies and strategies that aim to increase labour market opportunities for the rural households. For example, an improvement in accessibility of markets through roads and other infrastructures, will stimulate economic activities in areas like these and also make agriculture more profitable as farmers will be able to easily sell their crops.

ii. For areas like Mvomero, less remote and with more income opportunities, the government can support the improvement of conditions in these areas by providing market information to farmers so that the middlemen who largely operate the selling of farm output by buying in bulk from farmers do not have the larger part of profits that farmers toil to sustain themselves yearly.

iii. The government should also consider improvement in access to financial resources in rural areas like Kishapu and Mvomero where households lack the means to save their incomes or borrow. Access to financial services will improve farm households' abilities to access credit and be able to save and receive financial advice for improvement of their farming activities and investment in other off-farm economic activities.

iv. Policies to stabilise prices should also be considered by the government and other stakeholders so that diet choices of rural household will not be

compromised. Stabilisation of prices can take the form of direct government interventions and stability of food supply.

v. Improvement in farm incomes and food security should be accompanied by policies, strategies and interventions to improve crop yield and reduce the effect of shocks and hazards. The government should extend appropriate support to rural farmers in terms of farm extension services so that farmers may be guided to better and more farm produce.

vi. In light of the poor diet choices, nutritional education to rural households is a strategy that, if adopted properly, will help households make informed diet choices. With this, even with the lack of income, households may opt to eat nutrient rich foods that are less expensive.

9.3 Recommendations for the Study Area

i. The seasonal nature of food insecurity can be reduced in both study areas if strategies that will help to increase farm output and incomes are adopted. At the district level, the local governments should support farmers with schemes such as irrigation for those close to the rivers so that they can have year-round food and income.

ii. Giving opportunities for local farmers to work in local government projects as they come so that the seasonal nature of income can also be reduced can bridge the lack of off-farm income for rural households. Furthermore, skills training for the farmers is needed so that they may be able to work in the projects and find further opportunities for self-employment.

iii. The types of foods consumed in the rural areas determine people's caloric and nutrient consumption. Customs and traditions in the societies and within the households affect decisions to farm certain crops and food choices. A crop like sorghum that is suited for dryer areas like Kishapu should be encouraged by the local government and measures taken to educate people on its benefit as it has more calories than many other cereal crops.

9.4 Recommendations for Households

i. Even with the low availability of financial services for saving and loans in rural areas, households should try to access these services in order to improve their

incomes and be able to invest. They should also be able to make personal efforts to find financial and investment advice so that they can diversify incomes and improve food security.

ii. Balanced diet is essential for overall nutrition of individuals and households. Households should be able to choose food items from various food groups so as to improve household dietary diversity.

9.5 Recommended Areas for Further Study

In both study areas, households with average high incomes such as those belonging to quartile 3 and 4, even though they portrayed better food access security, better dietary diversity and better affordability of choice diets than households with lower average incomes, where households were just barely food secure. Further study may need to be conducted to find out how internal household customs and traditions influence food security status. This can be done with a detailed case study research. This case study may also allow an in-depth analysis of consumption patterns of women and children less than 2 years of age. This can also be expanded to explain nutrient intake by age since different age groups and gender differ in requirement as compared to the adult equivalent used in this study.

Furthermore, research studies to address the gender dimensions of food security and nutrition within households should be investigated. Also, since household obtain their nutrients from foods, it is important to link that source of nutrients to the nutrition outcomes in rural Tanzania instead of addressing nutrition itself as an end goal.

Since foods go through carious nodes in value chains before they are consumed, it is important to also conduct a value chain analysis and link it with the food security of households and also relate to nutrition.

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APPENDICES

Appendix 1: Household Survey Questionnaire

Appendix 1 (a) First Round (Pre-Harvest) Questionnaire

QUESTIONNAIRE
TANZANIA AGRIDIET PROJECT
AGRICULTURE-NUTRITION HOUSEHOLD SURVEY (2014)
Round One

Enumerator's Name: **Signature:**
……. **……**

First Appointment Date Enumerated ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Start Time ☐☐ Hour ☐☐ Minutes
End Time ☐☐ Hour ☐☐ Minutes

Presence at the household
Male ☐ Female ☐

If absent, reason for absence
……
……

Second Appointment Date Enumerated ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Start Time ☐☐ Hour ☐☐ Minutes
End Time ☐☐ Hour ☐☐ Minutes

Checked By: Name: ……. Signature…… … ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Interview Results (circle the right number)
1. Completely Filled
2. Partially Filled
3. Refused
4. Building Ruined / Removed
5. Empty Building
6. Others: …

OVERVIEW OF THE AGRIDIET PROJECT

We are conducting research with Sokoine University of Agriculture and St. Augustine's University under the Irish Aid funded AgriDiet project to examine the link between agriculture and nutrition. We want to explore ways in which your farming and food management practices impact on nutrition, particularly of women and children in rural household.

STRUCTURE OF THE QUESTIONNAIRE

Title Page
Identification Details
Module One: *Household Characteristics*
Module Two: *Household Economy*
Module Three *Food and Care Practice*
Module Four *Health Status*
Module Five *Social Capital*

IDENTIFICATION DETAILS

Location of the respondent

S/N	Location	Name
ID1	Region	……
ID2	District	……
ID3	Division	……
ID4	Ward	……
ID5	Village	……

Details of the respondent and household head

		Codes
ID6	Name & Number of household head …	
ID7	Sex of household head (Male = 1, Female = 2)	
ID8	Name of First respondent ……	
ID8a	Relationship of Respondent to Household Head (use code ID9)	
ID9	Name of Second Respondent. ……	
ID9a	Relationship of Second Respondent to Household Head (use code ID9)	
ID10	Name of Translator. ……	
ID10a	Relationship of translator to Household Head (use code ID9)	

Code ID9&10: Relationship of Respondent to Household Head Codes

1= Self
2 = Wife/Husband/Partner
3 = Son/Daughter
4 = Step son/daughter
5 = Grandchild
6 = Father/Mother
7 = Brother/Sister
8 = Niece/Nephew
9 = Father/Mother-in-Law
10 = Sister/Brother-in-law
11 = Daughter/son-in-law
12 = Grandparent
13 = Uncle/Aunt
14 = Other relative
15 =Helper/Servant
16 = Not Related

MODULE ONE

INFORMATION ON HOUSEHOLD CHARACTERISTICS (HC)

We would like information regarding all members of this household (children and adults). This includes those who are members of the household who are away today but who normally live here. Could you please answer the following questions, starting with household head/yourself and then moving from the oldest to the youngest household member.

	HC1	**HC2**	**HC3**	**HC4**	**HC5**	**HC6**
ID	**Name** (start with the HH head)	**Sex** Male=1 Female=2	**Age (Years)** (Months only for children <2yrs)	**Marital Status** 1=Single 2=Married 3=Widowed 4=Divorced/Separated	Relationship with HH Head (Code 1a)	Number of Years in School
1						
2						
3						

Code 1a: Relationship with HH head

1 = Self
2 = Wife/Husband/Partner
3 = Son/Daughter
4 = Step son/daughter
5 = Grandchild
6 = Father/Mother
7 = Brother/Sister
8 = Niece/Nephew
9 = Father/Mother-in-Law
10 = Sister/Brother-in-law
11 = Daughter/son-in-law
12 = Grandparent
13 = Uncle/Aunt
14 = Other relative to head/Spouse
15 = Helper/Servant
16 = Not Related

MODULE ONE

INFORMATION ON HOUSEHOLD CHARACTERISTICS (HC)

	HC1	**HC7**	**HC8**	**HC9**	**Additional Points of Interest**

ID	Name	Major occupation (Code 1c)	Member living outside the household 1 = Yes 2 = No	If Yes, give reason for living outside h/hold (Code 1d)	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					

Code 1c: Major occupation

1= Farming
2= Small scale entrepreneur
3= Labourer/Skilled-unskilled
4= Natural resource extraction (stone, sand…)
5= Civil servant
6= Private sector/NGO employee
7= Paid Cooperative official
8= Police/Armed forces member
9= Pensioner (receiving pension)
10= Other activity (Specify)
11= Currently unemployed
12= Student/Underage

Code 1d: Reason for living outside the household

1= Education (High school/College)
2= Search for job
3= To stay with other relatives
4= Others (Specify…)

MODULE TWO
HOUSEHOLD ECONOMY (HE)

Module 2.1: Household Asset Ownership/Possession

2.1.1. Housing and Facilities (HF)

HF1. Please, kindly provide some details of your homestead buildings

No.	Type of Building structure	Tick	Is it rented/owned? (1=rented, 2=Owned, 3=Not rented & Not owned)	No. Of rooms	*Condition (1=Poor, 2=Moderate, 3= Good)
1	Human dwelling				
2	Kitchen				
4	Shower/bathroom				
5	Other (specify)				

*****

1. Poor: walls made of polls or mud, thatched roof, poorly ventilated windows and stubble doors

2. Moderate: mud brick walls, corrugated iron sheet roofing, earth floor, non-grilled windows and wooden/iron sheet doors

3. Good: brick walls, corrugated iron sheets for roofing, cemented floor, grilled windows and wooden/iron sheet doors

HF2. If rented, what is the monthly rent? ……. TZS

HF3. What is the main source of energy used for Lighting?

1 Electricity
2 Solar
3 Gas
4 Kerosene (lantern/chimney)
5 Kerosene (Wick lamps)
6 Candles
7 Firewood
8 Others (Specify)

HF4. What is the main source of energy used for Cooking?

1 Electricity
2 Solar
3 Gas (Industrial)
4 Gas (Biogas)
5 Kerosene
6 Charcoal
7 Firewood
8 Animal residuals
9 Others (specify)

2.1.2. Asset Ownership (2013 agriculture year) (AO)

AO1. Household Items during the 2013 agriculture year

Please provide information on the following household items during the past 12

months.

	Item	Does your household own the following asset? (1=Yes, 2=No)	If yes, specify the quantity ?
1	Radio		
2	Mobile Phone		
3	Bicycle		
4	Motor vehicle		
5	Motorcycle (Any type)		
6	Television		
7	Beds		
8	Cupboards		
9	Normal chairs		
10	Furniture Suit (Cushion chairs)		
11	Iron (Electric/Charcoal)		
12	Cooker (Electric or Gas)		
13	Refrigerator/Freezer		
14	Other (specify)		

AO2. Agricultural production equipment during the 2013 agriculture year

Please provide information on ownership of agricultural equipment during the past 12 months

	Name/Type of equipment/ asset equipment	Does your household own the following asset? (1=Yes, 2=No)	If yes, specify the quantity ?
1	Hand Hoe		
2	Ox-plough (Set)		
3	Water Pump (Motorised/Mechanical)		
4	Milling Machine (Motorised/Hand)		
5	Machete		
6	Others (specify)		

2.1.3. Land holding during the 2013 cropping year (LH)

Please provide information on the following

LH1. Did your household own/access any agricultural land during the past 12 months?

1 = YES, then continue

2 = NO, then go to LH3

LH2. Land Category	Total Area (acre)	Crops	Livestock	Cost
LH2.1. Owned				
LH2.2. Rented-in/Borrowed				
LH2.3. Rented-out land				

LH3. Did you have access to communal grazing land? (1=Yes, 2=No)

LH4. If your response to LH3 is 'yes', is the area of land available for your livestock
(1) Adequate

2) Inadequate

LH5. *(Enumerator ask this question if LH2.1was answered)* who owns the land?
1) Male Head of Household

2) Female Spouse/ Head of Household

3) Both

2.2: Non/off Farm Sources of Income (SI)
SI1: Please provide the average annual income from the following sources during the past 12 Months.

SN	Income source		Did you/ your household receive income from… (1=Yes, 2=No)	Amount (TZS)
1	Non/off-farm employment	Self-employment: petty trading (hairdresser, carpenter, sale of beverages, handicrafts, etc.)		
		Salaries/Labour wages of resident household		

		member		
		Small scale mining		
		Charcoal/ fuel wood sales		
2	Migrant remittances/ transfer from other households	From elsewhere in Tanzania (friends, relatives, neighbours, etc.)		
		From another country (friends, relatives, etc.)		
3	Pension payments			
4	Renting out/leasing of house, land, equipment, etc.			
5	Other income sources (Specify)			
	Total estimated annual income			

SI2. Which months of the year do you not have any income to the household? ……..……

2.3. Credit and Savings (CS)

CS1. Did you receive any farm input vouchers from the government during the past 12 months? 1=Yes, 2=No

CS2. If yes, What type(s) of farm input voucher?

(a) Mineral Fertilizer (List the fertilizer types) …….

(b) Improved crop seed varieties (List the crops) ……

c) Other (specify)…….

CS3. In which month(s) of the year was the voucher received? _____

CS4. In which month(s) of the year was the voucher needed? _____

CS5. Does any member of this household operate a saving or current account?	1=Yes	2=No

Member number

CS6a. **Amount saved in past 12 months (TZS).**

First member		
Second member		
Third member		

CS6. What were the other ways you saved during the past 12 months?

1. _____2. _____, 3. _____

CS7. If Yes to either CS5 or CS6, what was the main reason for saving? ……...

CS8.. Has any member of the household taken a bank loan during the last 12 Months?	1=Yes	2=No

12 months?

Member number

CS8a. **Amount taken in past 12 months (TZS).**

First member		
Second member		
Third member		

CS9. If Yes to CS8, what was the loan for? …….

CS10**.** If 'No' to CS8, explain the reasons why the household did not take loan for any purpose during the last 12 months? ……

2.4. Crop Production and Disposal (CP)

CP1. How long have you been cultivating crops? _____ Years or Months

Crop production (2013 production year)

Kindly provide the following detailed information on crops grown, output obtained and their disposal

S/N	Crop(s) grown	Area allocated for each crop (acres)	Area Under Irrigation agric. (acres)	Area Under Intercrop (acres)	Quantity produced (kg)	Quantity consumed at home (kg)	Quantity Sold (kg)	Quantity retained for seed (kg)	Processed harvest (kg)	Post-harvest loss? (kg)
	CP2	CP3	CP4	CP5	CP6	CP7	CP 8	CP 9	CP10	CP 11
1	Maize									
2	Rice									
3	Sorghum									
4	Sesame									
5	Green Grams									
6	Other Legumes									
7	Sun flower									
8	Sweet Potatoes									
9	Cotton									
10	Tomatoes									
11	Onions									
12	Vegetables									
13	**Other**									

	Crops									

CP10. Why did your household grow the type(s) of crop(s) you mentioned during the past 12 months? ……

CP11. What fruit tree (s) does your household have?

No	Type	Tick	No. Of fruit trees	*No. Of bags harvested
1	No Fruit tree			
2	Orange			
3	Mango			
4	Pawpaw			
5	Guava			
6	Other (specify) ……			

CP12. Please indicate how many days of... [*labour category*] were spent in... [*Major crop production activity*] during the past 12 months?

Labour category	Major crop production activities							
	Land preparation		Planting		Weeding		Harvesting	
	Man Days	Woman Days	Man Days	Woman Days	Man Days	Woman Days	Man Days	Woman Days
Family labour								
Hired labour								

CP13.How did you address pests on your field crops during the past 12 months?

1) Did not take any measure
2) Selection of pest resistant plant species/varieties
3) Pesticides (*enumerator*: *list all that are ever used on your farm*) _____
4) Mixed/ inter cropping
5) Other (Specify)

CP14.How did you address crop diseases on your farm during the past 12 months? *(Enumerator: circle all that apply)*

1) Did not take any measure
2) Plant spacing
3) Fungicides (*enumerator: list all that are ever used on your farm*)
4) Selection of resistant plant species/varieties
5) Other (specify)

_____

CP15. How did you address weeds on your farm during the past 12 months? *(multiple answers possible).*

1) Did not take any measure
2) Hand weeding
3) Herbicides *(enumerator: list all that are ever used on your farm)*
4) Use of fast emerging crop varieties
5) Other (specify)

_____

CP16. During the past 12 months, did you grow different crops from the previous year? 1. Yes 2. No =>CP18

CP17. If Yes to CP16, what is the main reason you changed the crops you grow?

……
……

CP18. How did you make the decision when to harvest the crop during the past 12 months?

1) Maturity
2) Market price
3) Danger from theft
4) Other (specify) _____

CP19. Does your household have access to any storage facility? 1) Yes 2) No

CP20. If YES to CP19: Which are they? (a) On Farm (b) In House (c) Public

CP21. If YES to CP19 how did you store the crops during the past 12 months? *(Enumerator: circle all that apply)*

1 = In locally made traditional structure
2 = In modern store
3 = In Sacks/open drum
4 = In airtight drum
5= Other (specify)_____

CP22. How did you protect your stored crops during the past 12 months? *(Enumerator: circle all that apply)*

1) Did not take any measure
2) Ashes
3) Pesticides/insecticides *(enumerator: list all that are ever used on your farm)* _____
4) Tree leaves and other herbs
5) Others (specify)
6) Cow dung

CP23. If you Experienced any losses, what are the main reasons for the loss?

1. _____ 2. _____ 3. _____

CP24. Where did you sell your harvests during the past 12 months? *(Enumerator:*

circle all that apply)

1= In the village market
2 = In the neighbouring village market
3 = Sell to traders who visit the village
4 = On the roadside
5 = To the Neighbour
6 = Other (specify)

CP25. What difficulties did you face when trying to sell your crops?

a. Poor Transport Infrastructures
b. No formal market
c. Low prices
d. Low demand
e. Others (Specify). ……

CP26. How did you address these difficulties? …….

CP27. What is the distance of your homestead to your most commonly used output market place? (Give one-way estimate in min.) _____

CP28. What are the three main problems you experienced when growing crops in 2013?

1. _____ 2. _____ 3. _____

CP29. If the rains are very poor or fail do you:

(1) Plant same crops anyway
(2) Do not plant any crop
(3) Plant different crops - *(Please mention the crops) ……..*
(4) Make prayers/Rituals to gods
(5) Planting of short-term varieties
(6) Migrate
(7) Other (Specify)

2.5. Livestock Production and Disposal (2013 agricultural year) (LP)

LP1. How long have you been keeping livestock? _____ Years/Months

Provide details for livestock production activities of your household during the past 12 months

S/N	Livestock and livestock product type	How many… Do you keep?	Quantity sold (No)	Quantity consumed at home (No)
	LP2	LP3	LP4	LP5
	I: Livestock type			
1	Calves			
2	Heifers			
3	Milking cows			

4	Dry cows			
5	Bulls			
6	Oxen			
7	Goats			
8	Sheep			
9	Donkey			
10	Chicken			
12	Others (Specify)			
	II: Livestock products:	Kg/Lt.	Kg/Lt.	Kg/Lt.
1	Milk			
2	Butter			
3	Yoghurt			
4	Cheese			
5	Hide (No)			
6	Skin (No)			
7	Animal manure (Bags)			
9	Others (Specify)			

LP6. Why did your household keep the type(s) of livestock you mentioned during the past 12 months? ……

LP7. We will now ask you information regarding labour distribution by gender in the major livestock production activities. Please indicate a typical number of hours/days of... [*labour category*] spent in... [*Major livestock activity*] during the past 12 months?

Labour category	**Major livestock production activities**																	
	Pasture/ fodder establishment and management (Days)			**Animal grazing (Outdoor) (hrs./day)**			**Animal feeding (Indoor) (hrs./day)**			**Manure handling/cleaning (hrs./day)**			**Milking (hrs./day)**			**Housing (Days)**		
	Man	**Woman**	**Child**	**Man**	**Woman**	**Child**	**Man**	**Woman**	**Child**	**Man**	**Woman**	**Child**	**Man**	**Woman**	**Child**	**Man**	**Woman**	**Child**
Family labour																		
Hired labour																		

LP8. Where did you sell your livestock/products during the past 12 months?

1= In the village market
2 = In the neighbouring village market
3 = Sell to traders who visit the village
4 = On the roadside
5=Neighbour
6 = Other (specify)

LP9. How did you address animal diseases during the past 12 months?

1) Did not take any measure
2) Seek advice from veterinarian
3) Use traditional medicine
4) Seek advice from friends/neighbours/relatives
5) Seek advice from agriculture input shops
6) Selection of disease resistant livestock species
7) Other (specify)

LP10. What are the three main problems that you experienced in livestock production in the past 12 months Start with the most important problem facing your household?

1. _____ 2. _____ 3. _____

LP11. What difficulties did you face when trying to sell your livestock/livestock products?

a. Poor Transport Infrastructures
b. No formal market
c. Low prices
d. Low demand
e. Others (Specify). …….

LP12. How do you address these difficulties? ……

2.6 Agricultural Inputs and Uses (AIU)

AIU1.Please provide information on the uses & sources of agriculture input during the past 12 months

	Type of input	**Did you use…?**	**If Yes, give source?**	**Estimated annual expenditure 2013**	**If No, give reason for not using…**	**Assessment of availability of …**
		Code 1	**Code 2**	**(TZS)**	**Code 3**	**Code 4**
1	Mineral fertilizers					
2	Animal manure					
3	Pesticides					
4	Herbicides					
5	Improved Seeds/Seedlings					
6	Chicks/breeding stock					
7	Veterinary medicines					

8	Animal feeds/Concentrates					
9	Mechanization services					

Code 1	**Code 2**	**Code 3**	**Code 4**
1=Yes 2=No	1 = Government institutions 2 = Buy from shops 3 = Own farm 4= Other (specify)	1=Very expensive 2=Not available 3=Not needed 4=Laborious work to apply and use 5=Don't know how to use	1=Easily obtained 2=Obtained with difficulty 3=Not available

AIU2 What is the distance of your homestead to your most commonly used input market centre? (Give one way estimate in minutes) _____

2.7. Household Decision Making (HDM)

No	**Who decides on the following?**	**Male spouse**	**Female spouse**	**Both**
HDM1	Purchase of farm equipment			
HDM2	Crops to cultivate in the farm			
HDM3	Sale of crops			
HDM4	How to spend cash from sale of crops			
HDM5	Foods to feed the family			
HDM6	Livestock species to raise			
HDM7	Sale of livestock			
HDM8	How to spend cash from sale of livestock			
HDM10	Attend farm training			
HDM11	Other (specify)			

2.8. Agricultural Information and Extension Services (AIE)

AIE1. During the past 12 months...

	Sources of advice/ information	**AIE1a**. Did you receive advice/ information for your agricultural/ livestock activities from ...*[sources]*? 1=Yes 2=No → NEXT ROW	**AIE1b.** Was the information about…? Crop production 1=Yes 2=No	Livestock production 1=Yes 2=No	Agro-processing 1=Yes 2=No	Agricultural Marketing and prices 1=Yes 2=No	**AIE1c**. How many times did someone from...? *[Source]* visit your farm in the past 12months?
1	Government extension						
2	Non-Governmental Organisation						
3	Cooperative/Farmer's association						
5	Radio/Television						
6	Publication						
7	Neighbour/Relatives/Friends						
8	Other (specify)						

AIE2. If yes to any of the items in AIE1a, Please provide information about how useful and accessible to you/your household were each source of agricultural advice/information during the past 12 months.

	Source of advice/ information	**AIE2a.** How useful was … *[Source]* as a source of advice/information? (1=Not useful, 2= Somehow Useful 3=Very useful)	**AIE2b**. How accessible was … *[Source]* as a source of advice/information? (1=Not accessible, 2 = Somehow accessible 3=Very accessible)
1	Government extension		
2	Non-Governmental Organisation		
3	Cooperative/Farmer's association		
5	Radio/Television		
6	Publication		
7	Neighbour/Relatives/Friends		

8	Other (specify)		

AIE3: If yes to any of the items in AIE1b, how important to you/your household were each type of agricultural advice/information during the past 12 months?

	Type of advice/ information	**AIE3a. How important was… *[Type]* advice/information (1=Not important, 2= Somehow important, 3=Very important)**
1	Crop production	
2	Livestock production	
3	Agro-processing	
4	Agricultural prices and marketing	
5	Other (specify)	

AIE4. Please indicate the best preferred method should agricultural information be made available to you/your household in the future. ……

AIE5. What are the 3 major challenges in accessing extension service delivery in your area?

(1) …… (2) …… (3) ……

AIE6. If you have livestock:

(a) Where do you get them treated or vaccinated?.....

(b) What is the distance from your homestead?.....km

MODULE THREE
FOOD AND CARE PRACTICES (FCP)

Module 3.1: Household Expenditure and Consumption

Now we will ask you questions related to your household expenditure and consumption of major food and non-food items during the last 30 days

3.1.1. Regular household food expenditure and consumption during the last 30 days

Item		1.Total quantity of ... consumed in the last 30 days	2. Amount of …consumed in the last 30 days from different sources			
			Own produce	Purchased	Gift/Borrowed	Transfers /Aid
		HEC1	HEC 2a	HEC2b	HEC2c	HEC2d
1	Maize/Maize Flour (kg)					
2	Rice (kg)					
3	Wheat flour (kg)					
4	Sorghum (kg)					
5	Bread (loaves)					
6	Local donuts /Vitumbua /Chapati (No)					
7	Sweet Potatoes (kg)					
8	Irish Potatoes (kg)					
9	Cassava (kg)					
10	Beans & other legumes (kg)					
11	Groundnuts (kg)					
12	Cooking Oil (lt.)					
13 14	Ginger & other Condiments (kg)					
15	Tomato (kg)					
16	Onion (kg)					
17	Carrots (kg)					
18	Cabbage (No)					
19	Lettuce & other vegetables (bundles)					
20 21	Mango, Papaya & other fruits (number)					
22	Tea/Coffee (packets)					
23	Sugar (kg)					
24	Salt (kg)					
25	Beef, Goat, Mutton (kg)					

26	Fish (Number)					
27	Chicken (Number)					
28	Eggs (Number)					
29	Milk (lt.)					
30	Honey (lt.)					
31	Others (Specify…)					

3.1.2. Purchase of Durable Items and Other Services (PDI)

S/N	**What was your household expenditure on the following items during the last 30 days?**	**In-cash expenditure (TZS)**	**In-kind expenditure/gift given away (TZS)**	**Total expenditure (TZS)**
	PDI1	PDI2	PDI3	PDI4
1	Cooking materials (charcoal, kerosene, etc.)			
2	Laundry (soap, detergents, etc.)			
3	Payment of household utilities (electricity, airtime vouchers & water bills, etc.)			
4	Kitchen utensils			
5	School fees & related			
6	Medical expenditure			
7	Special occasions (funerals, weddings, parties, rituals, charity, etc.)			
8	Personal care (body lotion, hair oil, etc.)			
9	Clothing and footwear (tailored clothes, ready-made clothes, rain clothes, underwear, baby clothes, diapers, hats, shoes, boots, etc.)			
10	Personal effects (costume/gold jewellery, handbags, wallets, wristwatch, clocks, umbrellas)			
11	Household furniture			
12	Transport (bought or paid fare)			
13	Building materials (renovation/construction)			
14	Hiring Farm Equipment			
15	Recreation (entertainment services, recreational goods and supplies)			
16	Money transfers			
17	Servant Salary			
18	Other (specify)			

Module 3.2: Food security/insecurity issues and Coping Mechanisms

3.2.1. Household Food Insecurity Access Scale (HFIAS)

For each of the following questions, consider whether they have happened in the past 30 days. If the answer is 'Yes' to a question, please indicate how often this happened.

Access to food (AF)

No.	Question	Response options: Assign code according to the following answers (How often did this happen?) (0) Never= it did not happen in the past 30 days (1) Rarely= once or twice in the past 30 days (2) Sometimes = three to ten times in the past 30 days (3) Often = more than ten times in the past 30 days
AF1	In the past (30 days), did you worry that your household would not have enough food?	
AF2	In the past [30 days], did it happen that you or any household member were not able to eat the kinds of foods you would have preferred to eat because of lack of resources?	
AF3	In the past [30 days], did it happen that you or any household member had to eat a limited variety of foods because of lack of resources?	
AF4	In the past [30 days] did it happen that you or any household member had to eat some foods that you really did not want to eat because of lack of resources?	
AF5	In the past [30 days] did it happen that you or any household member had to eat a smaller meal than you felt you needed because there was not enough food?	
AF6	In the past [30 days] did it happen that you or any	

	household member had to eat fewer meals in a day because there was not enough food?	
AF7	In the past [30 days] did it happen that there was no food to eat of any kind in your house, because of lack of resources to get food?	
AF8	In the past [30 days] did it happen that you or any household member went to sleep at night hungry because there was not enough food?	*If yes, ask respondent to describe*
AF9	"In the past [30 days] did it happen that you or any household member went a whole day and night without eating anything at all because there was not enough food?"	*If yes, ask respondent to describe*

3.2.2 HOUSEHOLD DIETARY DIVERSITY SCORE (HDDS)

Please describe the foods (meals and snacks) that you (or your household members) ate yesterday during the day and night. Start with the first food eaten in the morning.

(Interviewer) - Write down all foods and drinks mentioned by the respondent. When the respondent has finished, probe for meals & snacks not mentioned (Guideline for probing questions are provided). Consider foods eaten by any member of the household, exclude foods purchased and eaten outside the home.

	Breakfast	***Snack***	***Lunch***	***Snack***	***Dinner***	**Snack**
1						
2						
3						
4						
5						
6						

SN	**Food group**	**Examples**	**1 = Yes 2 = No**
HDD1	CEREALS	Maize, rice, wheat, sorghum, or any other grains or foods made from these (e.g. bread, *ugali*, porridge etc.)	
HDD2	VITAMIN A RICH VEGETABLES AND TUBERS	Pumpkin, carrots, or sweet potatoes that are orange inside + other locally available vitamin-A rich vegetables	
HDD3	WHITE TUBERS AND ROOTS	White potatoes, white yams, white cassava, or other foods made from roots	

HDD4	DARK GREEN LEAFY VEGETABLES	Any dark, green, leafy vegetables such as cassava leaves, bean leaves, spinach, amaranth, spinach, incl. wild veges etc.	
HDD5	OTHER VEGETABLES	Other vegetables (e.g. tomato, onion, eggplant), including wild vegetables	
HDD6	VITAMIN A RICH FRUITS	Ripe mangoes, ripe papaya + other locally available vitamin A-rich fruits	
HDD7	OTHER FRUITS	Other fruits, including wild fruits	
HDD8	ORGAN MEAT (IRON-RICH)	Liver, kidney, heart or other organ meats or blood-based foods	
HDD9	FLESH MEATS	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds	
HDD10	EGGS	Chicken, duck, guinea hen or any other egg	
HDD11	FISH	Fresh or dried fish or shellfish	
HDD12	LEGUMES, NUTS AND SEEDS	Beans, peas, lentils, nuts, seeds or foods made from these	
HDD13	MILK AND MILK PRODUCTS	Milk, cheese, yogurt or other milk products	
HDD14	OILS AND FATS	Oil, fats or butter added to food or used for cooking	
HDD15	RED PALM PRODUCTS	Red palm oil, palm nut or palm nut pulp sauce	
HDD16	SWEETS	Sugar, honey, sweetened soda or sugary foods such as chocolates, candies, cookies and cakes	
HDD17	SPICES, CONDIMENTS, BEVERAGES	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages or local examples	

HDD18. Did you or anyone in your household eat anything (meal or snack) OUTSIDE of the home yesterday? 1 = Yes 2 = No

DIETARY DIVERSITY GUIDING QUESTIONS FOR THE HOUSEHOLD SURVEY

1	Who was the first person in the household to wake up yesterday?	*1*.me/spouse 2.my daughter 3.Others Specify
2	After you woke up, what was the first thing prepared or consumed in the household?	
3	Did you make coffee /tea or porridge yesterday?	*1 =Yes*

	(Breakfast)	*2 = No*
4	At what time?	
5	Did you consume the tea or coffee with something else or only had the coffee?	*1 =Yes* *2 = No*
6	What were the ingredients in the coffee/tea/porridge?	
7	Do you sweeten all the tea/ coffee/ porridge at once, or does each person sweeten his or her own cup?	Sweeten all at once No sweeten at all Sweeten individually
8	What was the next thing prepared or consumed after the tea/ coffee/ porridge?	
(Asks for and writes down all the ingredients of each foods consumed at breakfast).		
9	Is there any beverage with breakfast?	
10	What was the next thing prepared or consumed after breakfast?	
11	Did anyone in the household eat anything between breakfast and lunch? For example, fruits, nuts or milk for the baby?	
12	(After requesting information on the ingredients of each meal after lunch). What was the next thing prepared after lunch?	
13	(Notes all the ingredients of each dish consumed at dinner) Was any beverage served with dinner?	
14	Did anyone in the household eat or drink anything after dinner? For example, a cup of tea/ coffee or a piece of fruit or milk for the baby?	
15	Did you all go to bed at the same time, or did some household members stay up later than others?	*1 = Yes if yes specify* *2 = No*
16	Did you eat or drink any last thing before going to bed?	
17	If something is eaten describe it	

3.3. Household Coping Strategies/Mechanisms and Related (HCS)

Please ask these questions to the mother. Ask questions HCS5 to HCS10 to the household head (husband) in case of male-headed households as well.

	HCS1. Number of servings per day [*First tick the composition of household members*]		
1	Household member*	Tick	Number/Frequency of meals
2	Children under 5		
3	Girls (6-18 years)		
4	Boys (6-18 years)		

5	Lactating mother		
6	Pregnant mother		
7	Non-lactating/Non-pregnant woman		
8	Husband & other adult men living in the household		

HCS2. Did your household face food shortages during the last 12 months? 1 = Yes 2 = No

HCS3. If 'Yes' to HC2, in which month(s) of the year were the food shortage serious in the household? List the months ……

HCS4. If again 'Yes', to HC2 What are the most important causes of food shortage in the household? Please list in the order of their importance (1=Most important)

1. ……
2. ……
3. ……

HCS5. What measures did you take when your household faced serious food shortage?

1) …... 2) …... 3) ……

HCS6.Where do you get food you do not produce?

(a) Buy from neighbours
(b) Buy from the local shops/market
(c) Seek from the forest
(d) Others (specify) ……

HCS7. What difficulties do you face when trying to buy foodstuff?

a. Poor Transport Infrastructure
b. High prices
c. Low supply
d. Lack of alternatives
e. No formal market
f. Others (Specify) ……

HCS8. How do you address these difficulties?

1)....
2) ……
3) ……

HCS9. What are the major traditional/socio-cultural activities that consumed a significant amount of your food produce in the past 12 months?

(a) Weddings
(b) Religious offering/Rituals
(c) Traditional dances
(d) Funerals
(e) Others (specify)

HCS10. Apart from funerals, what month do most of the major traditional social-cultural activities (e.g. weddings, traditional dances, etc.) take place in your area? ….

MODULE FOUR
HEALTH STATUS

4.1 Illness and disability (ILD)

ILD1. Was there any member of the household who suffered any kind of illness and/or disability during the past 12 months? 1= Yes, 2= No (List household member ID: ____, _____, _____

ILD2. Where do you normally seek help when a member of your household is sick? Multiple answers possible

1. District Hospital	4. Traditional healer	7. Other (specify)
2. Village Health Centre	5. Chemist / pharmacy	
3. Private Clinic	6. Do not consult	

ILD3. If 'no' (Option 6) in (ILD2) above, please give reasons:

(1) Could not afford expenses	(3) The service is too far
(2) The illness was not serious	(4) Others (Specify). ……

ILD4. Who takes care of the sick and/or disabled in the household? …….

ILD6. What is the average time spent in taking care of the sick and/disabled? ……. Hours per day

4.2 Water and Sanitation (WS)

WS1. What is the main source of drinking water for members of your household?

1 = Piped water,	4 = Unprotected well,	7 = Unprotected spring/River
2 = Public tap/standpipe,	5 = Rainwater collection	8 = Bottled water
3 = Protected well,	6= Protected spring	9 =other (specify)

WS2. How long does it take to fetch water and come back in most of the times? In minutes ……

WS3. Who is responsible to fetch water in the household?

(a) Adult women	(c) Female child	(e) Other (specify)
(b) Adult men	(d) Male	

child

WS4. What do you usually do to the water to make it safer for drinking?

1 =Boil,	3 =strain it through a cloth,	5 = No treatment
2 =Add Bleach/Chlorine	4 =use water filter (ceramic, sand, composite, etc.),	6 =other (specify)

WS5. What type of toilet facility does your household use?

1 = No toilet/bush
2 = Flush toilet
3 = Pit latrine – traditional
4 = Improved pit latrine – household owned
5 = Other type (specify)

WS6. Do you share toilet facility with other households?
1=Yes, 2=No

WS7. If yes to WS6 above, with how many households do you share the facility?

WS8. When do members of your household normally wash their hands? _____

WS9. How does your household primarily dispose of household waste?

1= Dumped in street/open space,	3= Rubbish pit	5=Burned,
2= Disposed in the compound/Farm	4= Dumped into river,	6= Other (specify)

MODULE FIVE

5. Social Capital

Now we would like to ask you some questions about how you feel about this village, and how you take part in the community activities

SC1 Are you/someone in your household a member of any groups/organizations? 1 = Yes 2 = No

SC2. If 'Yes' to SC1, list up to three in order of importance

Group	**Type of group (Write the option and name of group)**		**Participation**
	1 = Religious group	4 = Youth Group	1= An active member with position (e.g. Chairperson, Secretary, Treasurer)

	2 = Farmers' Association 3 = Development Committee	5 = Women's group 6 = Other (specify)	2= Active member but no formal position 3= Not an active member
Group A			
Group B			
Group C			

SC3. What is the value of these groups (listed in SC1) to your household wellbeing? ……

SC4. Are there any services where you or members of your household are occasionally denied or have only limited opportunity to use? 1 = Yes 2 = No

If Yes:
a. Education/schools
b. Health services/clinics
c. Job training/employment
d. Credit/finance
e. Water distribution/Sanitation Services
f. Agricultural extension
g. Justice/conflict resolution
h. Other (specify)

SC5. Are there any other members of this community excluded from some services? 1 = Yes 2 = No

SC6. If 'Yes' to SC5 what services are they excluded from?

a. Education/schools
b. Health services/clinics
c. Job training/employment
d. Credit/finance
e. Water distribution/Sanitation Services
f. Agricultural extension
g. Justice/conflict resolution
h. Other (specify)

SC7.If 'Yes' again to SC5, what are the reasons why some people are excluded from these services? *(Enumerator more than one option is possible)*

a. Income level/ Wealth/ Social Status
b. Disability
c. Age
d. Gender
e. Race/ethnicity
f. Religious beliefs
g. Political affiliation
h. Lack of education
i. Other, Specify…

SC8. What procedure is used to make the decision related to major development projects needed in this village? ……

SC9. Suppose someone in the village had something unfortunate happen to them, e.g.

bereavement. Who do you think they could turn to for help in this situation? ….

SC10. Please tell me whether in general you agree or disagree with the following statements: Use the code

1 = Strongly agree 2 = Agree 3 = Disagree 4 = Strongly disagree

SC16a. Most people in this village are willing to help if you need it

SC16b. I feel accepted as a member of this village

SC16c. The relationships in this village are harmonious

SC11. Who primarily resolves disputes in this village?

1=People work it out between themselves []
2=Family/household members []
2=Neighbours []
4=Community leaders []
5=Religious leaders []
6=Judicial leaders []
7=Other (specify) []

Appendix 1 (b) Second Round (Post-Harvest) Questionnaire

QUESTIONNAIRE

TANZANIA AGRIDIET PROJECT

AGRICULTURE-NUTRITION HOUSEHOLD SURVEY (2014)

ROUND TWO (POST HARVEST)

Enumerator's Name: **Signature:**
…… **……**

First Appointment Date Enumerated ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Start Time ☐☐ Hour ☐☐ Minutes

End Time ☐☐ Hour ☐☐ Minutes

Presence at the household

Male ☐ Female ☐

If absent, reason for absence
……
……

Who was interviewed at this household during the last survey?

Same Male ☐ Same Female ☐ Other (specify) ……

Second Appointment Date Enumerated ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Start Time ☐☐ Hour ☐☐ Minutes

End Time ☐☐ Hour ☐☐ Minutes

Checked By: Name: …… Signature…… ☐☐ / ☐☐ / ☐☐ (d d / m m / y y)

Interview Results (circle the right number)

1. Completely Filled
2. Partially Filled
3. Refused
4. Building Ruined / Removed
5. Empty Building
6. Others: …

OVERVIEW OF THE AGRIDIET PROJECT

We are conducting research with Sokoine University of Agriculture and St. Augustine's University under the Irish Aid funded AgriDiet project to examine the link between agriculture and nutrition. We want to explore ways in which your farming and food management practices impact on nutrition, particularly of women and children in rural household.

STRUCTURE OF THE QUESTIONNAIRE

Title Page
Identification Details
Module One: *Household Characteristics*
Module Two: *Household Economy*
Module Three *Food and Care Practice*
Module Four *Social Capital*

IDENTIFICATION DETAILS

Location of the respondent

S/N	Location	Name
ID1	Region	……
ID2	District	……
ID3	Division	……
ID4	Ward	……
ID5	Village	……

Details of the respondent and household head

		Codes
ID6	Name & Number of household head …… …… …	
ID7	Sex of household head (Male = 1, Female = 2)	
ID8	Name of First respondent …… ……	
ID8a	Relationship of Respondent to Household Head (use code ID9)	
ID9	Name of Second Respondent. ……	
ID9a	Relationship of Second Respondent to Household Head (use code ID9)	
ID10	Name of Translator. ……	
ID10a	Relationship of translator to Household Head (use code ID9)	

Code ID9&10: Relationship of Respondent to Household Head Codes

1= Self	*5 = Grandchild*	*9 = Father/Mother-in-Law*	*13 = Uncle/Aunt*
2 =	*6 =*	*10 =*	*14 = Other relative*

Wife/Husband /Partner	*Father/Mother*	*Sister/Brother-in-law*	
3 = Son/Daughter	*7 = Brother/Sister*	*11 = Daughter/son-in-law*	*15 =Helper/Servant*
4 = Step son/daughter	*8 = Niece/Nephew*	*12 = Grandparent*	*16 = Not Related*

MODULE ONE

INFORMATION ON HOUSEHOLD CHARACTERISTICS (HC)

HC10. How many people are living in this household? ……

HC11 Is there any household member who has moved to this household since our last visit? 1= Yes 2= No

HC12. Is there any household member who has moved from this household since our last visit? 1= Yes 2= No

HC9. If yes HC12, give reason for leaving outside the household

1= Education (High school/College)
2= Search for job
3= To stay with other relatives
4= Went to the market/business trip
5=Moved temporarily for farming activities
6= Other (Specify)

If yes again to HC12, Provide details of the new member(s)

	HC1	HC2	HC3	HC4	HC5	HC6	HC7
ID	**Name** (start with the HH head)	**Sex** Male=1 Female=2	**Age (Years)** (Months only for children <2yrs)	**Marital Status** 1=Single 2=Married 3=Widowed 4=Divorced	Relationship with HH Head (Code 1a)	Number of Years in School	Major occupation (Code 1c)
1							
2							
3							

Code 1a: Relationship with HH head

1 = Self	4 = Step son/daughter	7 = Brother/Sister	10 = Sister/Brother-in-law	13 = Uncle/Aunt
2 = Wife/Husband/Partner	5 = Grandchild	8 = Niece/Nephew	11 = Daughter/son-in-law	14 = Other relative to head/Spouse
3 = Son/Daughter	6 = Father/Mother	9 = Father/Mother-in-Law	12 = Grandparent	15 = Helper/Servant
				16=Not related

Code 1c: Major occupation

1= Farming	4= Natural resource extraction (stone, sand…)	7= Paid Cooperative official	10= Other activity (Specify)
2= Small scale entrepreneur	5= Civil servant	8= Police/Armed forces member	11= Currently unemployed
3= Labourer/Skilled-unskilled	6= Private sector/NGO employee	9= Pensioner (receiving pension)	12= Student/Underage

4.1 Illness and disability

ILD1. Was there any member of the household who suffered any kind of long-term illness and/or disability since the last visit? 1=Yes 2=No

If Yes, List the Household Member Names 1. _____ 2. _____ 3. _____

MODULE TWO
HOUSEHOLD ECONOMY

2.1.2. Asset Ownership (2014 production year (AO)

AO1. Household Items during the 2014 production year

Did your household add to or reduce any of the following items since last survey?

	Item	Did you add/reduce...? 1=Yes, 2=No	Quantity added of... since last survey	Quantity reduced of… since last survey
1	Radio			
2	Mobile Phone			
3	Bicycle			
4	Motor vehicle			
5	Motorcycle (Any type)			
6	Television			
7	Beds			
8	Cupboards			
9	Normal chairs			
10	Furniture Suit (Cushion chairs)			
11	Iron (Electric/Charcoal)			
12	Cooker (Electric or Gas)			
13	Refrigerator/Freezer			
14	Tables			
15	Other (specify). ……			

AO2. Agricultural production equipment during the 2014 production year

Did your household add to or reduce any of the following since last survey?

	Name/Type of equipment/ asset equipment	Did you add/reduce...? 1=Yes, 2=No	Quantity added of... since last survey	Quantity reduced of… since last survey
1	Hand Hoe			
2	Ox-plough (Set)			
3	Water Pump (Motorised/Mechanical)			
4	Milling Machine			

	(Motorised/Hand)			
5	Machete/knives			
6	Axe			
7	Shovel			
8	Wheel barrow			
9	Other (specify) ……			

2.3. Credit and Savings (CS)

CS11. What farm inputs were most needed by you in this season? (Circle all that apply)

1= Mineral fertilizer
2=Improved crop seed variety
3=Agrichemicals
4=Improved breeds of livestock
5=Veterinary medicine
6=Others (specify) ……

CS1. Did you receive any farm input vouchers from the government during the 2014 production season?

1=Yes, 2=No

CS2. If yes, What type(s) of farm input voucher?

(a) Mineral Fertilizer (List the fertilizer types) …….
(b) Improved crop seed varieties (List the crops) ……
(c) Other (specify)…….

CS3. If Yes in CS1, in which month(s) of the year was the voucher received? _____

CS4. In which month(s) of the year was the voucher needed? _____

CS12. How did you finance your farm input costs during the 2014 production season?

1=Did not buy inputs
2=Own finances
3=Loans from banks
4=Money lenders
5=Interested in finance but no access
6=Other sources (specify) ……

CS8. Has any member of the household taken a loan since last visit? 1=Yes 2=No

If Yes, then respond to CS9 and CS13

If No, then respond to CS10

Member number

CS8a. **Amount taken (TZS).**

First member
Second member
Third member

CS9. If Yes again to CS8, what was the loan for? …….

CS13. If Yes again to CS8, what was the source(s) of the loan?
1……. 2……. 3…….

CS10**.** If 'No' to CS8, explain the reasons why the household did not take loan for any purpose since last visit? ……

2.4. Crop Production and Disposal (CP)
Crop production (2014 production year)
Kindly provide the following detailed information on crops grown, output obtained and their disposal

S/N	**Crop(s) grown**	**Area allocated for each crop (acres)**	**Area Under Irrigation agric. (acres)**	**Intercropped with ... (CP2)**	**Quantity produced (kg)**	**Quantity consumed at home (kg)**	**Quantity Sold (kg)**	**Quantity retained for seed (kg)**	**Processed harvest (kg)**	**Post-harvest loss? (Kg)**	**Reason for growing …**	**Importance of ... to livelihood? (1=Not important, 2=Somehow important, 3=Very important)**
	CP2	**CP3**	**CP4**	**CP5**	**CP6**	**CP7**	**CP8**	**CP9**	**CP10**	**CP11**	**CP31**	**CP32**
1	Maize											

2	Rice											
3	Sorghum											
4	Sesame											
5	Green Grams											
6	Butter Beans											
7	Pigeon Peas											
8	Other Legumes											
9	Sun flower											
10	Sweet Potatoes											
9	Cotton											
10	Tomatoes											
11	Onions											
12	Vegetables											
13. i	Groundnuts											
13 ii	Pumpkins											
13 iii	Millet											

CP13. What amount of fruits did you harvest since the last visit?

No	Type	Tick	No. of bags harvested
1	No Fruit tree		
2	Orange		
3	Mango		
4	Pawpaw		
5	Guava		
5	Coconut		
6	Other (specify).		

CP14. Please indicate how many days of... [*labour category*] were spent in... [*Major crop production activity*] during the 2014 production year?

Labour category	**Major crop production activities - 2014 season**							
	Land preparation		**Planting**		**Weeding**		**Harvesting**	
	Man Days	Woman Days	Man Days	Woman Days	Man Days	Woman Days	Man Days	Woman Days
Family labour								
Hired labour								

CP15.How did you address pests on your field crops during the 2014 production year?

1) Did not take any measure
2) Selection of pest resistant plant species/varieties
3) Pesticides (*enumerator*: *list all that are ever used on your farm*) _____
4) Mixed/ inter cropping
5) Other (Specify) ...

CP16.How did you address crop diseases on your farm during the 2014 production year?

1) Did not take any measure
2) Plant spacing
3) Fungicides
4) Selection of resistant plant species/varieties
5) Other (specify) ...

(*enumerator: list all that are ever used on your farm*)

_____

CP17. How did you address weeds on your farm during the 2014 production year? *(Multiple answers possible).*

1) Did not take any measure
2) Hand weeding/hoeing
3) Herbicides
4) Use of fast emerging crop varieties
5) Other (specify) ……

(enumerator: list all that are ever used on your farm)

_____

CP18. During 2014 production year, did you grow different crops from previous year? 1. Yes 2. No =>CP18

CP19. If Yes to CP18, what is the main reason you changed the crops you grow? ……

CP20. What influenced your decision on when to harvest the crop during the 2014 production year?

1) Maturity
2) Market price
3) Danger from theft
4) Other (specify) _____

CP21. Does your household have access to any storage facility? 1) Yes 2) No

CP22a. If YES to CP21: Which are they (a) On Farm (b) In House (c) Public

CP22b. If YES to CP21 how are you storing the crops in this 2014 production year?

1 = In locally made traditional structure
2 = In modern store
3 = In Sacks/open drum
4 = In airtight drum
5= Other (specify) ……

CP23. How are you protecting your stored crops in this 2014 production year? *(Enumerator: circle all that apply)*

1) Did not take any measure
2) Ashes
3) Pesticides/insecticides *(enumerator: list all that are ever used on your farm)* _____
4) Tree leaves and other herbs
5) Others (specify) ……
6) Cow dung

CP24 If you experienced any post-harvest losses in 2014-production year, what are the main reasons for loss?

1. _____ 2. _____ 3. _____

CP25**: Please provide information about selling of the following products at your household (*Enumerator: first tick the products which apply from crop and livestock production sections)*

No.	I: Crops Sold	Tick	1 = Male; 2 = Female	Where is the product sold?	If you did not sell, what was the main reason? Code: 1= Low Harvest 2 = No market for it; 3= Low Prices; 4 = grown only for food
1	Maize				
2	Rice				
3	Sorghum				
4	Sesame				
5	Green Grams				
6	Butter Beans				
7	Pigeon Peas				
8	Other Legumes				
9	Sun flower				
10	Sweet Potatoes				
11	Cotton				
12	Tomatoes				
13	Onions				
14	Vegetables				
15	Groundnuts				
16	Pumpkins				
17	Millet				

CP26. What difficulties did you face when trying to sell your crops?

1= Poor Infrastructures
2= No formal market
3= Low prices
4= Low demand
e. Others (Specify). ……

CP27. How did you address these difficulties? ……..

CP29. What are the three main problems you experienced when growing crops in 2014 production year?

1. _____ 2. _____ 3. _____

CP33. What are the specific weather risks that crop production faced in this area?

(Circle all that apply)

1=Drought	3=Temperature	5=Other ……	(specify)
2=Excess rain/flood	4=Humidity		

CP34. If you ever experienced any of the weather risks outlined above, how did you manage it? ……

CP35. In which of the last ten years do you recall having most favourable weather for crop production? Mention the year(s) ……

CP36. In which of the last ten years do you recall having the worst weather for crop production? Mention the year(s) ……

2.5. Livestock Production and Disposal (2014 production year) (LP)

Provide details for livestock production activities of your household during the 2014 production year

S/N	Livestock and livestock product type	How many.. Do you keep?	Quantity sold (No)	Quantity consumed at home (No)	Reason(s) for keeping	Importance of … to livelihood? (1=Not important, 2=Somehow important, 3=Very important)
	LP2	**LP3**	**LP4**	**LP5**	**LP 13**	**LP14**
	I: Livestock type					
1	Calves					
2	Heifers					
3	Milking cows					
4	Dry cows					
5	Bulls					
6	Oxen					
7	Goats					
8	Sheep					
9	Donkey					
10	Chicken					
11	Ducks					
12	Others (Specify)					

	II: Livestock products:	Kg/Lt.	Kg/Lt.	Kg/Lt.	
11	Milk				
14	Hide (No)				
15	Skin (No)				
16	Animal manure (Bags)				
17	Eggs				

LP7. We will now ask you information regarding labour distribution by gender in the major livestock production activities. Please indicate a typical number of hours/days of... [*labour category*] spent in...[*Major livestock activity*] during the 2014 production year?

Labour category	Major livestock production activities- 2014 production season																	
	Pasture/ fodder establishment and management (Days)			Animal grazing (Outdoor) (hrs. /day)			Animal feeding (Indoor) (hrs. /day)			Manure handling/cleaning (hrs. /day)			Milking (hrs. /day)			Housing (Days)		
	Man	Woman	Child	Man	Woman	Child	Man	Woman	Child	Man	Woman	Child	Man	Woman	Child	Man	Woman	Child
Family labour																		
Hired labour																		

LP9. How did you address animal diseases during the 2014 production year?

1) Did not take any measure
2) Seek advice from veterinarian
3) Use traditional medicine
4) Seek advice from friends/neighbours/relatives
5) Seek advice from agriculture input shops
6) Selection of disease resistant livestock species
7) Other (specify)..

LP10. What are the three main problems that you experienced in livestock production in the 2014 production year? Start with the most important

problem facing your household.

1…… 2…… 3. ……

No.	II: Livestock Sold	Tick	1 = Male; 2 = Female	Where is the product sold?	If you did not sell, what was the main reason? Code: 1= Low Harvest 2 = No market for it; 3= Low Prices; 4 = kept only for food
1	Calves				
2	Heifers				
3	Milking cows				
4	Dry cows				
5	Bulls				
6	Oxen				
7	Goats				
8	Sheep				
9	Donkey				
10	Chicken				
11	Ducks				
12	Others (Specify)				
	II: Livestock product Sold				
13	Milk				
15	Hide				
16	Skin				
18	Eggs				

LP11. What difficulties did you face when trying to sell your livestock/livestock products?

1. Poor Transport Infrastructures
2. No formal market
3. Low prices
4. Low demand
5. Others (Specify). …….

LP12. How do you address these difficulties? ……

2.6 Agricultural Inputs and Uses (AIU)

AIU1.Please provide information on the uses & sources of agriculture input during the 2014 production year.

	Type of input	Did you use…?	If Yes, give source?	Estimated expenditure 2014	If No, give reason for not using…	Assessment of availability of …
		Code 1	Code 2	(TZS)	Code 3	Code 4
1	Mineral fertilizers					
2	Animal manure					
3	Pesticides					
4	Herbicides					
5	Improved Seeds/Seedlings					
6	Chicks/breeding stock					
7	Veterinary medicines					
8	Animal feeds/Concentrates					
9	Mechanization services					

Code 1
1=Yes
2=No

Code 2
1 = Government institutions
2 = Buy from shops
3 = Own farm
4= Other (specify)

Code 3
1=Very expensive
2=Not available
3=Not needed
4=Laborious work to apply and use
5=Don't know how to use

Code 4
1=Easily obtained
2=Obtained with difficulty
3=Not available

2.8. Agricultural Information and Extension Services (AIE)

AIE1. During the 2014 production year...

	Sources of advice/ information	**AIE1a**. did you receive advice/ information for your agricultural/ livestock activities from ...*[sources]*?	**AIE1b.** Was the information about…?				**AIE1c**. How many times did someone from... *[Source]* visit your
			Crop production	Livestock production	Agro-processing	Agricultural Marketing and	

						prices	farm in the past 12months?
		1=Yes	1=Yes	1=Yes	1=Yes	1=Yes	
		2=No → NEXT ROW	2=No	2=No	2=No	2=No	
1	Government extension						
2	Non-Governmental Organisation						
3	Cooperative/Farmer's association						
5	Radio/Television						
6	Publication						
7	Neighbour/Relatives/Friends						
8	Other (specify)						

AIE2. If yes to any of the items in AIE1a, Please provide information about how useful and accessible to you/your household were each source of agricultural advice/information during the 2014 production year.

	Source of advice/ information	**AIE2a.** How useful was … *[Source]* as a source of advice/information? (1=Not useful, 3= Somehow Useful 3=Very useful)	**AIE2b**. How accessible was … *[Source]* as a source of advice/information? (1=Not accessible, 2 = Somehow accessible 3=Very accessible)
1	Government extension		
2	Non-Governmental Organisation		
3	Cooperative/Farmer's association		
5	Radio/Television		
6	Publication		
7	Neighbour/Relatives/Friends		
8	Other (specify)		

AIE3: If yes to any of the items in AIE1b, how important to you/your household were each type of agricultural advice/information during the 2014-production year?

	Type of advice/ information	**AIE3a. How important was… *[Type]* advice/information (1=Not important, 2= Somehow important, 3=Very important)**
1	Crop production	
2	Livestock production	

3	Agro-processing	
4	Agricultural prices and marketing	
5	Other (specify)	

MODULE THREE
FOOD AND CARE PRACTICES (FCP)

Module 3.1: Household Expenditure and Consumption

Now we will ask you questions related to your household expenditure and consumption of major food and non-food items during the last 30 days

3.1.1. Regular household food expenditure and consumption during the last 30 days

Item		1.Total quantity of ... consumed in the last 30 days	2. Amount of …consumed in the last 30 days from different sources			
			Own produce	Purchased	Gift/Borrowed	Transfers/ Aid
		HEC1	HEC2a	HEC2b	HEC2c	HEC2d
1	Maize/Maize Flour (kg)					
2	Rice (kg)					
3	Wheat flour (kg)					
4	Sorghum (kg)					
5	Bread (loaves)					
6	Local donuts / Vitumbua /Chapati (No)					
7	Sweet Potatoes (kg)					
8	Irish Potatoes (kg)					
9	Cassava (kg)					
10	Beans & other legumes (kg)					
11	Groundnuts (kg)					
12	Cooking Oil (lt)					
13	Ginger & other Condiments (kg)					

14	Tomato (kg)					
15	Onion (kg)					
16	Carrots (kg)					
17	Cabbage (No)					
18	Lettuce & other vegetables (bundles)					
19	Mango, Papaya & other fruits (No)					
20	Tea/Coffee (packets)					
21	Sugar (kg)					
22	Salt (kg)					
23	Beef, Goat, Mutton (kg)					
24	Fish (Number)					
25	Chicken (Number)					
26	Eggs (Number)					
27	Milk (lt.)					
28	Honey (lt.)					
29	Coconut (No)					
30	Sardine (Kg)					

3.1.2. Purchase of Durable Items and Other Services (PDI)

S/N	**What was your household expenditure on the following items during the last 30 days?**	**In-cash expenditure (TZS)**	**In-kind expenditure/gift given away (TZS)**	**Total expenditure (TZS)**
	PDI1	PDI2	PDI3	PDI4
1	Cooking materials			

	(charcoal, kerosene, etc.)			
2	Laundry (soap, detergents, etc.)			
3	Payment of household utilities (electricity, airtime vouchers & water bills, etc.)			
4	Kitchen utensils			
5	School fees & related			
6	Medical expenditure			
7	Special occasions (funerals, weddings, parties, rituals, charity, etc.)			
8	Personal care (body lotion, hair oil, etc.)			
9	Clothing and footwear (tailored clothes, ready-made clothes, rain clothes, underwear, baby clothes, diapers, hats, shoes, boots, etc.)			
10	Personal effects (costume/gold jewellery, handbags, wallets, wristwatch, clocks, umbrellas)			
11	Household furniture			
12	Transport (bought or paid fare)			
13	Building materials (renovation/construction)			
14	Hiring Farm Equipment			
15	Recreation (entertainment services, recreational goods and supplies)			
16	Money transfers			
17	Servant Salary			
18	Other (specify). …			

Module 3.2: Food security/insecurity issues and Coping Mechanisms

3.2.1. Household Food Insecurity Access Scale (HFIAS)

For each of the following questions, consider whether they have happened in the past 30 days. If the answer is 'Yes' to a question, please indicate how often this happened.

Access to food (AF)

No.	Question	Response options: Assign code according to the following answers (How often did this happen?) (0) Never= it did not happen in the past 30 days (1) Rarely= once or twice in the past 30 days (2) Sometimes = three to ten times in the past 30 days (3) Often = more than ten times in the past 30 days
AF1	In the past (30 days), did you worry that your household would not have enough food?	
AF2	In the past [30 days], did it happen that you or any household member were not able to eat the kinds of foods you would have preferred to eat because of lack of resources?	
AF3	In the past [30 days], did it happen that you or any household member had to eat a limited variety of foods because of lack of resources?	
AF4	In the past [30 days] did it happen that you or any household member had to eat some foods that you really did not want to eat because of lack of resources?	
AF5	In the past [30 days] did it happen that you or any household member had to eat a smaller meal than you felt you needed because there was not enough food?	
AF6	In the past [30 days] did it happen that you or any household member had to eat fewer meals in a day because there was not enough food?	
AF7	In the past [30 days] did it happen that there was no food to eat of any kind in your house, because of lack of resources to get food?	
AF8	In the past [30 days] did it happen that you or any household member went to sleep at night hungry because there was not enough food?	*If yes, ask respondent to describe*
AF9	"In the past [30 days] did it happen that you or any household member went a whole day and	*If yes, ask respondent to describe*

	night without eating anything at all because there was not enough food?"	

3.2.2 HOUSEHOLD DIETARY DIVERSITY SCORE (HDDS)

Please describe the foods (meals and snacks) that you (or your household members) ate yesterday during the day and night. Start with the first food eaten in the morning.

(interviewer) - Write down all foods and drinks mentioned by the respondent. When the respondent has finished, probe for meals & snacks not mentioned (Guideline for probing questions are provided). Consider foods eaten by any member of the household, exclude foods purchased and eaten outside the home.

	Breakfast	***Snack***	***Lunch***	***Snack***	***Dinner***	**Snack**
1						
2						
3						
4						
5						
6						

SN	**Food group**	**Examples**	**1 = Yes 2 = No**
HDD1	CEREALS	Maize, rice, wheat, sorghum, or any other grains or foods made from these (e.g. bread, *ugali*, porridge etc.)	
HDD2	VITAMIN A RICH VEGETABLES AND TUBERS	Pumpkin, carrots, or sweet potatoes that are orange inside + other locally available vitamin-A rich vegetables	
HDD3	WHITE TUBERS AND ROOTS	White potatoes, white yams, white cassava, or other foods made from roots	
HDD4	DARK GREEN LEAFY VEGETABLES	Any dark, green, leafy vegetables such as cassava leaves, bean leaves, spinach, amaranth, spinach, incl. Wild veges etc.	
HDD5	OTHER VEGETABLES	Other vegetables (e.g. tomato, onion, eggplant), including wild vegetables	
HDD6	VITAMIN A RICH FRUITS	Ripe mangoes, ripe papaya + other locally available vitamin A-rich fruits	
HDD7	OTHER FRUITS	Other fruits, including wild fruits	
HDD8	ORGAN MEAT (IRON-RICH)	Liver, kidney, heart or other organ meats or blood-based foods	
HDD9	FLESH MEATS	Beef, pork, lamb, goat, rabbit, wild game, chicken, duck, or other birds	
HDD10	EGGS	Chicken, duck, guinea hen or any other egg	
HDD11	FISH	Fresh or dried fish or shellfish	
HDD12	LEGUMES,	Beans, peas, lentils, nuts, seeds or foods	

	NUTS AND SEEDS	made from these	
HDD13	MILK AND MILK PRODUCTS	Milk, cheese, yogurt or other milk products	
HDD14	OILS AND FATS	Oil, fats or butter added to food or used for cooking	
HDD15	RED PALM PRODUCTS	Red palm oil, palm nut or palm nut pulp sauce	
HDD16	SWEETS	Sugar, honey, sweetened soda or sugary foods such as chocolates, candies, cookies and cakes	
HDD17	SPICES, CONDIMENTS, BEVERAGES	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages or local examples	

HDD18. Did you or anyone in your household eat anything (meal or snack) OUTSIDE of the home yesterday? 1 = Yes 2 = No

DIETARY DIVERSITY GUIDING QUESTIONS FOR THE HOUSEHOLD SURVEY

1	Who was the first person in the household to wake up yesterday?	*1*.me/spouse 2.my daughter 3.Others Specify
2	After you woke up, what was the first thing prepared or consumed in the household?	
3	Did you make coffee /tea or porridge yesterday? (breakfast)	*1 =Yes* *2 = No*
4	At what time?	
5	Did you consume the tea or coffee with something else or only had the coffee?	*1 =Yes* *2 = No*
6	What were the ingredients in the coffee/tea/porridge?	
7	Do you sweeten all the tea/ coffee/ porridge at once, or does each person sweeten his or her own cup?	Sweeten all at once No sweeten at all Sweeten individually
8	What was the next thing prepared or consumed after the tea/ coffee/ porridge?	
(Asks for and writes down all the ingredients of each foods consumed at breakfast).		
9	Is there any beverage with breakfast?	
10	What was the next thing prepared or consumed after breakfast?	

11	Did anyone in the household eat anything between breakfast and lunch? For example, fruits, nuts or milk for the baby?	
12	(After requesting information on the ingredients of each meal after lunch). What was the next thing prepared after lunch?	
13	(Notes all the ingredients of each dish consumed at dinner) Was any beverage served with dinner?	
14	Did anyone in the household eat or drink anything after dinner? For example, a cup of tea/ coffee or a piece of fruit or milk for the baby?	
15	Did you all go to bed at the same time, or did some household members stay up later than others?	*1 = Yes if yes specify* *2 = No*
16	Did you eat or drink any last thing before going to bed?	
17	If something is eaten describe it	

3.3. Household Coping Strategies/Mechanisms and Related (HCS)

Please ask these questions to the mother. Ask questions HCS2 to HCS9 to the household head

HCS1. Number of servings per day [*First tick the composition of household members*]			
1	Household member*	Tick	Number/Frequency of meals
2	Children under 5		
3	Girls (6-18 years)		
4	Boys (6-18 years)		
5	Lactating mother		
6	Pregnant mother		
7	Non-lactating/Non-pregnant woman		
8	Husband & other adult men living in the household		

HCS2. Did your household face serious food shortages since last survey? 1= Yes 2= No

HCS3. If 'Yes' to HC2, in which month(s) were the food shortage serious in the household? List the months ……, ……..., …….

HCS4. If again 'Yes', to HC2 What were the most important causes of food shortage in the household? Please list in the order of their importance (1=Most important)

1) …… 2) …… 3) ……

HCS5. If YES to HCS2 What measures did you take if your household faced serious food shortage since last survey?

1) …… 2) …… 3) ……

HCS6.Where did you get food you do not produce?

(a) Buy from neighbours
(b) Buy from the local shops/market
(c) Seek from the forest
(d) Others (specify) ……

HCS7. What difficulties did you face when trying to buy foodstuff?

a. Poor Transport Infrastructure
b. High prices
c. Low supply
d. Lack of alternatives
e. No formal market
f. Others (Specify) ……

HCS8. How did you address these difficulties?

1) …… 2) …… 3) ……

HCS9. What (if any) were the major traditional/socio-cultural activities that consumed a significant amount of your food produce in the 2014 production year?

(a) Weddings
(b) Religious offering/Rituals
(c) Traditional dances
(d) Funerals
(e) Others (specify)

HCS10.What kinds of food do you usually buy from neighbours?

1) …… 2) …… 3) ……

HC11. What kinds of food do you usually buy from local shops?

1) …… 2) …… 3) ……

HC12. What kinds of food do you usually buy from the district market?

1) …… 2) …… 3) ……

HCS13. At what time of the year do you usually find it difficult to buy food because of high prices?

1) …… 2) …… 3) ……

HC14. What do you do in that situation? (HCS 13 above)

1) …… 2) …… 3) ……

HCS15. What kinds of food do you seek from the forest?

1) …… 2) …… 3) ……

HCS16. When do you usually consume such food? (Time in a year) (HCS 15 Above)

1) …… 2) …… 3) ……

HCS17. Whose duty is it to pick such food from the forest?

1) …… 2) …… 3) ……

HCS18. Are there any difficulties in finding forest foods? 1 = Yes 2 = No

HCS19. What are they? (HCS 18 Above)
1) …… 2) …… 3) ……

HCS20. How do you face these difficulties? (HCS 19 Above)
1) …… 2) …… 3) ……

HCS21. Did you exchange any goods (food/animals or non-food) them with other goods (food/animals or non-food) in the past 12 months?
1 = Yes 2 = No

HCS22. If yes to HCS21, what good did you give?
1) …… 2) …… 3) ……

HCS23. If yes again to HCS21, what goods did you receive?
1) …… 2) …… 3) ……

HCS24. Have you ever worked in other people's farms in exchange for food for the past 12 months?
1 = Yes 2 = No

HCS25. If yes to HCS24, What food/animals did you receive?

No	Food received	Amount
1		
2		
3		
4		
5		
6		

HCS26. Have you ever taken or repaid a loan using the food/animals you have produced?
1 = Yes 2 = No

HCS27. If yes to HCS26, how is the payment valued?

MODULE FIVE

5. Social Capital

Now we would like to ask you some questions about how you feel about this village, and how you take part in the community activities

SC1 Have you/someone in your household joined any groups/organizations in 2014?
1 = Yes 2 = No

SC2. If 'Yes' to SC1, list up to three in order of importance

Group	Type of group (Write the option and name of group)	Participation
	1 = Religious group 2 = Farmers' Association 3 = Development Committee 4 = Youth Group 5 = Women's group 6 = Other (specify)	1= An active member with position (e.g. Chairperson, Secretary, Treasurer) 2= Active member but no formal position 3= Not an active member
Group A		
Group B		
Group C		

SC3. What is the value of these groups (listed in SC1) to your household wellbeing? ……

INTERVIEWER: You have now come to the end of the interview. Make sure to do the following:

i. ***Thank the respondent for the cooperation shown by the members of the household during the interview***

ii. ***Take enough time to examine all the entries/boxes on all pages. Make sure that no empty boxes are left, for which an entry is required. In particular work out, with the help of the main informant, how information (missing) relating to members of the household who happen to be absent at the time of the interview can be obtained.***

Appendix 2: Guidance Note for Focus Group Discussions

Appendix 2 (a) First Round (Pre-Harvest) Focus Group Discussions

Introduction:

Thanks for agreeing to be part of this discussion. We appreciate your willingness to participate.

We
are.....
Coming
from.....

We are conducting research with Sokoine University of Agriculture and St. Augustine University of Tanzania under the Irish Aid funded AGRIDIET project to examine the link between agriculture and nutrition. We want to explore ways in which your farming and food management practices impact on nutrition, particularly of women and children in rural household. This is the second round of discussions; the first round was in January/ February 2014. We want to seek more information and clarification to issues, which we did not address during the first round of discussions.

Your involvement in this discussion is crucial. Since the study is about agriculture nutrition linkage, the findings of the research can benefit the entire rural households. Your opinions will help us to identify policies and interventions that can make a positive impact on agriculture and nutritional status.

This is not a test, and there is no right or wrong answer to the focus group questions. The most important thing is that you should feel comfortable and contribute as much as you can. We want to hear many different viewpoints and would like to hear from everyone. We hope you can be honest even when your responses may not agree with the rest of the group. In respect for each other, we ask that only one individual speak at a time in the group and that responses made by all participants be kept confidential.

We assure you that all the information that you provide to us will be used exclusively for our research. We want to capture everything, therefore will record the session but all responses will appear anonymously in our report.

1. Profile of the Focus Group

i. Number of people: Men_____, Women_____
ii. Nature of the Group (*i.e. men only, female only, mixed*): _____
iii. Location of meeting: _____

iv. Date: _____ Start time: _____ Finish time: _____

2. General welfare information

Relative to past production year what went well and what did not go well in this area during the 2014 production year in terms of crop and livestock production?

3. Farming practices

i. What were the main factors (besides food for consumption and cash earning) that determined which crops you cultivated in this area in 2014?

ii. What were the main factors (besides food for consumption and cash earning) that determined which livestock species you kept in this area during the 2014 production years?

iii. Where did you sell/ are you selling the agricultural outputs from 2014 production season? What were/are the challenges when selling the agricultural outputs?

iv. What have been the major agriculture production risks that you experienced in this area during the past 10 years? How did people manage the risk if it occurred in this area?

4. Agriculture information, inputs and credit services

i. What were the main challenges in accessing advice and information on farming in 2014? How did you deal with these challenges?

ii. What were the main challenges in accessing the farm inputs in 2014? How did you deal with these challenges?

iii. What were the main challenges in accessing credit services in 2014? How did you deal with these challenges?

5. Food Insecurity & coping mechanisms

i. What were the factors that determined what food people ate in this area in 2014?

[Please probe on how the social surroundings like friends, neighbours and community influence the type of food people ate in this area]

ii. How do people normally get food (besides own production) for home consumption in this area? What were the main difficulties to get food for home consumption in 2014?

iii. Where is the closest market for food in this area? What food is available at the market?

iv. During year 2014, was access to food affected seasonally? If yes, how and why? What were the 'lean' months?

v. What was the average price (per kg/local unit of measurement) of the major staple foods at the market in 2014? During year 2014, was the price of the major staple foods affected seasonally? If yes, how, when and why?

Appendix 2 (b) Second Round (Post-Harvest) Focus Group Discussions

Introduction:

Thanks for agreeing to be part of this discussion. We appreciate your willingness to participate.

We are.....
Coming from.....

We are conducting research with Sokoine University of Agriculture and St. Augustine University of Tanzania under the Irish Aid funded AGRIDIET project to examine the link between agriculture and nutrition. We want to explore ways in which your farming and food management practices impact on nutrition, particularly of women and children in rural household. This is the second round of discussions; the first round was in January/ February 2014. We want to seek more information and clarification to issues, which we did not address during the first round of discussions.

Your involvement in this discussion is crucial. Since the study is about agriculture nutrition linkage, the findings of the research can benefit the entire rural households. Your opinions will help us to identify policies and interventions that can make a positive impact on agriculture and nutritional status.

This is not a test, and there is no right or wrong answer to the focus group questions. The most important thing is that you should feel comfortable and contribute as much as you can. We want to hear many different viewpoints and would like to hear from everyone. We hope you can be honest even when your responses may not agree with the rest of the group. In respect for each other, we ask that only one individual speak at a time in the group and that responses made by all participants be kept confidential.

We assure you that all the information that you provide to us will be used exclusively for our research. We want to capture everything, therefore will record the session but all responses will appear anonymously in our report.

1. Profile of the Focus Group

i. Number of people: Men_____, Women_____
ii. Nature of the Group (*i.e. men only, female only, mixed*): _____
iii. Location of meeting: _____
iv. Date: _____ Start time: _____ Finish time: _____

2. General welfare information

Relative to past production year what went well and what did not go well in this area during the 2014 production year in terms of crop and livestock production?

3. Farming practices

i. What were the main factors (besides food for consumption and cash earning) that determined which crops you cultivated in this area in 2014?
ii. What were the main factors (besides food for consumption and cash earning) that determined which livestock species you kept in this area during the 2014 production years?
iii. Where did you sell/ are you selling the agricultural outputs from 2014 production season? What were/are the challenges when selling the agricultural outputs?
iv. What have been the major agriculture production risks that you experienced in this area during the past 10 years? How did people manage the risk if it occurred in this area?

4. Agriculture information, inputs and credit services

i. What were the main challenges in accessing advice and information on farming in 2014? How did you deal with these challenges?
ii. What were the main challenges in accessing the farm inputs in 2014? How did you deal with these challenges?
iii. What were the main challenges in accessing credit services in 2014? How did you deal with these challenges?

5. Food Insecurity & coping mechanisms

i. What were the factors that determined what food people ate in this area in 2014?

   [Please probe on how the social surroundings like friends, neighbours and community influence the type of food people ate in this area]

ii. How do people normally get food (besides own production) for home consumption in this area? What were the main difficulties to get food for home consumption in 2014?
iii. Where is the closest market for food in this area? What food is available at the market?
iv. During year 2014, was access to food affected seasonally? If yes, how and why? What were the 'lean' months?
v. What was the average price (per kg/local unit of measurement) of the major staple foods at the market in 2014? During year 2014, was the price of the major staple foods affected seasonally? If yes, how, when and why?

Appendix 3: Guidance Note for Key Informant Interviews

INTRODUCTION

Thanks for agreeing to be part of this discussion. I appreciate your willingness to participate.

I am.....

Coming
from.....

I am conducting research with Sokoine University of Agriculture and St. Augustine University of Tanzania under the Irish Aid funded AGRIDIET project to examine the link between agriculture and nutrition. We want to explore ways in which farming and food management practices impact on nutrition, particularly of women and children in rural household.

Your involvement in this discussion is crucial. Since the study is about agriculture nutrition linkage, the findings of the research can benefit the entire rural households. Your opinions will help us to identify policies and interventions that can make a positive impact on agriculture and nutritional status.

This is not a test, and there are no right or wrong answers to any of the questions. The most important thing is that you should feel comfortable and provide your honest opinion as much as you can. I assure you that all your response is confidential and will be used exclusively for our research purpose. I want to capture everything, therefore will record the session but all your responses will appear anonymously in our report.

PROFILE OF THE KEY INFORMANT

v. Category: _____
vi. Position (if representing any organisation) _____
vii. Location of the meeting: _____
viii. Date: _____ Start time: _____ Finish time: _____

KEY INFORMANT DISCUSSIONS GUIDING QUESTIONS

Category A: Village/Ward agricultural extension officers

i. Where did farmers obtain the main farm inputs in 2014? What were the challenges facing farmers in accessing these farm inputs? How did your office help farmers to address these challenges?
ii. Where did farmers obtain credit services? In your experience, what percentage of farmers in this area used credit services in 2014? What were

the challenges facing farmers in accessing credit services in this area? How did your office help farmers to address these challenges?

iii. What were the main problems that were associated with crop production in this area in 2014? How did your office help farmers to address such problems?

iv. What were the main problems that were associated with livestock production in this area in 2014? How did your office help farmers to address such constraints?

v. What were the major challenges in delivering agriculture extension services in this area in 2014?

Category B: Village elders

v. What main changes have taken place in the way people make a living over the past 30 years?

vi. How do people in this area obtain land for crop cultivation/ livestock keeping activities? What are the challenges?

vii. What are the social-cultural practices that affect the type and amount of food available to the household in this area?

viii. What are the main causes of food shortages in this area?

ix. What do people normally do when there is a shortage of food?

x. What do people normally do if rains are poor or fail?

xi. How do people in this community make savings?

Category C: Village executive officers (VEO)

i. What procedures are used to make decisions on major development projects needed in this village?

ii. What are the main causes of conflicts between villagers in this community? How do people resolve them?

iii. How do people get access to land resources?

iv. What were the main sources in which farmers in this village received agricultural information and advice in 2014?

v. Where did people obtain credit services in this village in 2014?

Category D: Village health centre representatives

i. What were the main health problems facing this community in 2014?

ii. What actions were in place to address the kinds of health problems you mentioned in 2014?

iii. What were the constraints in addressing health problems in 2014?

iv. What could be done to improve the health situation in this community?

Category E: Farm input suppliers (Agro-dealers)

i. What types of farm inputs did you supply to farmers in this area in 2014?

(i)_____
(ii)_____
(iii)_____
(iv)_____

If fertiliser is mentioned, please provide the following information:

No	Type of fertiliser	Price/kg in TZS (2013)	Price/kg in TZS (2014)

[*If there is a price difference*] Why has there been a price change?

If crop seed is mentioned, please provide information on the most common variety per each species supplied:

No	Type of crop seed (most common variety in the area)	Price/50kg pack in TZS (2013)	Price/50kg pack in TZS (2014)

[*If there is a price difference*] Why has there been a price change?

If pesticide/insecticide is mentioned, please provide information on the most commonly used in this area:

No	Type of pesticide/insecticide in its standard unit of measurement	Price in TZS (2013)	Price in TZS (2014)

[*If there is a price difference*] Why has there been a price change?

If vet medicine is mentioned, please provide information on the most commonly used in the area.

No	Type of vet-medicine in its standard unit of measurement	Price in TZS (2013)	Price in TZS (2014)

[*If there is a price difference*] Why has there been a price change?

ii. What challenges did you face in supplying farm inputs to this area in 2014? How did you deal with the challenges? How did you address them?

SELECTION OF KEY INFORMANTS IN MVOMERO AND KISHAPU DISTRICTS

The key informants will be purposefully selected from the village officials, elders/experienced farmers, health centres and agro-dealers based on their knowledge of faming systems, the local economy, food security and nutrition. A total of 10 key informants are proposed to participate from each study District as detailed in the table below.

Distribution of key informants

CATEGORY	MVOMERO		KISHAPU		TOTAL
	MILAMA	MAKUYU	LUBAGA	MWAKIPOYA	
A: Agriculture extension officers	1	1	1	1	4
B: Village elders	1	1	1	1	4
C: Village executive officers	1	1	1	1	4
D: Health centres representatives	1		1		2
E: Farm input suppliers (Agro-dealers)	3		3		6
TOTAL	**10**		**10**		**20**

Appendix 4: Market Price Survey Guide

The following is an example of a monthly guide to collecting price data in Mhunze market, Kishapu District and in Dakawa and Mvomero market, Mvomero District.

No.	Food Items	Seller 1	Seller 2	Seller 3
1	Maize (20Kg Bin)			
3	Rice (Kg)			
4	Sorghum (Kg)			
5	Wheat Flour (Kg)			
6	Cassava (Pile)			
7	Beans (Kg)			
8	Sugar (Kg)			
9	Bread			
10	Sweet Potatoes (20Kg Bin)			
11	Irish Potatoes (Pile)			
12	Local Salt (Kg)			
13	Salt (Packet - 100g)			
14	Beef (Kg)			
15	Goat meat (Kg)			
16	Chicken			
17	Mutton (Kg)			
18	Bar of Soap			
19	Tea Leaves (Packet) - 200g			
20	Groundnuts (Kg)			
21	Cooking Oil (Litre)			
22	Cabbage, Lettuce & other vegetables (bundle)			
23	Tomatoes (Pile)			
24	Onions (Pile)			
25	Mango			
26	Banana			
27	Eggs			
28	Fresh Milk (Lt)			

	Essential Non-Food Items	Seller 1	Seller 2	Seller 3
1	Charcoal (Bag)			
2	Firewood (Bundle)			
3	Bar of soap			
4	Body Jelly (300ml can)			
5	Washing Powder (1kg)			
6	Water Contribution (Monthly)			

Officer: …… Signature: …… Date: ……

Appendix 5: 2014 Average Market Price Survey Data

No.	Food Items	Kishapu		Mvomero			
		Mhunze Market		Dakawa Market		Mvomero Market	
		Pre-Harvest	Post-Harvest	Pre-Harvest	Post-Harvest	Pre-Harvest	Post-Harvest
1	Maize	578.7	402.8	444.5	250.0	555.6	483.3
2	Rice	1,133.3	933.3	1,066.7	1,000.0	1,083.0	1,000.0
3	Wheat	1,200.0	1,200.0	1,300.0	1,233.3	1,200.0	1,200.0
4	Sorghum	287.0	162.0	508.3	412.3	250.0	250.0
5	Bread	2,000.0	2,000.0	2,200.0	2,000.0	2,000.0	2,000.0
6	Donut	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
7	Sweet Potatoes	444.4	261.1	500.0	500.0	500.0	500.0
8	Irish Potatoes	1,000.0	1,000.0	500.0	515.0	800.0	800.0
9	Cassava	1,000.0	1,000.0	500.0	500.0	500.0	1,000.0
10	Beans	1,366.0	1,366.0	1,166.7	1,433.3	1,800.0	2,000.0
11	Groundnuts	2,000.0	1,833.3	2,000.0	1,950.0	2,233.3	2,000.0
12	Oil	2,950.0	2,933.3	3,000.0	2,900.0	2,733.3	2,350.0
13	Ginger	7,500.0	7,500.0	6,000.0	6,000.0	6,000.0	6,000.0
14	Tomato	933.3	966.7	733.3	400.0	1,000.0	400.0
15	Onion	1,000.0	500.0	1,100.0	650.0	1,500.0	1,500.0
16	Carrot	2,000.0	1,750.0	1,800.0	1,500.0	2,000.0	1,500.0
17	Cabbage	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0	1,000.0
18	Vegetables	2,000.0	4,000.0	2,000.0	2,000.0	2,000.0	2,000.0
19	Fruits	1,875.0	1,500.0	666.7	832.5	1,000.0	1,208.3
20	Tea	10,000.0	10,000.0	12,000.0	10,000.0	10,000.0	10,000.0
21	Sugar	1,850.0	1,800.0	2,000.0	2,000.0	2,000.0	1,650.0
22	Meat	4,000.0	4,500.0	4,000.0	5,000.0	5,000.0	5,000.0
23	Fish	6,000.0	4,833.3	4,500.0	4,560.0	4,500.0	4,500.0
24	Chicken	13,333.3	10,000.0	7,250.0	9,333.3	9,583.3	11,833.3
25	Eggs	3,750.0	3,937.5	2,912.5	2,687.5	3,750.0	3,750.0
26	Milk	958.3	750.0	550.0	583.3	900.0	1,000.0
27	Honey	5,200.0	5,000.0	6,000.0	4,800.0	6,000.0	5,000.0
28	Coconut	1,000.0	800.0	950.0	750.0	988.9	766.0
29	Sardine	9,500.0	9,000.0	10,000.0	10,000.0	10,000.0	10,000.0
30	Large Cattle		708,333.3		833,888.9		866,388.9
31	Medium Cattle		373,888.9		558,333.3		529,722.2
32	Small Cattle		215,555.6		254,583.3		282,916.7
33	Goat		47,120.4		56,458.3		62,222.2
34	Sheep		50,694.4		52,097.2		51,666.7

No.	Non-Food Items	Mhunze Market		Dakawa Market		Mvomero Market	
		Pre-Harvest	Post-Harvest	Pre-Harvest	Post-Harvest	Pre-Harvest	Post-Harvest
1	Charcoal (Bag)	21000.0	16000.0	15000.0	12000.0	23000.0	14000.0
2	Firewood (Bundle)	1000.0	1000.0	2800.0	2200.0	7000.0	5400.0
3	Bar of Soap	1000.0	1133.3	1000.0	1000.0	1000.0	1000.0
4	Body Jelly (300ml)	1800.0	1600.0	2000.0	1500.0	1500.0	1500.0
5	Washing Powder (1kg)	2000.0	2000.0	2200.0	2400.0	2400.0	2400.0

Appendix 6: Consumed

Appendix 6 (a): Monthly Consumption Pattern

District	Kishapu Pre-Harvest	Kishapu Post-Harvest	Mvomero Pre-Harvest	Mvomero Post-Harvest	Overall Pre-Harvest	Overall Post-harvest
Maize (kg)	70.408	60.651	51.203	49.673	60.881	55.206
Std. Dev.	*50.842*	*38.530*	*30.366*	*26.438*	*43.000*	*33.510*
Rice (kg)	10.225	20.147	11.161	14.753	10.690	17.471
Std. Dev.	*14.318*	*22.122*	*10.619*	*17.191*	*12.615*	*19.994*
Wheat Flour (kg)	2.451	5.259	1.154	0.968	1.807	3.130
Std. Dev.	*8.612*	*9.356*	*3.075*	*2.673*	*6.512*	*7.223*
Sorghum (kg)	31.459	5.165	2.357	1.729	17.023	3.460
Std. Dev.	*47.485*	*19.030*	*16.763*	*8.903*	*38.540*	*14.978*
Bread (loaves) (No.)	0.463	0.063	2.685	2.410	1.565	1.227
Std. Dev.	*5.114*	*0.637*	*9.284*	*4.704*	*7.554*	*3.541*
Donuts (No.)	10.776	4.639	67.096	32.139	38.713	18.281
Std. Dev.	*63.807*	*20.920*	*89.594*	*40.997*	*82.559*	*35.236*
Sweet Potatoes (kg)	22.239	44.420	1.052	7.681	11.729	26.196
Std. Dev.	*36.559*	*45.923*	*4.254*	*15.638*	*28.172*	*38.986*
Irish Potatoes (kg)	0.103	0.861	3.032	2.448	1.556	1.648
Std. Dev.	*0.817*	*3.825*	*5.251*	*3.681*	*4.017*	*3.834*
Cassava (kg)	0.020	0.000	1.080	3.245	0.545	1.610
Std. Dev.	*0.313*	*0.000*	*3.272*	*5.379*	*2.373*	*4.118*

District	Kishapu Pre-Harvest	Kishapu Post-Harvest	Mvomero Pre-Harvest	Mvomero Post-Harvest	Overall Pre-Harvest	Overall Post-harvest
Beans and other legumes (kg)	3.644	5.989	8.938	6.048	6.270	6.018
Std. Dev.	*4.577*	*8.229*	*5.810*	*4.553*	*5.854*	*6.658*
Groundnuts (kg)	13.247	17.895	0.586	1.056	6.966	9.542
Std. Dev.	*21.708*	*21.436*	*1.277*	*1.955*	*16.673*	*17.437*
Cooking oil (Lts)	2.598	3.374	2.551	3.514	2.575	3.443
Std. Dev.	*2.155*	*2.724*	*1.956*	*3.063*	*2.057*	*2.895*
Ginger (kg)	0.025	0.021	0.153	0.175	0.089	0.097
Std. Dev.	*0.217*	*0.158*	*0.579*	*0.327*	*0.440*	*0.267*
Tomato (kg)	5.094	10.231	6.588	10.934	5.835	10.580
Std. Dev.	*5.592*	*8.413*	*9.605*	*6.722*	*7.871*	*7.622*
Onion (kg)	1.601	2.974	1.650	2.227	1.626	2.603
Std. Dev.	*1.515*	*2.687*	*1.135*	*1.421*	*1.339*	*2.184*
Carrots (kg)	0.008	0.018	0.053	0.133	0.030	0.075
Std. Dev.	*0.125*	*0.156*	*0.531*	*0.489*	*0.384*	*0.366*
Cabbage (No.)	0.529	0.882	0.745	1.257	0.636	1.068
Std. Dev.	*4.061*	*1.651*	*1.953*	*2.036*	*3.193*	*1.860*
Vegetables (Bunches)	53.055	35.600	60.012	57.582	56.506	46.504
Std. Dev.	*44.668*	*44.871*	*56.878*	*52.693*	*51.159*	*50.082*
Fruits (No.)	3.239	7.043	22.167	15.191	12.628	11.085
Std. Dev.	*10.070*	*20.307*	*40.533*	*19.701*	*30.888*	*20.400*
Tea/coffee (g)	29.745	128.753	83.287	143.606	56.304	136.121
Std. Dev.	*55.339*	*157.935*	*78.187*	*137.339*	*72.696*	*148.117*

District	Kishapu Pre-Harvest	Kishapu Post-Harvest	Mvomero Pre-Harvest	Mvomero Post-Harvest	Overall Pre-Harvest	Overall Post-harvest
Sugar (kg)	3.297	4.474	3.504	3.926	3.400	4.202
Std. Dev.	*3.004*	*4.006*	*2.185*	*2.848*	*2.629*	*3.487*
Salt (kg)	1.412	1.798	1.046	1.267	1.230	1.534
Std. Dev.	*1.673*	*1.612*	*0.643*	*0.825*	*1.283*	*1.309*
Beef (kg)	2.345	4.620	2.958	2.669	2.649	3.652
Std. Dev.	*5.352*	*10.984*	*3.405*	*3.298*	*4.499*	*8.187*
Fish (No.)	0.227	1.498	3.072	6.414	1.638	3.937
Std. Dev.	*1.642*	*4.141*	*4.723*	*12.224*	*3.798*	*9.416*
Chicken (No.)	0.941	1.227	0.745	1.044	0.844	1.136
Std. Dev.	*1.563*	*1.435*	*1.777*	*1.386*	*1.674*	*1.413*
Egg (No.)	0.565	2.345	1.984	2.299	1.269	2.322
Std. Dev.	*2.930*	*5.022*	*6.601*	*4.748*	*5.138*	*4.883*
Milk (Lts)	17.723	18.347	8.195	9.036	12.997	13.728
Std. Dev.	*34.323*	*33.818*	*30.090*	*25.153*	*32.611*	*30.169*
Honey (Lts)	0.020	0.067	0.026	0.044	0.023	0.055
Std. Dev.	*0.207*	*0.279*	*0.322*	*0.261*	*0.270*	*0.270*
Coconuts (No.)	0.000	0.027	0.211	3.629	0.105	1.814
Std. Dev.	*0.000*	*0.313*	*1.258*	*5.971*	*0.892*	*4.577*
Sardine (Kg)	0.137	4.627	0.392	2.688	0.264	3.666
Std. Dev.	*0.803*	*5.110*	*0.874*	*2.304*	*0.848*	*4.087*

Appendix 6 (b): Pre-Harvest Foods Consumed per Day

NO.	FOOD ITEMS (KG/D)	OVERALL					KISHAPU					MVOMERO				
		Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)
I	***Cereals***	***0.77***	***0.19***	***2.59***	***0.42***	***1.25***	***0.83***	***0.25***	***2.59***	***0.41***	***1.40***	***0.71***	***0.19***	***1.69***	***0.43***	***1.05***
1	Maize	*0.52*	-	*2.03*	*0.20*	*0.95*	*0.52*	-	*2.03*	*0.16*	*0.98*	*0.51*	*0.14*	*1.40*	*0.21*	*0.93*
2	Rice	*0.10*	-	*0.83*	-	*0.30*	*0.08*	-	*0.83*	-	*0.28*	*0.11*	-	*0.56*	-	*0.32*
3	Wheat	*0.02*	-	*0.61*	-	*0.10*	*0.02*	-	*0.61*	-	*0.11*	*0.01*	-	*0.21*	-	*0.08*
4	Sorghum	*0.11*	-	*1.24*	-	*0.63*	*0.21*	-	*1.24*	-	*0.73*	*0.02*	-	*0.71*	-	*0.08*
5	Bread	*0.01*	-	*0.49*	-	*0.04*	*0.00*	-	*0.25*	-	-	*0.02*	-	*0.49*	-	*0.08*
6	Donut	*0.02*	-	*0.32*	-	*0.12*	*0.00*	-	*0.21*	-	*0.03*	*0.04*	-	*0.32*	-	*0.15*
II	***Roots and Tubers***	***0.11***	***-***	***1.79***	***-***	***0.35***	***0.17***	***-***	***1.79***	***-***	***0.51***	***0.05***	***-***	***0.44***	***-***	***0.14***
7	Sweet Potatoes	*0.09*	-	*1.79*	-	*0.51*	*0.17*	-	*1.79*	-	*0.73*	*0.01*	-	*0.29*	-	*0.09*
8	Irish Potatoes	*0.02*	-	*0.33*	-	*0.10*	*0.00*	-	*0.12*	-	-	*0.03*	-	*0.33*	-	*0.14*
9	Cassava	*0.01*	-	*0.29*	-	*0.05*	-	-	*0.01*	-	-	*0.01*	-	*0.29*	-	*0.07*
III	***Vegetables and Fruits***	***0.18***	***-***	***1.25***	***0.04***	***0.38***	***0.11***	***-***	***0.80***	***0.03***	***0.21***	***0.25***	***-***	***1.25***	***0.07***	***0.52***
10	Tomato	*0.06*	-	*0.83*	-	*0.16*	*0.04*	-	*0.40*	-	*0.13*	*0.07*	-	*0.83*	*0.01*	*0.19*
11	Onion	*0.02*	-	*0.10*	-	*0.04*	*0.01*	-	*0.10*	-	*0.04*	*0.02*	-	*0.07*	*0.00*	*0.04*
12	Carrot	*0.00*	-	*0.10*	-	-	*0.00*	-	*0.03*	-	-	*0.00*	-	*0.10*	-	-
13	Cabbage	*0.01*	-	*0.64*	-	*0.04*	*0.00*	-	*0.64*	-	*0.01*	*0.01*	-	*0.22*	-	*0.05*
14	Vegetables	*0.05*	-	*0.42*	-	*0.15*	*0.04*	-	*0.21*	-	*0.10*	*0.06*	-	*0.42*	*0.01*	*0.21*
15	Fruits	*0.05*	-	*0.98*	-	*0.28*	*0.01*	-	*0.53*	-	*0.08*	*0.09*	-	*0.98*	-	*0.50*

NO.	FOOD ITEMS (KG/D)	OVERALL					KISHAPU					MVOMERO				
		Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)
IV	***Meats, Poultry, Fish and Eggs***	***0.13***	***-***	***1.87***	***-***	***0.38***	***0.14***	***-***	***1.69***	***-***	***0.41***	***0.13***	***-***	***1.87***	***0.00***	***0.32***
16	Meat	*0.02*	*-*	*0.24*	*-*	*0.09*	*0.02*	*-*	*0.24*	*-*	*0.08*	*0.03*	*-*	*0.21*	*-*	*0.09*
17	Chicken	*0.01*	*-*	*0.19*	*-*	*0.02*	*0.01*	*-*	*0.19*	*-*	*0.02*	*0.01*	*-*	*0.09*	*-*	*0.02*
18	Eggs	*0.00*	*-*	*0.07*	*-*	*0.01*	*0.00*	*-*	*0.03*	*-*	*0.00*	*0.00*	*-*	*0.07*	*-*	*0.01*
19	Fish	*0.01*	*-*	*0.17*	*-*	*0.06*	*0.00*	*-*	*0.17*	*-*	*0.00*	*0.02*	*-*	*0.17*	*-*	*0.08*
20	Sardine	*0.00*	*-*	*0.08*	*-*	*0.02*	*0.00*	*-*	*0.08*	*-*	*0.00*	*0.00*	*-*	*0.05*	*-*	*0.03*
21	Milk	*0.09*	*-*	*1.76*	*-*	*0.48*	*0.11*	*-*	*1.44*	*-*	*0.51*	*0.07*	*-*	*1.76*	*-*	*0.43*
V	***Legumes***	***0.11***	***-***	***1.00***	***0.01***	***0.25***	***0.13***	***-***	***1.00***	***-***	***0.33***	***0.10***	***-***	***0.37***	***0.03***	***0.16***
22	Beans	*0.06*	*-*	*0.29*	*-*	*0.16*	*0.03*	*-*	*0.27*	*-*	*0.10*	*0.09*	*-*	*0.29*	*0.02*	*0.20*
23	Groundnuts	*0.05*	*-*	*0.96*	*-*	*0.30*	*0.10*	*-*	*0.96*	*-*	*0.39*	*0.01*	*-*	*0.16*	*-*	*0.04*
VI	***Oils and Fats***	***0.03***	***-***	***0.20***	***-***	***0.07***	***0.02***	***-***	***0.13***	***-***	***0.06***	***0.03***	***-***	***0.20***	***0.01***	***0.08***
24	Oil	*0.02*	*-*	*0.18*	*-*	*0.06*	*0.02*	*-*	*0.13*	*-*	*0.06*	*0.03*	*-*	*0.18*	*0.01*	*0.06*
25	Coconut	*0.00*	*-*	*0.19*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*0.00*	*-*	*0.19*	*-*	*-*
VII	***Misc.***	***0.03***	***-***	***0.15***	***0.01***	***0.07***	***0.03***	***-***	***0.13***	***-***	***0.06***	***0.04***	***-***	***0.15***	***0.01***	***0.07***
26	Sugar	*0.03*	*-*	*0.14*	*-*	*0.08*	*0.03*	*-*	*0.13*	*-*	*0.08*	*0.04*	*-*	*0.14*	*0.01*	*0.08*
27	Honey	*0.00*	*-*	*0.05*	*-*	*-*	*0.00*	*-*	*0.02*	*-*	*-*	*0.00*	*-*	*0.05*	*-*	*-*
28	Tea	*0.00*	*-*	*0.01*	*-*	*0.00*	*0.00*	*-*	*-*	*-*	*0.00*	*0.00*	*-*	*0.01*	*-*	*0.00*
29	Ginger	*0.00*	*-*	*0.05*	*-*	*0.00*	*0.00*	*-*	*0.02*	*-*	*-*	*0.00*	*-*	*0.05*	*-*	*0.01*

	FOOD GROUP LIMITS	OVERALL					KISHAPU					MVOMERO				
		Mean	*Min*	*Max*	Percentiles		*Mean*	*Min*	*Max*	Percentiles		*Mean*	*Min*	*Max*	Percentiles	
					25%	75%				25%	75%				25%	75%
I	Cereals	58.12	13.51	97.96	48.85	68.18	60.63	13.51	97.96	50.49	72.63	55.56	21.13	93.46	47.33	65.08
II	Roots and Tubers	6.68	-	67.57	-	9.59	9.55	-	67.57	-	16.92	3.76	-	31.91	-	5.55
III	Vegetables and Fruits	13.41	-	59.53	5.78	18.01	8.69	-	50.48	3.95	12.00	18.21	-	59.53	10.30	23.19
IV	Meats, Fish and Poultry	8.52	-	65.61	0.78	11.36	8.63	-	65.61	-	12.32	8.40	-	51.90	2.38	10.96
V	Legumes	7.86	-	42.98	3.53	10.75	8.00	-	42.98	2.43	11.90	7.72	-	21.09	4.84	9.94
VI	Oils and Fats	1.96	-	11.34	0.91	2.65	1.65	-	10.33	0.70	2.43	2.27	-	11.34	1.23	2.92
VII	Miscellaneous	2.58	-	14.39	1.17	3.58	1.97	-	14.39	0.75	2.79	3.20	-	11.50	1.90	4.13

Appendix 6 (c): Post-Harvest Foods Consumed Per Day

NO.	FOOD ITEMS (KG/D)	OVERALL					KISHAPU					MVOMERO				
		Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)
I	***Cereals***	***0.73***	***0.12***	***4.35***	***0.33***	***1.16***	***0.69***	***0.12***	***2.53***	***0.32***	***1.16***	***0.76***	***0.16***	***4.35***	***0.35***	***1.16***
1	Maize	*0.49*	-	*2.17*	*0.15*	*0.97*	*0.45*	-	*1.99*	*0.15*	*0.92*	*0.54*	*0.07*	*2.17*	*0.17*	*1.05*
2	Rice	*0.16*	-	*2.27*	-	*0.50*	*0.16*	-	*0.75*	-	*0.55*	*0.16*	-	*2.27*	*0.02*	*0.44*
3	Wheat	*0.03*	-	*0.44*	-	*0.12*	*0.04*	-	*0.44*	-	*0.14*	*0.01*	-	*0.22*	-	*0.07*
4	Sorghum	*0.03*	-	*1.35*	-	*0.17*	*0.04*	-	*1.35*	-	*0.25*	*0.02*	-	*1.09*	-	*0.11*
5	Bread	*0.01*	-	*0.13*	-	*0.04*	*0.00*	-	*0.05*	-	-	*0.01*	-	*0.13*	-	*0.06*
6	Donut	*0.01*	-	*0.16*	-	*0.05*	*0.00*	-	*0.06*	-	*0.02*	*0.02*	-	*0.16*	-	*0.07*
II	***Roots and Tubers***	***0.24***	***-***	***2.52***	***0.01***	***0.54***	***0.33***	***-***	***2.52***	***0.04***	***0.62***	***0.14***	***-***	***1.09***	***-***	***0.31***
7	Sweet Potatoes	*0.20*	-	*2.52*	-	*0.62*	*0.32*	-	*2.52*	-	*0.80*	*0.08*	-	*1.09*	-	*0.28*
8	Irish Potatoes	*0.02*	-	*0.52*	-	*0.08*	*0.01*	-	*0.52*	-	*0.05*	*0.03*	-	*0.35*	-	*0.11*
9	Cassava	*0.02*	-	*0.47*	-	*0.09*	-	-	-	-	-	*0.03*	-	*0.47*	-	*0.13*
III	***Vegetables and Fruits***	***0.23***	***-***	***1.20***	***0.06***	***0.45***	***0.16***	***-***	***0.56***	***0.04***	***0.30***	***0.29***	***-***	***1.20***	***0.10***	***0.51***
10	Tomato	*0.10*	-	*0.45*	*0.01*	*0.24*	*0.08*	-	*0.40*	-	*0.20*	*0.12*	-	*0.45*	*0.02*	*0.29*
11	Onion	*0.02*	-	*0.16*	*0.00*	*0.06*	*0.02*	-	*0.16*	-	*0.05*	*0.03*	-	*0.15*	*0.01*	*0.06*
12	Carrot	*0.00*	-	*0.05*	-	*0.01*	*0.00*	-	*0.03*	-	-	*0.00*	-	*0.05*	-	*0.01*
13	Cabbage	*0.01*	-	*0.15*	-	*0.05*	*0.01*	-	*0.06*	-	*0.03*	*0.01*	-	*0.15*	-	*0.06*
14	Vegetables	*0.05*	-	*0.62*	-	*0.15*	*0.03*	-	*0.17*	-	*0.10*	*0.06*	-	*0.62*	*0.01*	*0.19*

NO.	FOOD ITEMS (KG/D)	OVERALL					KISHAPU					MVOMERO				
		Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)	Mean	Min	Max	Lower Limit (10%)	Upper Limit (90%)
15	Fruits	0.05	-	0.74	-	0.18	0.02	-	0.40	-	0.11	0.07	-	0.74	-	0.26
IV	**Meats, Poultry, Fish and Eggs**	**0.20**	**-**	**1.97**	**0.01**	**0.50**	**0.20**	**-**	**1.97**	**0.01**	**0.55**	**0.19**	**-**	**1.81**	**0.02**	**0.44**
16	Meat	0.03	-	0.51	-	0.13	0.03	-	0.51	-	0.14	0.03	-	0.20	-	0.09
17	Chicken	0.01	-	0.08	-	0.03	0.01	-	0.05	-	0.02	0.01	-	0.08	-	0.03
18	Eggs	0.00	-	0.04	-	0.01	0.00	-	0.04	-	0.01	0.00	-	0.03	-	0.01
19	Fish	0.02	-	0.70	-	0.10	0.01	-	0.11	-	0.05	0.04	-	0.70	-	0.14
20	Sardine	0.03	-	0.50	-	0.10	0.04	-	0.50	-	0.10	0.03	-	0.19	-	0.09
21	Milk	0.10	-	1.91	-	0.54	0.12	-	1.91	-	0.55	0.08	-	1.63	-	0.53
V	**Legumes**	**0.13**	**-**	**1.02**	**0.02**	**0.27**	**0.18**	**-**	**1.02**	**0.02**	**0.38**	**0.08**	**-**	**0.33**	**0.01**	**0.16**
22	Beans	0.06	-	0.49	-	0.15	0.05	-	0.49	-	0.13	0.07	-	0.29	0.01	0.16
23	Groundnuts	0.07	-	1.00	-	0.30	0.13	-	1.00	-	0.41	0.01	-	0.11	-	0.05
VI	**Oils and Fats**	**0.05**	**-**	**0.38**	**0.01**	**0.19**	**0.03**	**-**	**0.13**	**0.00**	**0.06**	**0.08**	**-**	**0.38**	**0.01**	**0.25**
24	Oil	0.03	-	0.29	0.01	0.08	0.03	-	0.09	0.00	0.06	0.04	-	0.29	0.01	0.09
25	Coconut	0.02	-	0.32	-	0.14	0.00	-	0.07	-	-	0.04	-	0.32	-	0.19
VII	**Misc.**	**0.04**	**-**	**0.24**	**0.01**	**0.08**	**0.04**	**-**	**0.24**	**0.01**	**0.07**	**0.05**	**-**	**0.24**	**0.01**	**0.09**
26	Sugar	0.04	-	0.23	-	0.10	0.03	-	0.19	-	0.08	0.04	-	0.23	0.00	0.11
27	Honey	0.00	-	0.04	-	0.00	0.00	-	0.02	-	0.01	0.00	-	0.04	-	0.00
28	Tea	0.00	-	0.02	-	0.00	0.00	-	0.02	-	0.00	0.00	-	0.02	-	0.00
29	Ginger	0.00	-	0.03	-	0.01	0.00	-	0.03	-	-	0.00	-	0.03	-	0.01

	FOOD GROUP LIMITS	OVERALL					KISHAPU					MVOMERO				
		Mean	*Min*	*Max*	Percentiles		*Mean*	*Min*	*Max*	Percentiles		*Mean*	*Min*	*Max*	Percentiles	
					25%	75%				25%	75%				25%	75%
I	Cereals	61.10	6.84	463.51	34.47	73.21	59.43	7.67	463.51	29.63	71.97	62.79	6.84	379.40	38.49	75.77
II	Roots and Tubers	20.01	-	196.19	4.94	25.06	28.45	-	196.19	9.84	34.48	11.43	-	96.44	2.71	15.97
III	Vegetables and Fruits	18.60	-	88.92	8.06	24.76	13.06	-	52.43	5.96	17.20	24.22	-	88.92	13.28	31.77
IV	Meats, Fish and Poultry	15.39	-	157.77	3.79	18.31	15.50	-	123.29	2.81	19.91	15.28	-	157.77	4.75	17.87
V	Legumes	10.32	-	92.81	3.67	12.92	14.25	-	92.81	5.59	18.08	6.34	-	29.47	2.84	8.80
VI	Oils and Fats	4.23	-	31.64	1.24	4.98	2.17	-	10.33	0.95	2.83	6.32	-	31.64	2.11	8.10
VII	Miscellaneous	3.44	-	19.02	1.43	4.68	2.97	-	15.50	1.36	3.85	3.91	-	19.02	1.55	5.50

Appendix 7: Linear Programming Sensitivity Report

Variable Cells

Cell	Name	Final Value	Reduced Cost	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$C$32	Maize Optimal Portion Size (g/d)	538.54	0.00	0	0.00	1E+30
$C$33	Rice Optimal Portion Size (g/d)	147.02	0	0	0.00	0.01
$C$34	Wheat Optimal Portion Size (g/d)	25.28	0	0	0.01	0.03
$C$35	Sorghum Optimal Portion Size (g/d)	0	0.04	0	1E+30	0.04
$C$36	Bread Optimal Portion Size (g/d)	0	0.15	0	1E+30	0.15
$C$37	Donut Optimal Portion Size (g/d)	11.73	0	0	0.01	0.08
$C$38	Sweet Potatoes Optimal Portion Size (g/d)	152.01	0	0	0.01	0.00
$C$39	Tomato Optimal Portion Size (g/d)	98.79	0	0	0.00	0.02
$C$40	Onion Optimal Portion Size (g/d)	23.87	0	0	0.04	0.05
$C$41	Vegetables Optimal Portion Size (g/d)	0	0	0	1E+30	0.01
$C$42	Fruits Optimal Portion Size (g/d)	44.73	0	0	0.01	0.03
$C$43	Meat Optimal Portion Size (g/d)	0	0.00	0	1E+30	0.00
$C$44	Chicken Optimal Portion Size (g/d)	5.42	0	0	0.09	0.28
$C$45	Eggs Optimal Portion Size (g/d)	0	0.50	0	1E+30	0.50
$C$46	Fish Optimal Portion Size (g/d)	0.10	0	0	0.00	0.01
$C$47	Milk Optimal Portion Size (g/d)	83.92	0.01	0	0.01	1E+30
$C$48	Beans Optimal Portion Size (g/d)	52.72	0	0	0.01	0.03
$C$49	Groundnuts Optimal Portion Size (g/d)	76.73	0	0	0.00	0.00
$C$50	Oil Optimal Portion Size (g/d)	31.84	0	0	0.06	0.00
$C$51	Sugar Optimal Portion Size (g/d)	39.23	0	0	0.01	0.02
$G$32	Maize Positive Value of Relative Difference	0.27	0	1.00	0.57	1.00
$G$33	Rice Positive Value of Relative Difference	0	0.85	1.00	1E+30	0.85

Cell	Name	Final Value	Reduced Cost	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$G$34	Wheat Positive Value of Relative Difference	0	0.72	1.00	1E+30	0.72
$G$35	Sorghum Positive Value of Relative Difference	1.00	0	1.00	1.12	1.00
$G$36	Bread Positive Value of Relative Difference	1.00	0	1.00	0.98	1.00
$G$37	Donut Positive Value of Relative Difference	0	0.88	1.00	1E+30	0.88
$G$38	Sweet Potatoes Positive Value of Relative Difference	1.11E+16	0	1.00	1E+30	0.65
$G$39	Tomato Positive Value of Relative Difference	0	0	1.00	4.06E+14	0.41
$G$40	Onion Positive Value of Relative Difference	0	0	1.00	1E+30	0.86
$G$41	Vegetables Positive Value of Relative Difference	1.00	0	1.00	0.22	1.00
$G$42	Fruits Positive Value of Relative Difference	5.55E+17	0	1.00	1E+30	0.58
$G$43	Meat Positive Value of Relative Difference	1.00	0	1.00	0.09	1.00
$G$44	Chicken Positive Value of Relative Difference	0	0	1.00	1E+30	0.50
$G$45	Eggs Positive Value of Relative Difference	1.00	0	1.00	0.95	1.00
$G$46	Fish Positive Value of Relative Difference	1.00	0	1.00	0.27	0.08
$G$47	Milk Positive Value of Relative Difference	0.15	0	1.00	1.20E+14	0.57
$G$48	Beans Positive Value of Relative Difference	0	0	1.00	1E+30	0.54
$G$49	Groundnuts Positive Value of Relative Difference	0.30	0	1.00	0.17	0.21
$G$50	Oil Positive Value of Relative Difference	2.17E+19	0	1.00	1E+30	0.14
$G$51	Sugar Positive Value of Relative Difference	0	0.76	1.00	1E+30	0.76

Constraints

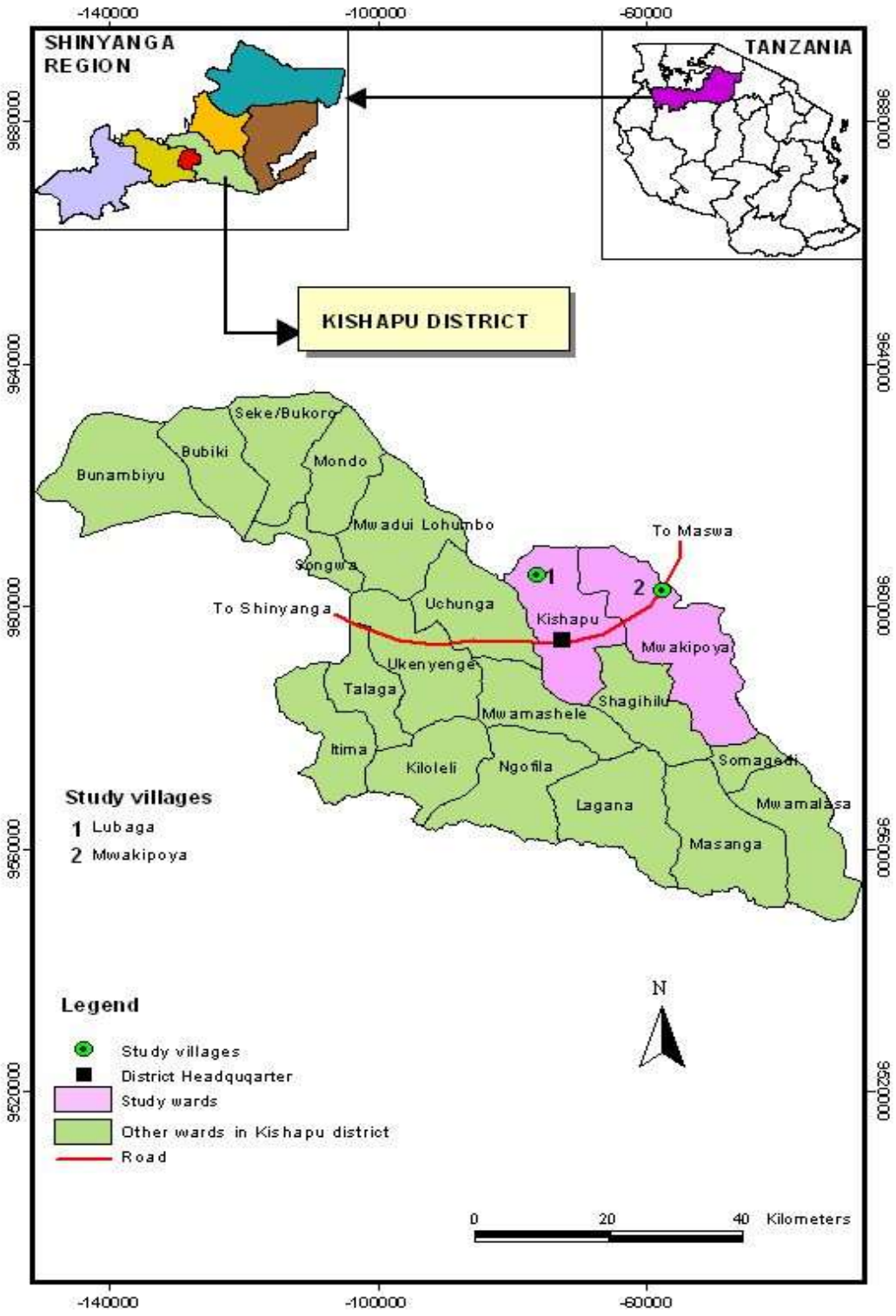
Cell	Name	Final Value	Shadow Price	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$C$59	Cereals Group Optimal	722.56	0	1,409.04	1E+30	686.48
$C$60	Vegetables & Fruits Group Optimal	167.39	0	573.16	1E+30	405.77
$C$61	Meats, Fish & Poultry Group Optimal	89.44	0	547.31	1E+30	457.87
$C$59	Cereals Group Optimal	722.56	0	308.81	413.75	1E+30
$C$60	Vegetables & Fruits Group Optimal	167.39	0	56.24	111.14	1E+30
$C$61	Meats, Fish & Poultry Group Optimal	89.44	0	14.76	74.68	1E+30
$E$32	Maize (Mean-Optimal)/Mean	0.27	0	0	1E+30	0.54
$E$33	Rice (Mean-Optimal)/Mean	8.31E+15	0	0	1E+30	1.78E+15
$E$34	Wheat (Mean-Optimal)/Mean	0	0	0	1E+30	0
$E$35	Sorghum (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$36	Bread (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$37	Donut (Mean-Optimal)/Mean	0	0	0	1E+30	-
$E$38	Sweet Potatoes (Mean-Optimal)/Mean	6.36E+15	0.33	0	0	0.10
$E$39	Tomato (Mean-Optimal)/Mean	0	0.80	0	0	0.01
$E$40	Onion (Mean-Optimal)/Mean	0	0.57	0	0	0.06
$E$41	Vegetables (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$42	Fruits (Mean-Optimal)/Mean	0	0.71	0	1.11E+16	0.02
$E$43	Meat (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$44	Chicken (Mean-Optimal)/Mean	0	0.75	0	0	0.02
$E$45	Eggs (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$46	Fish (Mean-Optimal)/Mean	1.00	1.00	0	1.00	1E+30
$E$47	Milk (Mean-Optimal)/Mean	0.15	1.00	0	0.15	1E+30

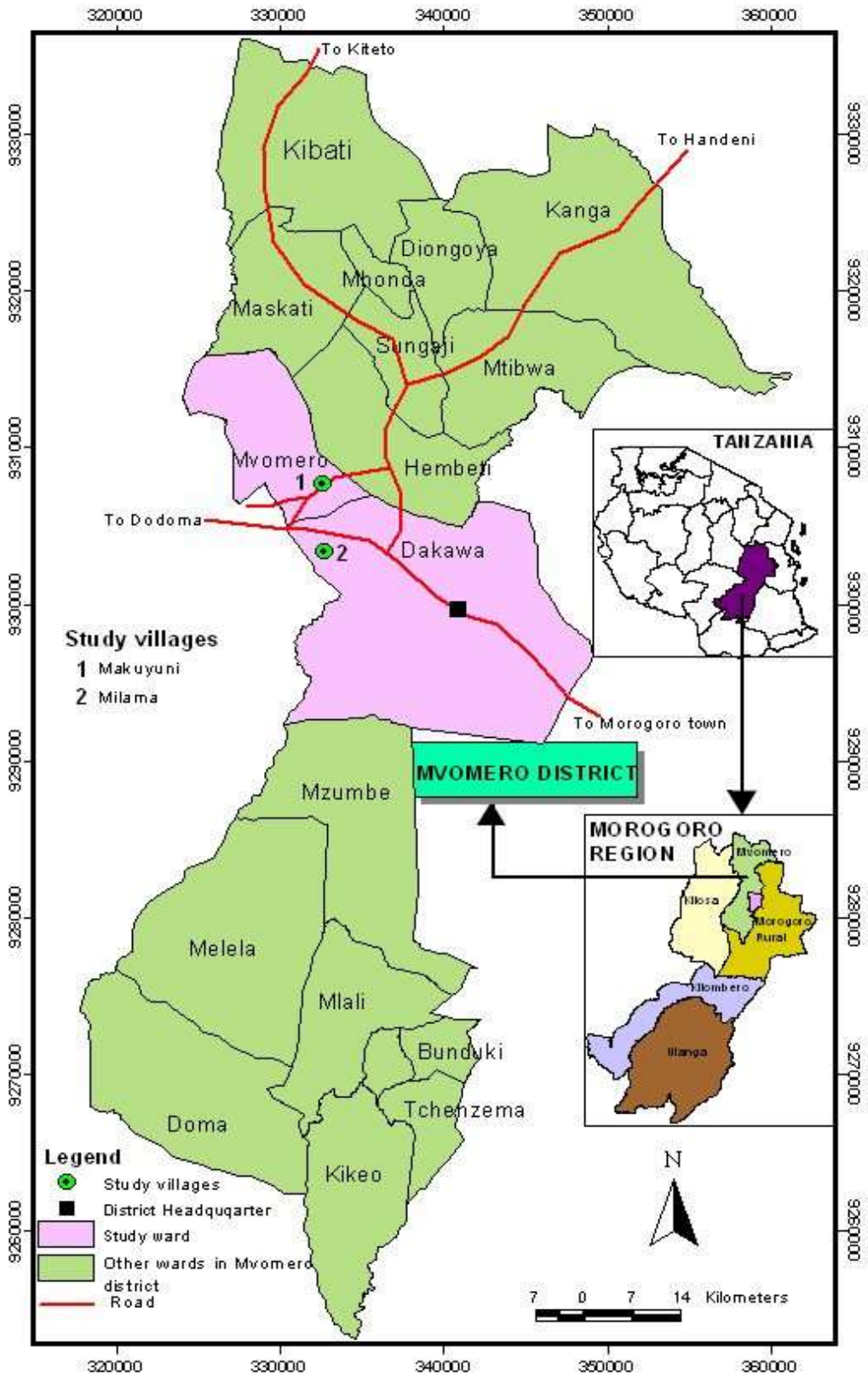
Cell	Name	Final Value	Shadow Price	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$E$48	Beans (Mean-Optimal)/Mean	0	0.73	0	0	0.01
$E$49	Groundnuts (Mean-Optimal)/Mean	0.30	0	0	1E+30	0.60
$E$50	Oil (Mean-Optimal)/Mean	0	0.07	0	4.34E+19	0.62
$E$51	Sugar (Mean-Optimal)/Mean	2.35E+15	0	0	1E+30	2.22E+16
$F$32	Maize Negative Value of relative Difference	0.27	1.00	0	0.27	1E+30
$F$33	Rice Negative Value of relative Difference	8.31E+15	0.15	0	0.01	1.78E+15
$F$34	Wheat Negative Value of relative Difference	0	0.28	0	0	0
$F$35	Sorghum Negative Value of relative Difference	1.00	0	0	1E+30	2.00
$F$36	Bread Negative Value of relative Difference	1.00	0	0	1E+30	2.00
$F$37	Donut Negative Value of relative Difference	0	0.12	0	0	0
$F$38	Sweet Potatoes Negative Value of relative Difference	6.36E+15	0.67	0	0	0.00
$F$39	Tomato Negative Value of relative Difference	0	0.20	0	0	0.06
$F$40	Onion Negative Value of relative Difference	0	0.43	0	0	0.09
$F$41	Vegetables Negative Value of relative Difference	1.00	0	0	1E+30	2.00
$F$42	Fruits Negative Value of relative Difference	0	0.29	0	1.11E+16	0.03
$F$43	Meat Negative Value of relative Difference	1.00	0	0	1E+30	2.00
$F$44	Chicken Negative Value of relative Difference	0	0.25	0	0	0.10
$F$45	Eggs Negative Value of relative Difference	1.00	0	0	1E+30	2.00
$F$46	Fish Negative Value of relative Difference	1.00	0	0	1E+30	1.99
$F$47	Milk Negative Value of relative Difference	0.15	0	0	1E+30	0.30
$F$48	Beans Negative Value of relative Difference	0	0.27	0	0	0.01
$F$49	Groundnuts Negative Value of relative Difference	0.30	1.00	0	0.30	1.42755E+15
$F$50	Oil Negative Value of relative Difference	0	0.93	0	4.34E+19	0.00
$F$51	Sugar Negative Value of relative Difference	2.35E+15	0.24	0	0.02	0
$H$52	Total Cost of Optimal (TZS/d)	1,100.00	0.01	1,100.00	97.08	0.43
$I$32	Maize kcal	640.86	0	987.69	1E+30	346.83
$I$33	Rice kcal	255.81	0	800.75	1E+30	544.94

Cell	Name	Final Value	Shadow Price	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$I$34	Wheat kcal	92.02	0	427.64	1E+30	335.62
$I$35	Sorghum kcal	0	0	177.90	1E+30	177.90
$I$36	Bread kcal	0	0	102.76	1E+30	102.76
$I$37	Donut kcal	37.06	0	170.28	1E+30	133.22
$I$38	Sweet Potatoes kcal	147.45	0	451.99	1E+30	304.55
$I$39	Tomato kcal	20.74	0	51.23	1E+30	30.48
$I$40	Onion kcal	9.55	0	24.24	1E+30	14.69
$I$41	Vegetables kcal	0	0	33.31	1E+30	33.31
$I$42	Fruits kcal	29.08	0	117.44	1E+30	88.36
$I$43	Meat kcal	0	0	214.10	1E+30	214.10
$I$44	Chicken kcal	15.45	0	59.04	1E+30	43.59
$I$45	Eggs kcal	0	0	16.52	1E+30	16.52
$I$46	Fish kcal	0.08	0	86.18	1E+30	86.10
$I$47	Milk kcal	50.35	0	305.69	1E+30	255.34
$I$48	Beans kcal	63.79	0	171.01	1E+30	107.22
$I$49	Groundnuts kcal	435.03	0	1,401.20	1E+30	966.17
$I$50	Oil kcal	274.49	0	660.07	1E+30	385.58
$I$51	Sugar kcal	151.80	0	375.81	1E+30	224.00
$I$32	Maize kcal	640.86	0	157.14	483.72	1E+30
$I$33	Rice kcal	255.81	0	0	255.81	1E+30
$I$34	Wheat kcal	92.02	0	0	92.02	1E+30
$I$35	Sorghum kcal	0	0	0	0	1E+30
$I$36	Bread kcal	0	0	0	0	1E+30
$I$37	Donut kcal	37.06	0	0	37.06	1E+30
$I$38	Sweet Potatoes kcal	147.45	0	0	147.45	1E+30
$I$39	Tomato kcal	20.74	0	1.44	19.30	1E+30
$I$40	Onion kcal	9.55	0	1.16	8.39	1E+30

Cell	Name	Final Value	Shadow Price	Constraint R. H. Side	Allowable Increase	Allowable Decrease
$I$41	Vegetables kcal	0	0.02	0	0.03	0
$I$42	Fruits kcal	29.08	0	0	29.08	1E+30
$I$43	Meat kcal	0	0	0	1.07E+14	1E+30
$I$44	Chicken kcal	15.45	0	0	15.45	1E+30
$I$45	Eggs kcal	0	0	0	0	1E+30
$I$46	Fish kcal	0.08	0	0	0.08	1E+30
$I$47	Milk kcal	50.35	0	0	50.35	1E+30
$I$48	Beans kcal	63.79	0	0	63.79	1E+30
$I$49	Groundnuts kcal	435.03	0	0	435.03	1E+30
$I$50	Oil kcal	274.49	0	43.28	231.20	1E+30
$I$51	Sugar kcal	151.80	0	0	151.80	1E+30
$I$52	Total kcal	2,223.56	0.01	2,223.56	0.27	93.77

Appendix 8: Maps of Study Areas

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Kibati
Kanga
Diongoya
Mhonda
Maskati
Sungeli
Mtibwa
Mvomero
1
Hembeti
To Dodoma
2
Dakawa
TANZANIA
Study villages
1 Makuyuni
2 Milama
To Morogoro town
MVOMERO DISTRICT
Mzumbe
MOROGORO REGION
Mvomero
Kilosa
Morogoro Rural
Kilombero
Ulanga
Melela
Mlali
Bunduki
Tchenzema
Doma
Kikeo
N
Legend
Study villages
District Headquqarter
Study ward
Other wards in Mvomero district
Road
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