FOOD CONSUMPTION PATTERNS AND NUTRITIONAL STATUS OF CHILDREN LIVING IN BANANA PRODUCING AREAS IN KISII COUNTY

EDNA KWAMBOKA ONYONO

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN COMMUNITY NUTRITION OF UNIVERSITY OF ELDORET, KENYA

OCTOBER, 2015

DECLARATION

DECLARATION BY THE CANDIDATE

I certify that this is my original work and has not previously been submitted for the award of any other degree in any other university or institution of higher education. No part of this thesis may be reproduced without prior written permission of the author and/or University of Eldoret

Onyono, Edna Kwamboka

Sign:…… Date:……

AGR/PGF/12/11

DECLARATION BY THE SUPERVISORS

This thesis has been submitted for examination with our approval as University supervisors:

Signature: …… Date: ……

Dr. Charlotte Serrem

University of Eldoret, Kenya

Signature: …….. Date: ……

Dr. Dorcas Serem

University of Eldoret, Kenya

DEDICATION

This work is dedicated to my parents Mr. and Mrs. Hezron Momanyi Onyono. Through their love and constant support I have made it this far. My husband Paul Lameck, for believing in my capabilities and encouraging me throughout the course of my studies.

May God Bless you abundantly.

ABSTRACT

Under-nutrition is a major public health problem in most developing countries where due to poverty, majority of the population depend on a single starchy staple for all their nutrient needs. Kisii County, the highest banana production area in Kenya has a 24% prevalence of malnutrition. In Uganda bio-fortification of the banana fruit with vitamin A and iron has been used as a means to alleviate deficiency among children who are dependent on the banana. Therefore, this study investigated the extent of dependence on the banana fruit as a staple food and its influence on the quality of diet and nutritional status of children in Kisii County. A sample of 280 children from two divisions (Kenyenya and Keumbu), in Kisii County, Kenya was randomly selected for the study. Both qualitative and quantitative methods were used to collect data. A pre-tested Quantitative Food Frequency Questionnaire (QFFQ) was used to collect information on nutrient intake. Focus Group (FG) discussions were conducted in the two divisions separately and Anthropometric measures (MUAC, height, weight) were taken to determine the overall nutritional status of the children. Chi-square test was done to identify variables that affected banana consumption. Nutrient intake was analyzed by the Nutri-Survey program. ENA for SMART was used to analyze anthropometric data which was then compared against the WHO z-score standards. Results showed that Educational level of caregivers, mother's employment status, household income per month and nutritional knowledge of the caregiver influenced the consumption patterns of the children and also form the basic causes of malnutrition. The children's diet was diversified including legumes, dairy products, eggs, meats, fish, vegetables and fruits resulting in sufficient nutrient intake. Bananas were the most consumed food item in terms of weight while maize was the highest contributor in nutrients. The daily contribution by banana was 266 g/day. The nutrient contribution made by banana was; energy 252.9 Kcal (13.8%), Protein 3.1 g (5.7%), Vitamin A 101 µg (14.7%), Iron 1.5 mg (11.6%), Vitamin E 0.7 mg (8.9%), zinc 0.6 mg (5.5%). Plants mainly in the form of beans contributed 77% protein while 23% was animal sourced. There were cases of moderate malnutrition among children in households of low income status of which 0.7% were wasted, 1.1% were stunted and 2.1% of the children were underweight. The population was not at risk of protein, energy, vitamin A and iron deficiency but was deficient in calcium and potassium. Banana is the food item consumed in the largest amounts by 2-5 year old children in Kenyenya and Keumbu divisions, making it the most suitable vehicle for biofortification and any other intervention programs to alleviate malnutrition in the community. It is recommended that this population be encouraged to consume more animal sourced foods, green leafy vegetables and fruits or be provided with supplements to increase calcium and potassium intake.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASAL	-	Arid and Semi- Arid Lands
BMI	-	Body Metabolic Index
EAR	-	Estimated Average requirements
EER	-	Estimated Energy Requirement
IDA	-	Iron Deficiency Anaemia
LOAEL	-	Lowest-Observed-Adverse-Effect Level
MUAC	-	Mid Upper-Arm Circumference
PEM	-	Protein Energy Malnutrition
QFFQ	-	Quantitative Food Frequency Questionnaires
RDA	-	Recommended Dietary Allowances
VAD	-	Vitamin A Deficiency

ACKNOWLEDGEMENTS

I would like to thank:

My God for giving me the opportunity and the ability to learn.

My supervisors Dr. Charlotte Serrem and Dr. Dorcas Serem for their guidance, encouragement and valuable pieces of advice throughout the study.

My lecturers for having taught me well and impacting on my knowledge.

Mr. Edwin Kirwa of Chemistry Lab, University of Eldoret, for carrying out the proximate analysis of the banana varieties from Kisii County.

My research assistants, Peris Nyaboe and Martha Kerubo, for their consistency and hard work throughout the data collection period.

The Chiefs of Kenyenya and Keumbu Locations for giving me permission to carry out this research in their area.

All the village elders assigned to take us through their villages in various households, for their untiring service.

All the families who agreed to participate in this study.

All my classmates, for their constant input in the development of this work through discussions and consultations.

I am thankful to my family for their continuous support throughout the process of writing this thesis and their unconditional love.

May the good Lord bless the work of your hands.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter discusses the background of the study, statement of the problem, purpose of the study, the research objectives, research hypothesis and justification of the study.

1.1 Background to the study

The World Health Organization (WHO) regards malnutrition as the most important threat to public health worldwide (Sheeran, 2008). Malnutrition, constituting chronic undernourishment and micronutrient malnutrition affects 870 million people globally (Food and Agriculture Organization (FAO, 2012). The vast majority of undernourished people, 97%, live in developing countries. Due to poverty, dependence on starchy staples that include maize, wheat, bananas, rice, sorghum and cassava for all the protein, micronutrient and energy requirements is the main cause of malnutrition in such countries (Mayer, Pfeiffer & Bayer, 2008). Starchy staples have poor protein quality because they are limiting in the indispensable amino acid lysine as well as vitamin A and trace minerals iron, iodine and zinc (Suri, Strutt & Ghosh, 2012).

Children are the most vulnerable segment of a population, and their health status is normally an indicator of the health of the community (Rao et al., 2005). Inadequate intake of food has a harmful effect on children's growth, intellectual development, immune system and mortality rate due to their higher nutritional requirements

(Pinstrup-Andersen & Schioler, 2001). Consequently, an estimated 26% of children below 5 years globally are stunted, 8% children are wasted and 16% have low weight for their age (UNICEF/WHO/World Bank, 2012).

To address the problem of malnutrition, nutrition specific direct intervention strategies that have been employed include fortification of food with amino acids, minerals and vitamins, pharmaceutical supplementation and the promotion of dietary diversification (FAO, 1997). Although food fortification and supplementation programs have been effective in some countries, their overall success remains limited (Stein, Qaim, Meenakshi, Nestel, Sachdev & Bhutta, 2008). Bio-fortification is a new agricultural-based approach in which staple food crops are bred for higher amounts of selected micronutrients in the edible parts (Mayer, Pfeiffer & Beyer, 2008). This is an example of a nutrient-sensitive (indirect) development intervention which can have a major impact on nutrition, though taking place in agriculture a non-nutrition program (Nabarro, 2010). The Food and Agriculture Organization (2012), proposed an agriculture-nutrition-health framework to solving the problem of malnutrition in developing countries. This may be achieved through improved micronutrient and protein status which have been shown to improve under-five mortality and morbidity. Researchers have used food consumption data to measure the potential nutritional effect of foods such as golden rice (Unnevehr, Pray & Paarlberg, 2007) and iron-rich rice and wheat (Stein et al., 2008).

Banana a fruit of the plant *Musa spp* is grown over 120 countries and is consumed by about 400 million people making it the fourth most important staple food after rice,

wheat and maize (FAO, 2004). In Africa it provides 25% of the carbohydrates and 10% of the calorie intake for approximately 70 million people (International Institute of Tropical Agriculture, IITA, 1992). Green bananas are rich in carbohydrates (Ahuja et al., 2012), however, most cultivated varieties have low levels of protein and micronutrients particularly vitamin A, vitamin E, iron and iodine. Consequently, major deficiencies associated with protein and micronutrients have been reported among communities which heavily rely on banana for food (Mclntyre, Bouldin, Urey & Kizito, 2001; Bachou & Labadarios, 2002). For example, in Uganda iron deficiency anemia (IDA) and vitamin A deficiency (VAD) affect 15-32% of children under-five years (Namanya, 2011).

Unlike Uganda, banana is not the leading staple food in Kenya. However, Kisii County, the leading producer in Kenya is heavily dependent on banana both as a staple and commercial food accounting for over 70% of farmers' incomes (Nguthi, Onyango, Muniu, Muthamia & Njuguna, 1999). Statistics show that 24.1% of under-fives attending clinics in Kisii County have nutrient deficiency related diseases (Maoga, 2010). No study has been conducted to establish the effect of dependence on the banana fruit as a staple on the nutritional status of children in the Kenyan communities. It is important to evaluate the food consumption patterns of such children to establish whether a diet with high banana consumption predisposes them to malnutrition and whether use of the bio-fortified banana could abate malnutrition. Therefore, the aim of the study is to establish the extent of dependence on the banana as a staple food and its influence on the quality of diet and nutritional status of 2-5 year old children in Kisii County, Kenya using a food consumption survey.

1.2 Statement of the problem

Micronutrient malnutrition is a threat to children in areas that depend on a starchy staple food as the key source of all nutrients (Mangusho, 2013). One of the main reasons for the poor nutrient contribution from the starchy staples is that they are limiting in the indispensable amino acid lysine as well as Vitamin A and trace minerals iron and zinc among others (Aghamirzael, Heydari-Dalfard, Karami & Fathi, 2013). Bachou & Labadarios (2002), showed that major deficiencies associated with protein and micronutrients have been reported among communities which heavily rely on banana for food. Banana is one of such staples in Kenya and Kisii community is renowned for its banana production as well as consumption. Though Kisii County enjoys the benefit of having fertile lands and consequently producing a variety of foods 24.1% of its children's population is malnourished (Maoga, 2010). Studies show that iron and Vitamin A deficiencies are common among children in this region. It is important therefore to find out whether the large consumption of the banana food crop aggravates the situation. From the findings, the researcher will then recommend the most appropriate and sustainable strategies to combat malnutrition in Kisii County.

1.3 Research Objectives

1.3.1 Broad objective

To establish the contribution by banana fruit to the usual food intake of 2-5 year old children in Kisii county, with reference to influence on quality of diet and nutritional status.

1.3.2 Specific objectives

i. To find out the relationship between socio- demographic, socio-economic characteristics and banana consumption.

ii. To find out the extent to which the banana fruit contributes to Protein, Energy, vitamin A and iron in the usual food intake of children aged 2-5 years.

iii. To determine the common deficiencies of nutrients in the diet of children aged 2-5 years in Kisii County.

iv. To assess the nutritional status of children aged 2-5 years in the study area through anthropometric measurements.

v. To determine the protein, ash (minerals) and fat content of the three commonly consumed banana varieties in Kenyenya and Keumbu Divisions.

1.4 Research Questions

i. Do household characteristics, such as, socio-economic variables affect banana consumption in children?

ii. What is the nutrient contribution of banana to the usual food intake of children in Kisii County?

iii. Does dependence on the cooked banana lead to diets deficient in energy, protein, vitamin A and iron?

iv. What is the overall nutritional status of the children in Kisii County using anthropometric measurements?

1.5 Significance of the study

This study through documentation will provide information on the extent of banana contribution in children's diet, if its consumption contributes to micro-nutrient malnutrition, among other factors in Kisii region. With this information, a more relevant and sustainable intervention program can be put in place to alleviate malnutrition in the region with the involvement of the Kenya government Ministries of Agriculture and Health Research Institutes. In addition, the findings from this study will form a basis for future research.

1.6 Scope and limitations of the study

This study considered only children aged between 2-5 years of age and their food intake as this is the catch-up growth age for children. All foods that the children consume were recorded with a special reference to cooked banana. The researcher concentrated only in Kenyenya and Keumbu Divisions despite there being many other areas that are banana growing in Kisii County and its environs. This is because they are the largest producers of bananas. A number of factors contributed to the limitations of the study. The researcher had to rely on the good memory capacity of the respondents in giving the quantities consumed by the children. Another setback was with the program used for analysis- Nutri-survey. It did not contain all the foods consumed locally, so, related foods were used in calculation of the amounts and nutrients.

1.7. Conceptual framework.

The conceptual framework for malnutrition adapted from UNICEF (1990) has been used in this study (Fig 1.1) and it reflects relationships among factors and their possible influences on children's nutritional status. This model relates the causal factors for under-nutrition with different social-organizational levels. However, the researcher has highlighted only those factors that relate to the current study. Income poverty (due to unemployment, low wages, or lack of education) can lead to household food insecurity. People of low socioeconomic status are most vulnerable to food insecurity since purchasing power serves as a main determinant of the ability-to-afford nutritional food sources. Households that cannot attain nutritious foods due to income poverty are most associated with the inadequate diet and disease that leads to malnutrition (Black et al., 2008).

Inadequate education and necessary dietary knowledge among mothers does great injustice to the children. If a mother has little or no knowledge on how well to feed her children, the necessity for the child to get all the dietary requirements and the foods necessary to provide these nutrients in various stages of growth, then the children will be under-nourished. Inadequate access to food may be a result of two factors. Either, the households are too poor to afford buying the foods needed or the place has inferior infrastructure rendering it inaccessible for some food commodities to reach the community thus the households only depend on what they can produce. Therefore, if the supply of food is inadequate, it is likely that the community especially the children will have inefficient access to food resulting in malnutrition.

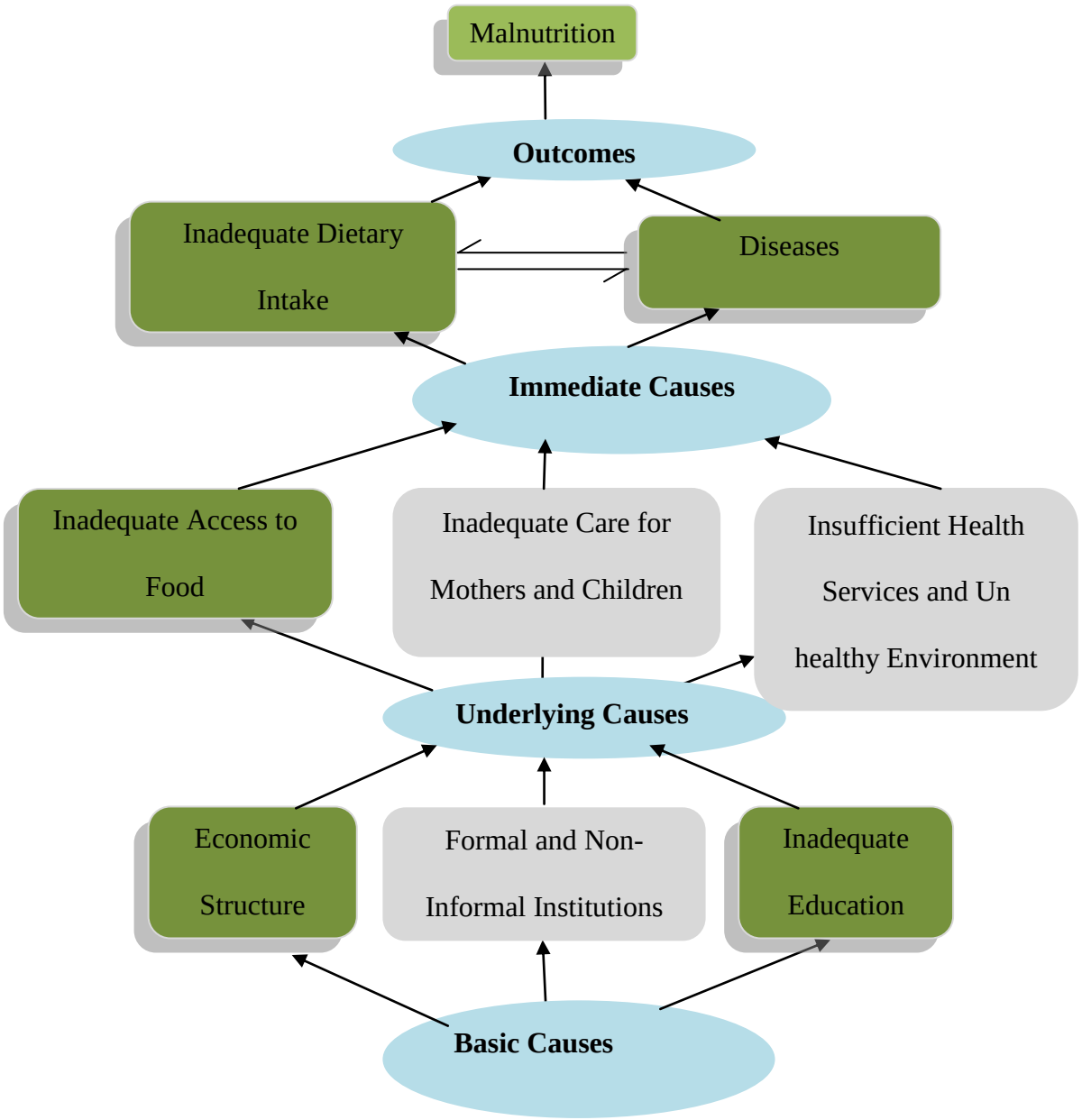


Fig 1.1: Source: Adopted from UNICEF (1990). (The green colored boxes show the section of the flow chart that directly relate to the study).

The underlying causes lead to the immediate causes. The factors here interrelate and have been described as the synergy between diet, nutrition and disease (Scrimshaw & SanGiovanni, 1997). In 1968, Scrimshaw and colleagues documented the synergistic relationship between malnutrition and infection. Malnutrition adversely affects a

person's ability to utilize energy and nutrients from the diet. This synergy becomes a vicious cycle (Scrimshaw et al., 1968). Generally, under-nutrition and infection are inseparable. In conclusion, the immediate causes affect individuals, the underlying causes relate to families while the basic causes are related to the community and the nation. This study looked into the possible ways of alleviating malnutrition in Kisii County with special reference to banana fruit intake. Therefore, this conceptual framework is useful as it highlights the factors that contribute to malnutrition and how they relate to one another. A better appreciation of the underlying causal factors of malnutrition is essential for planning appropriate interventions (USAID, 2006).

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

In this review focus is on issues concerning the global burden of malnutrition, nutrition situation in Kenya, Nutrition deficiencies, Micronutrient Malnutrition Interventions, Banana Consumption, Nutrient contribution of bananas to the diet and Food Consumption Surveys are discussed.

2.1 The burden of malnutrition.

Malnutrition is a general term that indicates a lack of some or most nutritional elements necessary for human health. The two basic types of malnutrition are Protein Energy Malnutrition (PEM) and Micronutrient deficiency. This means that the basic diet is inadequate in terms of diversity and quality, including both macronutrients ,such as, carbohydrates, proteins and fats as well as micro-nutrients including vitamins and minerals.

According to FAO (2010), 13.1% of people globally are malnourished, an increase from the 1995-97 estimates. The vulnerable groups of the population are mostly infants, preschool children, school-age children, and women of child-bearing age. This clearly qualifies children as the most visible victims of under-nutrition (Black et al., 2008). To further show that children are under threat, global statistics show that malnutrition contributes to 2.6 million deaths of children under five each year, constituting one third of the global total (UNICEF, 2011). Apart from deaths caused, the burden of disease and malnutrition stalls a country's economic growth. In their

study on the economic cost of hidden hunger, Stein & Qaim (2007) reported that a variable selection of micronutrient deficiencies cost an average of about 5% of the GDP of developing countries and contributes up to 10% of the global burden of disease. The gravity of the situation can be seen especially in the developing countries. For these very reasons, world leaders conducted the World Summit for Children in 2002, The International Conference for Nutrition, 1992 and The World Food Summit, 1996. Commitments were made to reduce malnutrition globally with special attention to developing countries.

Stein and Qaim (2007) further reported that micronutrient malnutrition, particularly vitamin A deficiency (VAD), Iron Deficiency Anaemia (IDA), vitamin E deficiency and Iodine Deficiency Disorders (IDD) are major contributors to malnutrition in many developing countries and public health concerns globally. Also, Wardlaw, Hamp & Disilvestro (2004), stated that under-nutrition in developing countries is caused by lack of enough nutritious foods and poor child care practices. However, the United Nation Children's Fund (UNICEF) conceptual framework summarizes the causes of malnutrition as being interrelated sectors at societal, household and individual levels (UNICEF, 1998). At the societal level the causes are basic due insufficient national supplies. Household level causes are underlying, influenced by insufficient food production, income status and intra-household food distribution. Lastly, at the individual level, the causes are immediate and form a synergy between access to a nutritionally adequate diet coupled with good health free from diseases.

2.2 Nutritional requirements of young children

Proper nutrition plays a crucial role in the health and development of young children. Diet influences a child's physical, mental, cognitive, and psychosocial growth. For example, brain development can be restricted by even mild malnutrition, and chronic under-nutrition can lead to life-long cognitive limitations and behavioral impairments (Alaimo, Olson & Frongillo, 2001).

According to UNICEF (1998), the nutritional status of the children gets affected when they start taking complementary foods which are often bulky starchy staples that are readily available, but low in essential nutrients and high in anti-nutrient factors. In developing countries, the nutrients that are a major concern yet essential for proper growth and development include carbohydrates, proteins, iron, zinc, iodine, calcium and vitamin A (Akhtar & Ashgar, 2011). These nutrients are also of low bio-availability and poor quality especially in starchy staple foods. The requirements for these nutrients in children’s diets in relation to the Recommended Dietary Allowances (RDA) for different age groups, to meet growth and developmental needs are shown in Table 2.1.

Table 2.1: Recommended Dietary Allowances (RDA's) values of selected nutrients for children aged 2-3 and 4-5 years

Nutrient	Units	2-3 yrs	4-5 yrs
Energy	Kcal	992-1046	1642-1742
Protein	G	13	19
Vitamin A	µg	300	400
Iron	Mg	7	10
Vitamin E	Mg	6	7
Vitamin B1	Mg	0.5	0.6
Vitamin B2	Mg	0.5	0.6
Vitamin B6	Mg	0.5	0.6
folic acid	µg	150	200
Vitamin C	Mg	15	25
sodium	Mg	**1000**	**1200**
potassium	Mg	**3000**	**3800**
calcium	Mg	500	800
magnesium	Mg	80	130
phosphorus	Mg	460	500
zinc	Mg	3	5

Adopted from Institute of Medicine (IOM) 2000)

Proteins are essential for human cells and body tissues and it forms the basic part within all cells. They are responsible for providing amino acids and nitrogen which is required for non-essential amino acids and nitrogen balance in the body (Kruger, Van de Spuy & Viljoen, 2004). The amino acids support linear growth and maintenance, builds enzymes and hormones, acts as a defender of the body against diseases by providing anti-bodies, controls electrolytes and fluid balance, regulates acid balance, transports nutrients and provides energy needed (Whitney & Rolfes, 2002). They are sourced from both animals and plants. All animal proteins are complete, that is, they contain all the essential amino acids, while the majority of vegetable proteins (with the exception of soy bean) are not complete because they supply an assortment of amino acids which is not correctly balanced (Mann & Truswell, 2001). The institute

of Medicine (IOM, 2000) recommends that the protein intake of the total energy intake should make up 5-20 % of the total energy intake.

Vitamin A

The term vitamin is designated to a group of retinoid compounds with the biologic activity of all trans-retinol (Solomons, 2001). Preformed vitamin A can be obtained mostly from dietary animal sources such as liver, fish liver oils, eggs and dairy products as retinyl palmitate whereas carotenoids that can be converted into retinol are obtained from vegetable foods like dark green leafy vegetables and deep orange fruits. As one of the most widely studied nutrients in relation to the immune function, vitamin A plays an essential role in a large number of physiological functions that encompass vision, growth, reproduction and immunity (West, 2000). It is also fundamental in maintaining the integrity of the epithelia. To support all required functions, the recommended intake for vitamin A from birth to one year is 375 µg of retinol daily. The Recommended Dietary Allowance for children aged 1-3 years, 4-6 years and 7-10 years is 400 µg, 500 µg and 700 µg, respectively (IOM, 2000).

Children require different amounts of iron at various ages and stages. Infants born of healthy mothers with adequate iron stores have iron supply for the few months until they are weaned (Oski, 1993). After this period, the iron requirements often rise because the child no longer relies on the mother’s breast milk for food and nutrient supply (Kruger et al., 2004). A study by Olivares et al., (1999), established that there are two forms of iron that are available from the diet. These can either be haem iron whose origin is from animal products or non-haem iron which is derived from plant

foods such as pulses, cereals or fruits. Iron in the body is generally controlled by available iron stores which determine if there is a need for iron or not. The recommended intake for 1-2 year old children is 120 µg/kg body weight/day or 11 mg per day (21 mg at low bioavailability, 11 mg at intermediate bioavailability and 7 mg at high bioavailability). Also the required intake for children aged 2-6 years is 56 µg/kg/day or 10 mg per day (12 mg at low bioavailability, 6 mg at intermediate bioavailability and 4 mg at high bioavailability). However, the Recommended Dietary Allowance for children aged 1-3 years and 4-6 years is 7 mg and 10 mg respectively (IOM, 2000).

Zinc is obtained from animal products cereals and legumes. However, its bioavailability may be low because of the presence of fiber and phytates in the diet that often limit the absorption of zinc (Van Lieshout & West, 2004). Dietary zinc requirements in infants are recognized as soon as the child is weaned. The Recommended Dietary Allowance (RDA) for children aged 1-3 years and 4-5 years is 3 mg and 5 mg respectively. In young children, zinc deficiency is expressed as a reduction in appetite, poor taste acuity and poor growth. It has also been observed in association with PEM in infants, increased rates of infection and diarrhea in developing countries (Shankar, 2000).

2.3 The Nutrition situation in Kenya

Nutrition needs in Kenya are complicated by an unstable economic environment, rise in food and fuel prices, adverse weather conditions, insufficient budgetary allocations and weak sector coordination (GOK, 2011). Malnutrition exists in various forms,

including acute and chronic malnutrition, micronutrient deficiencies as shown in figure 2.1.

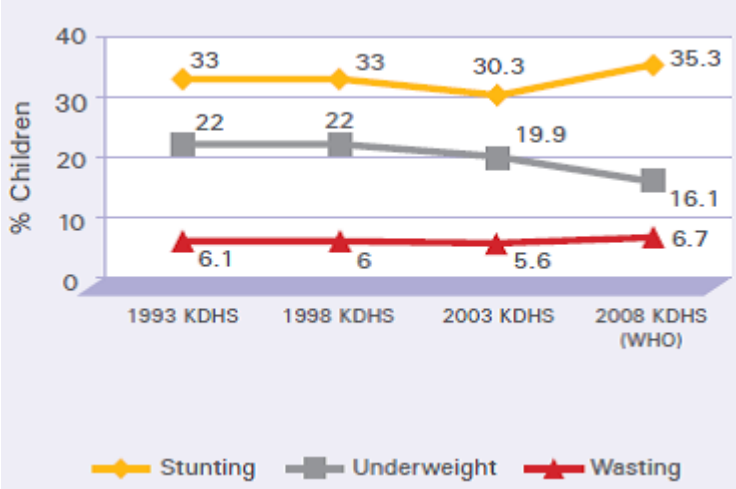


Figure 2.1: Trends in stunting, underweight and wasting in Kenya (KDHS, 2010)

Figure 2.1 shows the trends of under-nutrition in Kenya since 1993 to 2008. In general, the prevalence for stunting and wasting is on the rise as underweight prevalence declines. Nutrition is critical to survival, health and development. The Kenya Demographic Health Survey (KDHS) 2008-09 shows that malnutrition is on the increase among children under-five years of age. The proportion of stunted children increased from 33% to 35% in the period 1993 to 2008-09 with the most affected age group being 18-23 months (46%). The proportion of wasted children under five years has not changed significantly over the period 1993 to 2008-09. North Eastern Province has the highest proportion of children that are severely wasted (8%). The prevalence of underweight children stands at 16% nationally mostly affecting children between 24-35 months followed by those between 48-59 months and lowest in the age group of less than 6 months (KNBS & ICF Macro, 2010). The report

indicates that the worst malnourished populations are those staying in Arid and Semi-arid Lands (ASAL) which includes Coastal, North Eastern and the Eastern regions. These nutritional deficiencies generally known as PEM and other micronutrient deficiencies such as vitamin A, iron deficiency anaemia, iodine and zinc deficiencies are a major concern not only globally but also in Kenya. Micronutrient malnutrition is also called "hidden hunger" because its effects often go unnoticed (Faber & Wenhold, 2007).

2.4 Nutrient Deficiencies

Nutrient deficiencies can either be a result of lack of Macro-nutrients such as Protein Energy Malnutrition or micro-nutrients like vitamins and minerals. Micro-nutrients, though required in small quantities, are essential for normal functioning of body systems. The impact of nutrient deficiencies is well known and documented. According to the Food Agricultural Organization (FAO, 2012), more than 2 billion people worldwide today are estimated to be deficient in key vitamins and minerals, particularly vitamin A, iodine, iron and zinc. Most of these people live in low income countries. The most vulnerable segment of the population is the children who are typically deficient in more than one micronutrient (WHO/World Food Program/UNICEF, 2007). Micronutrient deficiencies are highly prevalent in Kenya, particularly at crucial stages of the life cycle when needs for specific minerals and vitamins are high. Among the main causes of the widespread micronutrient deficiencies are low levels of micronutrients in diets of reduced diversity and characteristics of the normal diet that make some of the micronutrients consumed unavailable in terms of absorption (phytates in maize and whole wheat flour, etc).

However, some vitamins and minerals are not found in sufficient quantities in the overall diet of the general population. It is noted that Vitamin and mineral deficiencies exist even among population groups with sufficient food in terms of meeting energy requirements. The most common deficiencies include VAD, IDA, and zinc deficiency. If left unchecked, these deficiencies will set a vicious cycle effect that will take many generations to correct (Government of Kenya, 2011).

2.4.1 Protein Energy Malnutrition

Protein–energy malnutrition (PEM) or protein–calorie malnutrition refers to a form of malnutrition where people are deprived of protein, energy, or both (Mann & Truswel, 2001). It is a group of body depletion disorders which includes marasmus, kwashiorkor and marasmic kwashiorkor. Although PEM affects many adult lives, it most often strikes early in childhood. It is one of the most prevalent and devastating forms of malnutrition in the world, afflicting one of every four children worldwide. Inadequate food intake leads to poor growth in children. Children who are underweight for their height may be suffering from acute PEM (recent severe food deprivation), whereas children who are short for their age have experienced chronic PEM (long-term food deprivation). PEM is most prevalent among the impoverished communities in Africa, Central America, South America, and East and Southeast Asia (Thompson, Manore & Vaughan, 2011)

Kwashiorkor

Kwashiorkor comes from an African word meaning ‘displaced child’ referring to the illness of the older infant who is denied breast milk when the new baby is born. Kwashiorkor is common in children between one and five years. It is due to a protein deficiency after protein rich foods are discontinued during weaning and the child is given food low in proteins and calories (Thompson et al., 2011). Some symptoms include children who are small for age, pale, dry and flaky skin, reddish hair, limp and underdeveloped muscles, oedema, frequent digestive problems, lack of enthusiasm and an unhappy look (Thompson et al., 2011). A study carried out in Kilifi-Kenya and Dar-es-Salaam-Tanzania on infections associated with severe malnutrition among hospitalized children, found that kwashiorkor was more prevalent in Kilifi than Dar-es-Salaam suggesting that the Kenyan population is more prone to Kwashiorkor and therefore reasons for this need to be investigated (Sunguya, Koola & Atkinson, 2006)

Marasmus

Marasmus is generally seen in infants less than one year old. It occurs due to a deficiency of proteins, carbohydrates and fats. Marasmus is the childhood equivalent to starvation in adults and is more serious than kwashiorkor. The symptoms include a large face over a shrunken body, sunken eyes hollow cheeks giving a prematurely aged look, oedema is absent and the abdomen is curved inward, dry loose and wrinkled skin due to less of fat below the skin (Thompson et al., 2011). Marasmus is more frequent in children younger than 5 years because this period is characterized by increased energy needs and increased susceptibility to viral and bacterial infections

2.4.2 Vitamin A Deficiency

According to WHO (2014), Vitamin A Deficiency (VAD) is the leading cause of preventable blindness in children due to progressive degeneration of mucous membranes in the eye and increases the risk of disease and death from severe infections. Prolonged deficiency results in drying of the conjunctiva while acute cases lead to eye ulcers, inflammation and interior infection leading to irreversible blindness (UN/SCN, 2004). According to WHO (2004), VAD is frequently reported among children in the underdeveloped countries. The deficiency lowers the immune system of children increasing the risk of infection from other diseases. VAD is estimated to affect at least 250 million children in developing world, 250,000 to 500,000 Vitamin A Deficient children become blind every year, half of them dying within 12 months of losing their sight, (UNICEF/MI, 2004).

In Kenya, researchers have identified several cases of VAD. For example, in a study carried out by Ngare, Muttunga & Njoroge (2000) to determine the prevalence of VAD in Pre-school children in Kenya found that the deficiency was still a significant public health problem. Similarly, another study carried out in Western Kenya on the health and nutritional status of children in relation to VAD found that the region had the highest levels of VAD in Kenya (Nabakwe & Ngare, 2004). According to the latest Demographic and Health Survey in Kenya, the prevalence of VAD of under-fives is 84.4% (KNBS & ICF Macro, 2010). This implies that interventions to reduce VAD have either not been effected or are unsuccessful since the prevalence is still high. Therefore, more effort is required to reduce the prevalence of VAD in Kenya.

2.4.3 Iron Deficiency Anaemia

Anaemia occurs when a person has lower than normal levels of red blood cells (RBCs) in the blood. IDA is the most common type of anaemia which occurs when the body does not have enough of the mineral iron (American Society of Hematology, 2010); Centre for Disease Control (CDC, 2011). This may be as a result of poor diet or certain intestinal diseases like Malaria (in the tropics), worm infections, physiological status and chronic infections such as HIV, particularly where medical care is limited, (Uganda Bureau of Statistics, UBOS, 2007). Iron can be found in foods such as meat, eggs and some dark green vegetables. Young children need even more iron in their diet, as it is essential during times of rapid growth and development.

Symptoms of severe to moderate IDA include, general fatigue, weakness, pale skin, shortness of breath, dizziness, strange cravings for non-food items, such as dirt and clay, tingling or a crawling feel in the legs, swelling or soreness in the tongue, cold hands and feet, fast or irregular heartbeat, brittle nails and frequent headaches (ASH, 2010). According to WHO (2004), IDA affects about 1.5 billion people in the developing world. IDA is associated with maternal death, impaired physical and cognitive development among children. It also results in increased risk of morbidity in children (De Steur et al., 2010). IDA can be addressed through consumption of iron rich foods and supplements. IDA levels in Kenya are 69% among the 6-72 months old (KNBS & ICF Macro, 2010). Western Kenya is documented as having high prevalence of anemia and malnutrition among pre-school children (Kwena et al., 2003). However, other parts of the country also show levels of IDA. For instance, in

Murang'a County, Kenya, Anemia was found to be a significant problem among the Primary school children (Gitau, Kimiywe, Waudo & Mbithe, 2013).

2.4.4 Zinc Deficiency

Zinc is a trace mineral essential to all forms of life because of its fundamental role in gene expression, cell development and replication, (Hambridge, 2000). Zinc is associated with reduced immune status in children. Zinc deficiencies are known to occur in young children since they have high needs of zinc as they grow. It results in severe growth retardation, hinders digestion and absorption, causing diarrhea which worsens malnutrition. Preliminary research shows that additional zinc can reduce incidence of diarrhea and pneumonia in children (Storozhenko et al., 2007; Shekar et al., 2006). Whitney & Rolfes (2011) in their review recommend reduced consumption of foods high in phytates and fiber as they inhibit zinc absorption. Zinc deficiency has been shown to affect children in other parts of the world. An example is South Africa. After the national survey was conducted in 1999 to provide estimates on food consumption and the contribution of various foods to the nutrient intake of children aged 1-9 years, it was found that almost half of the children were at risk of being zinc deficient (Labadarios et al., 2005). In Kenya zinc deficiency among under-fives is at 51% (KNBS & ICF Macro, 2010).

2.5 Micronutrient Malnutrition Interventions

The Government of Kenya has made a commitment to reduce micronutrient deficiencies in an effort to attain MDGs and achieve vision 2030 (UNICEF, 2009). In an effort to deal with the nutrition concerns brought about by food insecurity, some

intervention strategies that aim at solving the nutrition problems have been introduced. The fight to reduce malnutrition uses strategies that pay particular attention to increasing the amount of food consumed, leading to an increase in the energy intake and to increasing the consumption of protein and micronutrient rich foods to improve the quality of nutrition (UNICEF, 1998).

Strategies implemented can result in either long-term or short-term impacts. According to Ramalingaswam (1998), the success of each strategy depends on the availability of policy support, safety regulations, multiple sectoral involvement, economic and marketing incentives, constant monitoring of the nutrient levels, food regulatory systems, sustainability, education, communication and continued investments. Three primary strategies which are nutrition specific have been used globally including Kenya for treating nutrient deficiency. They include food fortification, dietary supplementation and the promotion of dietary diversification through nutrition education and a nutrition sensitive strategy (biofortification) (Standing Committee on Nutrition (SCN, 2011).

Fortification

Fortification refers to the addition of one or more nutrients in small quantities to a food to improve the nutrient status of that particular nutrient in the population that it is intended for (Hongo, 2003). In Kenyan supermarkets a variety of food products such as maize flour, porridge flour for children, spreads like margarine have been fortified with various nutrients especially, vitamin A, iron and vitamin E.

In a review, Van Lieshout & West (2004) pointed out that, for fortification programs to be successful, the population at risk should be a regular consumer of the potential fortification vehicle in large amounts. Also, day to day variations in consumption must be minimal, the price of the product to be fortified should not be too high compared to its unfortified version, the physical characteristics such as taste and colour must not be altered by the fortification process and lastly, the fortified food must be produced by a limited number of manufacturers for easy monitoring of the process.

Flour fortification with iron and folic acid is globally recognized as one of the most effective and low-cost micronutrient interventions (Copenhagen Consensus, 2012). Iron fortification of foods has been shown to be an effective strategy to alleviate IDA among school-age children and infants. An example of successful iron fortification intervention has been achieved in Kenya through consumption of whole maize flour fortified with Sodium iron edetic acid (NaFeEDTA) in households (Andang'o et al., 2007). This improved the iron status of children.

Dietary diversification

The main aim of dietary diversification is to increase the availability, accessibility, production, bioavailability and consumption of foods that are rich in essential nutrients (Ruel & Levine, 2000). It is often promoted by encouraging households to have kitchen gardens, utilize indigenous foods available and proper preparation, preservation, processing and storage methods. An effective dietary diversity intervention strategy can be implemented through promoting the use of improved

cereal varieties, including foods that enhance the absorption of minerals, modifying milling practices, promoting soaking, fermentation and germination of cereals to reduce phytic acid activity (Gibson & Ferguson, 1998). Educational interventions have been used to promote intake of variety of foods with enhanced nutritional content. It includes teaching people about dietary diversification and mostly target the household food provider or the person responsible for making nutritional choices for the family (often the mother) (Roy et al., 2005). An educational intervention in moderately malnourished children in rural Bangladesh showed that an older nutrition program improved 20% of children yet a newer more intensive culturally relevant program improved the nutritional status of up to 60% of children (Roy et al., 2007). If implemented correctly educational interventions ideally can prevent malnutrition rather than treat it (Dewey & Adu-Afarwuah, 2008).

Supplementation

Dietary supplementation often takes two forms, supplementary feeding in which participants receive more/better food, and direct supplementation in which specific micronutrients are given to participants in a refined form (Hongo, 2003). Direct supplementation is more cost efficient than direct feeding, but a properly implemented multi-vitamin requires prior knowledge of the main deficiencies prevalent in a given region (Allen, 2003). Additionally, direct supplements can be taken outside of meal times in order to optimize the level of absorption (Zimmermann & Hurrell, 2007).

A study conducted in Kenya to determine whether provision of oral supplementary iron to primary school children would improve their growth showed that the iron-

supplemented children grew significantly in terms of weight, weight for height, arm circumference and skinfold thickness. It was concluded that where iron deficiency anemia and under-nutrition are prevalent in children, iron supplementation will improve growth and hemoglobin levels (Latham, Stephenson, Kinoti, Zaman & Kurz, 1990). Also in order to combat micro-nutrient deficiencies, the Government of Kenya has set up continuing micronutrient supplementation program for provision of vitamin A capsules to the vulnerable groups (Hongo, 2003).

It therefore can be concluded that, each intervention has its place in the overall strategy to assure adequate vitamin and mineral nutrition for all members of the population across their full life cycle. They have different costs, different stakeholders in terms of responsibility, and while some strategies may be effective on their own (universal salt/iodized salt) a careful integration of multiple interventions is necessary to substantially decrease or eliminate each of the major micronutrient deficiencies.

Biofortification

This is a recent dietary based strategy that uses plant breeding techniques is biofortification. It uses selective plant breeding techniques to improve the nutritional content of crops (Nestel et al, 2006). According to Mayer, Pfeiffer & Beyer (2008), biofortification is the delivery of micronutrients via micronutrient-dense crops. It offers a cost-effective and sustainable approach, complementing these efforts by reaching rural populations (Baltussen, Knai & Sharan, 2004). Ongoing research and breeding programs are intended to enrich the major food staples in developing countries with the most important micronutrients, iron, provitamin A, zinc and folate

(Hongo, 2003). For example, the Consultative Group for International Agricultural Research (CGIAR) launched Harvest Plus, a program in which conventional plant-breeding methods have been used to fortify beans and pearl millet with iron, rice and wheat with zinc, and maize, sweet potatoes and cassava with pro-vitamin A (Bouis, Hotz, McClafferty, Meenakshi & Pfeiffer, 2009).

Researchers have further used genetic engineering methods to fortify important staple food crops with micronutrients. These include the Golden rice in Asian countries where Vitamin A deficiency is prevalent (IRRI, 2013), the Bio-Cassava Plus project in the United States of America to fortify the edible roots of the cassava (manioc) plant with pro-vitamin A, vitamin E, iron and zinc, whilst at the same time increasing the protein content and reducing cyanide levels (Sayre et al., 2011). Sorghum has also been fortified with pro-vitamin A, vitamin E, iron, zinc and amino acids (Africa Bio-fortified Sorghum (ABS), 2013; Hokanson et al., 2010). Research on biofortification of bananas, with higher levels of micronutrients, pro-vitamin A, vitamin E and iron by scientists from Australia, Uganda, Tanzania and USA has also been conducted.

Therefore, considering the above examples and the emerging research on biofortification of foods it is possible that in due time many staple foods could be fortified with necessary nutrients to alleviate malnutrition in rural areas (Hossain & Mohiuddin, 2012; Namanya, 2011). It is necessary for nutrition researchers to conduct studies to establish whether populations that is heavily dependent on specific starchy staples for most of their nutrient requirements could benefit from biofortification of such foods.

2.6 Food consumption patterns in Kenya

O'Brien-Place & Frankenberger (1989) defined the term food consumption as the amount of food prepared at the household level or the amount of food eaten by individuals. For the purpose of this study, the term will be defined as; available food which is either acquired through agricultural production or purchased and eaten to impact on the nutritional status of a population. It is recognized that individual food consumption is influenced by many factors. These include price, income variables, total supply of food, the efficiency of the distributing and marketing structures, public expenditures on sanitary and health provisions, cultural habits and intra-household decisions on food distribution (Hoorweg & Niemeijer, 1986). Other factors that make the food consumption patterns to vary are socio-economic level and household characteristics. In a study Delislie (1990) found that traditional diets mainly found in low income households of countries in East Africa consist of grains such as maize, millet sorghum, or roots and tubers. Shah & Frohberg (1980) who carried out a study on food consumption patterns in rural and urban Kenya found that, the average rural small holder farmer obtained a large share of the daily calorie intake from a limited range of foods contrary to their urban counterparts whose food basket is more diverse.

Since the early 20th century, maize has been the main staple crop of Kenya (Nyoro et al., 2004); while other staples like banana, cassava and sweet potato follow (FAO, 2005). Though figures have changed over the years, the pattern of consumption remains the same in which maize is the preferred staple crop in Kenya (Ofwona, 2013). The dietary pattern for Kenya has had no major shift since 2005 as reflected in Table 2.2 though the volumes of staple carbohydrate consumption have declined in

recent years (Muyanga et al, 2004). It is important to note that in recent years, the agricultural sector in Kenya has been confronted by a host of problems among them occasional droughts which affect small scale farmers' access to food (Ogutu, 2012), thus leading to a shift in the consumption patterns of different regions in an effort to adapt.

Table 2.2: Trends in per Capita Supply of Major Food Groups (in g/day)

Major food groups	1965-67	1972-74	1979-81	1986-88	1993-95	2000-02
Cereals (Excl. beer)	408	406	391	340	317	326
Fruits and vegetables	165	149	159	193	251	255
Milk and eggs	189	176	177	260	210	235
Starchy roots	214	209	187	161	155	152
Sweeteners	39	53	59	66	50	61
Pulses, nuts, oil crops	64	59	31	24	23	48
Meat and offals	52	51	54	51	45	46
vegetable oils	4	5	13	13	19	20
Other	125	122	91	73	48	43
fish, sea food	8	7	9	16	16	14
Animal fats	1	2	2	1	1	2

(Source: Kenya Nutrition Profile, 2005)

2.6.1 Production of banana

Cultivated edible bananas are derived from two species of the *Musa spp. L; M. acuminate* and *M. balbisiana* and most banana cultivars are hybrids of the two species (Ammar-Khodja, 2000). They are grown in over 120 countries and consumed by up to 400 million people making banana the fourth most important staple food crop in world production after rice, wheat and maize (FAO, 2004). East African Highland bananas is a major staple food in East and Central African countries including Uganda, Rwanda, Burundi, Parts of the Democratic Republic of Congo, Kenya and Tanzania where an estimated 90% of total production is used for domestic

consumption (Ammar-Khodja, 2000). Amongst these countries Uganda has the largest production and is ranked the largest consumer in the world (Fungo, 2009). India is the highest producer of bananas in the world, followed by Uganda (FAO, 2003). Notably, the bulk of world banana production comes from relatively small plots and kitchen or backyard gardens where statistics are lacking (FAO, 2003). True plantains (AAB), which are cooked before eating, are dominant in West Africa with Cameroon leading in production (Cauthen, Jones, Gugerty & Anderson, 2013). In East Africa the most common varieties are highland bananas (AAA), which are steamed or used for making beer (Sharrock & Frison, 1998).

In Kenya, Kisii is a leading banana producing region with an average farmer production of 17 tons ha-1, (Kwach, Makworo, Nasambu & Onyango, 2000). The crop is largely grown by small scale holders with average farm sizes of just 0.3 hectares, (Qaim, 1999). In this study, Qaim found that Nyanza and Western provinces account for 64.4% of production while Central and Eastern provinces account for 26%. The rest of the provinces in the country were classified as minor producers, with Rift Valley accounting for 33.9% and Coast province accounting for 5.5%. Dijksra's & Magori (1994) reported that bananas accounted for over 70% of farmers' incomes in Kisii, contributing to the year round food security and income. The commonly grown varieties are East Africa Highland bananas and Apple bananas in Western and Nyanza Provinces and Cavendish and Kampala in Central and Eastern Provinces (Nguthi et al., 1999). The East African Highland Bananas in the Kisii region include, Ng'ombe (AAA), Nusu Ng'ombe (AAA) and Kisii Ndizi (AAA).

2.6.2 Nutrient contribution of bananas to the diet

Most cultivated bananas have low levels of micronutrients particularly vitamin A., Vitamin E., iron and iodine which are very essential for the growth of children. This has led to micronutrient malnutrition in communities that rely heavily on bananas as a staple (Mclntyre et al., 2001; Bachou & Labadorious, 2002). Table 2.3 shows the nutrient composition of the banana per 100 g. However, it is good to note that data for micronutrient content varies depending on the geographic location of the fruit sampled, sampling procedure, sample size and method of estimation (Namanya 2011).

Table 2.3: Nutrient composition of the banana fruit (value per 100 g)

Nutrient	Value per 100g	% of RDA
Energy	90 Kcal	4.5
Carbohydrates	22.84 g	18
Protein	1.09 g	2
Fats	1.09 g	1
Fiber	2.6 g	7
Folates	20 µg	5
Niacin	0.665 mg	4
Panthothenic	0.334 mg	7
Pyridixine	0.367 mg	28
Riboflavin	0.073 mg	5
Thiamine	0.031 mg	2
Vitamin A	64 IU	2
Vitamin C	8.7 mg	15
Vitamin E	0.1 mg	1
Zinc	0.15 mg	1
Calcium	5 mg	0.5
Iron	0.26 mg	2

(Source: USDA 2013).

In order to find appropriate food consumption data of different regions and among different populations, food consumption surveys must be carried out. This can either

be nationally or just in areas that are most affected by malnutrition in order to come up with the right and sustainable intervention.

2.7 Food Consumption Surveys

Food Consumption Surveys (FCS), sometimes referred to as Food Intake Surveys (FIS) or Dietary Surveys (DS) monitor food use such as, types of food intake, amounts of food intake and dietary practices, by data collection at three different levels. Level one is the National level where the survey is used as an indicator of food availability in a nation, in the Household level the survey is used to measure food use and lastly on level three the surveys are used to measure individual intake of foods and beverages (Lee & Niemen, 2003). Generally, the food consumption data is used to find out if the public is exposed to any potential dietary risks e.g. those from contaminants understand the size of the risk and which population groups may be most at risk, (FAO, 2004).

Methods and materials of data collection are considered according to the objectives of the surveys. For instance to assess households; food inventories, household accounts and food lists are used while to assess individuals' dietary intake, the 24-hour recall, Food Frequency Questionnaires and diet histories are used (FAO/WHO, 1998). The main limitation of FCS is that they depend on accurate report or recall of food quantity and type by the participants in the study and the quality of nutrient and energy values depends on the quality and accuracy of food consumption tables. FCS has been carried out in various countries both developing and developed. In the USA Nationwide FCS were conducted in 1977-78 and 1987-88. Also, since 1971- 1994 the

1st, 2nd and 3rd National Health and Nutrition Examination (NHANE) were carried out respectively (Murphy et al., 1992). In Africa, a major NFCS was carried out in South Africa in 1999 in order to collect baseline information for the formulation of appropriate policy guidelines for food fortification and also for the development of appropriate Nutrition Education (NE) material for children (Labadarios et al., 2005).

In order to carry out biofortification of a certain staple crop, baselines and post-dissemination impact and effectiveness surveys are conducted in target regions with and without the intervention to determine whether bio-fortified crops can improve human health outside experimental conditions (Bouis, Hotz, McClafferty, Meenakshi & Pfeiffer, 2009). For instance, a Food Consumption Survey was conducted in Mali to describe the consumption patterns of young children and to estimate the potential effect of bio-fortified sorghum on the total iron and zinc. It was found that there was need to bio-fortify sorghum (International Crops Research Institute for the Semi-Arid-Tropics (ICRISAT), 2008). Also in Zambia, Household Consumption and Expenditure Surveys (HCES) were used to estimate the adoption and impact of biofortification of pro-vitamin A maize (Lividini et al., 2012). However, national FCS have not been carried out in Kenya, though, small-scale cross-sectional surveys have been carried out in different locations of the country by different agencies (GOK, 2008).

2.8 Summary of Literature and gaps in knowledge

Globally, malnutrition is a great threat to public health. Studies from Asian countries and Uganda have confirmed that dependence on one type of starchy staple aggravates

malnutrition. In these studies, bio-fortification of the staple with the deficient micronutrient has been employed as a strategy to abate the deficiency. In East Africa, Uganda has successfully bio-fortified its bananas with provitamin A and Iron and this has reduced VAD and IDA in children population.

Similarly, Kenya has a significant level of zinc, iron and vitamin A deficiencies. Though strategies like fortification, diversification of foods and supplementation have been used, their overall success has been limited. Some parts of Kenya produce and consume a lot of bananas. A good example is in Kisii County whose population depends on the staple both for food and income. Tissue culturing has been widely conducted in Kenya by research institutes e.g. KARI to improve on the bananas resistance to pests and diseases and also to increase its yield. However, little has been done to improve the nutrient content of the banana especially in the regions that seem to depend on it as food. Since little has been done on the possible bio-fortification of banana fruit in areas known for high production and consumption in Kenya, a baseline study on the food consumption patterns of the population in Kisii region was conducted to establish the extent of banana consumption and its contribution to the diet of children in the community. This will form the basis for future research.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Overview

This section describes the study area, research design, sampling procedures and sample size determination. It further discusses the research instruments that were used in the study, validity and reliability of the instruments, data collection procedures and data analysis.

3.1 Research Design

A descriptive survey was carried out to answer questions related to food consumption patterns of children aged 2-5 years in two locations.

3.1.1 Study area

This study was conducted in Kisii County located to the Southwest of Kenya (Appendix 1). It is home to the Gusii people the sixth largest ethnic group with a population of 1,750,534 people (KBNS, 2010). Two divisions, Kenyenya and Keumbu were sampled for the study. Kenyenya division is in Gucha District. It covers an area of 115.1 Km^2 with a population of 107,199 people and 22,029 households, while, Keumbu division is in Kisii Central District. It covers an area of 70.9 Km^2 with a population of 55,102 people and 11,769 households (KBNS, 2010).

3.1.2 Study population

The target population constituted all the households with children aged 2-5 years in the selected areas.

3.2 Sampling

Mugenda & Mugenda (2003), describes sampling as the process of selecting a number of individuals for a study in such a way that the individuals selected represent the larger group from which they are selected. The sampling process was randomized apart from the initial stage of identifying the two divisions under study.

3.2.1 Sampling procedure

Purposive sampling was used to select the areas of study using information obtained from the Kenya Agricultural Research Institute (KARI) in Kisii and the Ministry of Agriculture (MoA) Kisii District Offices, on the locations with highest banana Production in Kisii region. The two divisions chosen for sampling were Keumbu and Kenyenya. These two areas were stratified into their administrative units, that is, locations, which were then sampled randomly using simple random sampling. The same procedure was used to identify the sub-locations and villages included in the study. From the centre of the villages sampled, Spin-a- pen random walk method was used to indicate the direction where the researchers were to start from. Using systematic sampling every 10^{th} household a child aged between 2-5 years was selected until the desired sample size was reached. Only one child in each selected household was included in the survey. If there was more than one child in that age bracket in a household, then all children were numbered and simple random sampling was used to determine which one was included in the survey.

3.2.2 Sample size determination

The sample size was derived from the target population of the already sampled locations Kenyenya and Keumbu as shown in table 3.1

Table 3.1: Number of households in Kenyenya and Keumbu Divisions

Location	Number of households
Kenyenya	22029
Keumbu	11769
Total	**33798**

Adapted from KNBS & ICF Macro, 2010

According to Mugenda & Mugenda (2003), when the population is above 10,000 the following formula is applied in order to get the desired sample size:

$$n = \frac{Z^2 \text{pq}}{d^2}$$

Where:

n= desired sample size when target population is greater than 10,000

Z= the standard normal deviate at the required confidence level (1.96)

p= the proportion in the target population estimated to have characteristics being measured (in this case p= 24.1% this is according to the baseline study conducted by Maoga, 2010 in Kisii County)

q= 1-p: 0.76

d= the level of statistical significance; (0.05 or 95%)

Therefore:

$$n = \frac{Z^2 pq}{d^2}$$

$$n = \frac{1.96^2 \text{ x } 0.24 \text{ x } 0.76}{0.05^2}$$

$$n = \frac{0.70070784}{0.0025}$$

= 280

Two hundred and eighty households were sampled. The method of proportional allocation under the sizes of the samples from the different locations was used by the researcher as suggested by Kothari (2004). This method helped the samples from the two divisions to be proportional to their sizes. The number of households sampled in each division is shown in Table 3.2

Table 3.2: Sample size in each Division

Division	Number of households to be sampled
Kenyenya	182
Keumbu	98
Total	**280**

3.4 Data collection

Data was collected from December 2013 to January 2014 using both qualitative and quantitative techniques. It was done in two phases which ran concurrently. A cross sectional food consumption survey was conducted using an interviewer administered Quantitative Food Frequency Questionnaire (QFFQ) to the selected sample. This ran

alongside Focus Group Discussions. The results indicated the common diet consumed by children in those locations.

3.4.1 Data collection instruments.

3.4.1.1 Quantitative Food Frequency Questionnaires (QFFQ)

Food frequency questionnaires assess nutrient intake by determining how frequently a person consumes a limited number of foods that are major sources of nutrients (Lee & Niemen, 2003). The QFFQ used in this study was adopted from the one used in a similar study on sorghum consumption in western Kenya by Nokuthula (2009) but was modified to suit the current study by changing the foods and including estimated weights of foods per portion.The questionnaires were prepared in the English language but during administration, trained research assistants used Kisii, the local dialect or Kiswahili to communicate if the need arose, to ensure that the questions were well understood and answered. The questionnaires were pretested in Marani area in Kisii County before the initial commencement of data collection using 10% of the sample size that is, 28 caregivers and children and adjustments made before the actual study commenced.

The questionnaire consisted of a list of foods which contained 79 food items and beverages in total categorised into eleven food groups namely, starchy staples, beverages, legumes, dairy, fruits, vegetables, sugar/sweets, meats, eggs, additives and spreads from which the population sourced its nutrient intake. Respondents who were persons involved in the feeding of the children were asked to indicate how many times a day, week, month or year that the children consumed the selected foods in

order to estimate the usual diet. Standard portion sizes (cups, plates, spoons, bowls, and rulers) commonly used locally by the respondents were used to help the respondents estimate the correct portion sizes consumed. The respondents were then required to describe the size, of each of his or her child's usual serving as small, medium or large relative to these standard servings. To determine the food intake per day, the portions were multiplied by the number of portions consumed per week and divided by 7 or per month and divided by 30.An estimated daily nutrient intake was arrived at after analysis of the portion sizes per food consumed which was then compared to the RDA.

3.4.1.2 Anthropometric Measures

To determine the nutritional status of the children in the community, anthropometric measures that included weight, height, and Mid Upper-Arm Circumference (MUAC) were taken and these were determined as described by Lee & Niemen (2003). Two measurements for each parameter were recorded per child in the study.

Weight

Weight predicts caloric expenditure and body composition. Body weights of the children were measured using a SECA weighing scale (Vogel and Halke Hamburg, Model 7141014009) of at least 120 kg capacity and accurate to 100 g (0.1 kg). The subjects stood in the middle of the scale's platform and body weight equally distributed on both feet. The weight was read to the nearest 100 g (0.1 kg) and recorded. If the child was too young to stand on the scale, the weight of the mother carrying the child was taken and then the weight of the mother was subtracted from

the total weight to find that of the child. The measurements were taken twice and an average of the two recorded.

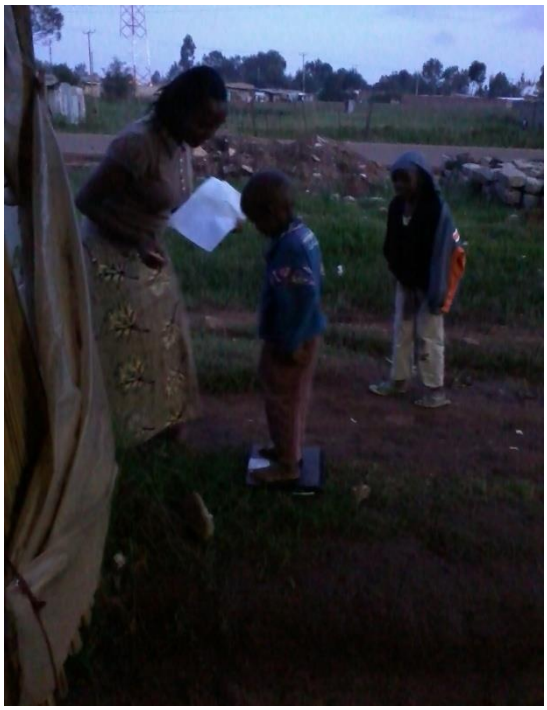


Fig 3.1: Measurement of childrens weight (Source: Author, 2014)

Height

Height was measured using a microtoise. When being measured, the subjects were advised to stand barefoot with minimal clothing to facilitate correct positioning of the body. The subjects stood with the heels together, arms to the side, legs straight, shoulders relaxed and looked straight ahead. Heels, buttocks, shoulder blades, and back of the head if possible were placed against the vertical surface of a wall. Just before the measurement was taken the subject would inhale deeply, hold the breath and maintain erect posture. The measurement was read to the nearest 0.1 cm.

Fig 3.2: Measurement of childrens height (Source: Author, 2014)

Mid Upper Arm Circumference (MUAC)

MUAC is an indicator of muscle and subcutaneous body tissue**.** In order to take the measurement, the child's elbow was bent 90 degrees. Using a non-stretchable tape, the mid-point of the upper arm was measured. Once the mid arm was established, the tape was placed around the upper arm at the level of the marked mid-point. The measurement was then recorded to the nearest 0.1 cm. The parameters of weight and height were used to calculate the indices of weight-for-age (W/A), weight-for-height (W/H), and height-for-age (H/A) and compared with the WHO Z-scores.

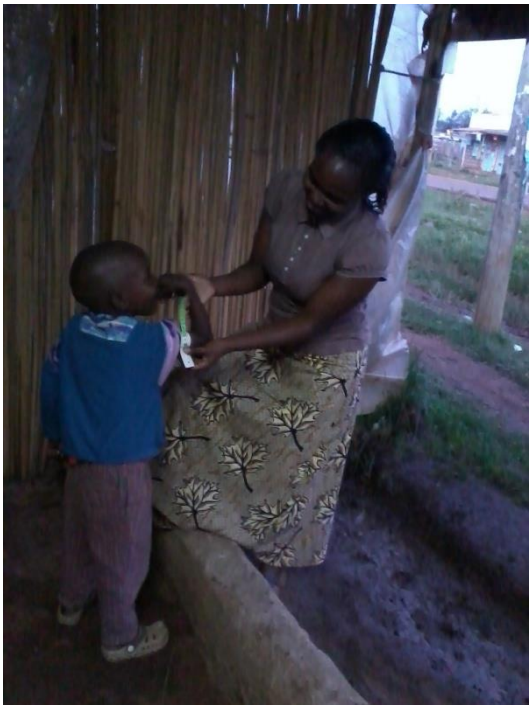


Fig 3.3: MUAC measurements of children (Source: Autheor, 2014)

3.4.2 Data collection procedures.

The process of data collection was facilitated by the researcher, trained assistants and a local village elder as assigned from the relevant Chief's office. Piloting of the questionnaires used was conducted to familiarize the researcher and the assistants with the place and population under study before carrying out the final research (Mugenda & Mugenda, 2003).

3.4.3 Focus Groups

Sample characteristics

The demographic characteristics of the individuals involved in the focus group interviews are presented in Table 3.3**.** The participants mostly were mothers and a small number of caregivers of children aged between 2 and 5 years old in the two

selected Divisions. These participants are responsible for the daily food preparation and feeding of the whole family especially the children. Two focus groups were conducted in Kenyenya and Keumbu Divisions of Kisii County. The participants were aged between 23-65 years. Both younger and older women were interviewed together to capture the varied views and reactions from the different age groups. They were selected based on their involvement in banana production in the households and mainly of their responsibility in feeding the children since they knew which foods the child ate. The focus group participants were purposively selected with the help of the local guide provided by the chief of the area. The guide had to know the area well enough and be familiar with almost all the households in the villages.

Table 3.3: Demographic characteristics of the sampled mothers and caregivers from Kenyenya and Keumbu divisions who took part in the focus group interviews

Location	Age range	Characteristics	Focus group size	
			Target	Achieved
Kenyenya	29-49	Mothers and caregivers responsible for the day to day running of the households	12	10
Keumbu	23-65	All were members of a Women's Association concerned with marketing and selling of bananas.	12	10

Time of interviews

The first group discussions were held in Keumbu Division on 14th January 2014 between 10.30hrs-11.37hrs. The interview lasted approximately 70 minutes. The

second focus group discussion which was held at Kenyenya lasted for approximately 70 minutes also, from 10.30hrs-11.40hrs. It was conducted on the 16th January 2014. The discussions at Keumbu Division took place at the chief's office grounds while those at Kenyenya were held at a participant's homestead. The place where discussions were held was selected based on its proximity, ease of access and convenience for both the researcher and the participants. A comfortable sitting arrangement was set up at the designated areas where the interview would be carried out without many disturbances from the outsiders.

Focus Group guide

A structured interview guide in the form of Focus Groups (FG) was administered. It comprised an introduction, interview and closure. The interview section was arranged with mostly open ended questions to get detailed responses from the respondents. The questions addressed in the focus group interview were centered on the general food production and banana consumption. The core topics discussed under each of the focus areas are listed in Table 3.4

Table 3.4: FDG question guide for mothers and caregivers of children aged between 2 and 5 years from Kenyenya and Keumbu Divisions

Category	Questions
General food and banana production	What crops do you commonly grow?
	How much land is under banana cultivation?
	Averagely, how much is harvested annually?
	What varieties do you commonly grow and why?
Banana processing	Do you have a banana processing factory in the area?
	What processes do bananas go through for consumption?
	Do you know of any banana products? Mention and discuss the processes that are involved
Food and banana consumption	What forms of bananas are frequently consumed?
	What is the preferred variety of banana for cooking?
	Who is responsible for meal preparation and purchase of food items?
	Who is responsible for feeding the children?
	Who is the largest consumer of banana in the household?
	Do bananas have any traditional/ cultural value in the community?
	How is banana perceived in the area? How important is the banana?

Conducting the focus group

Efforts were made for the discussions to be conducted in a quiet surrounding. As the participants were sitting down ready to start the session, one of the research assistants went round with a foolscap writing their names, ages and also information about their families' size, number and ages of their children.

As the session began each participant would introduce herself by giving out the name and where she resides. Also they were requested to speak loudly, slowly and give each other a chance to make their contribution so as to enable those who were taking notes enough time to capture all the information

3.5 Determination of nutrient composition of banana fruit.

Protein, fat and ash (minerals) and moisture content of three varieties of banana fruit grown in Kenyenya and Keumbu Divisions of Kisii County were determined. The Three varieties included *Kisii ndizi* (local variety), *Ng'ombe* and *Nusu ng'ombe*. The bananas were cut into thin slices and sun-dried on flat trays until completely dry, then milled into flour using a laboratory mill. A chemical analysis was conducted in the Chemistry Laboratory of the University of Eldoret. The services were provided by the laboratory technician. For the chemical analyses, the following methods were used: Moisture content by the oven drying method: AOAC (Method 934.01, 1995), Protein content by Kjeldahl method: AOAC (Method 984.13, 1995), crude fat Soxhlet extraction method: AOAC (Method 920.29, 1995) and (ash mineral) by AOAC (Method 923.03, 1995).

3.6 Validity and Reliability.

Validity is the extent to which differences found with a measuring tool reflect true differences among the respondents being tested (Mugenda & Mugenda, 2003). To ensure validity of data, the scale used to take measurements was calibrated using known weight in this case, a kilogram of sugar.

Reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials (Mugenda & Mugenda, 2003). Reliability of the QFFQ was ensured by the piloting it before the research started. Modifications were done to the research instruments and administered again to the same households by

the same interviewers to test for consistency in the answers given to the previous ones.

3.7 Data Analysis

Demographic data from the QFFQ was entered, cleaned, coded and entered into an excel worksheet for further analysis and presentation. To test for relationships among variables relating to banana consumption, the chi-square test was conducted. Descriptive statistics included frequencies and percentages and enabled the researcher to meaningfully describe distribution of measurements. Data on dietary consumption and the calorie contribution of various foods was analyzed by the Nutri-Survey Program. Every food item indicated in the questionnaires was recorded in the program which calculated the specific nutrients consumed per child. Qualitative data got from the two Focus Group discussions conducted was presented into themes and patterns that addressed the objectives of the study and lastly, the anthropometric measures were measured against the Z-scores and the standards set by World Health Organization (WHO).

3.8 Ethical Considerations

This study was undertaken with special considerations of all ethical concerns. Permission to carry out this research was granted by the Institute Research and Ethics Committee (IREC). The major ethical issues that were addressed by the study included informed consent, privacy and confidentiality, anonymity and researchers' responsibility (Mugenda & Mugenda 2003). Informed consent (Appendix 3) was upheld by providing the respondents with adequate information about the study. This

included the purpose of the study, the procedures to be followed; the benefits of the study to them and the community as a whole and the extent of privacy and confidentiality to be maintained. This information was the basis upon which the selected respondents made an informed decision on whether or not to participate in the study. This study respected privacy of the respondents and maintained confidentiality of all data collected to the extent agreed between the two parties. Therefore, all data collected and analyzed was used for the purpose for which the study was undertaken and was not divulged to unauthorized persons. The research also refrained from collecting data that pertained to the identity of the respondents.

CHAPTER FOUR

RESULTS AND DATA PRESENTATION

4.0 Overview

This chapter presents results of the data collected from the field. The analysis was based on the responses from the researcher administered QFFQ as well as information from the two focus group discussions. The qualitative data from the QFFQ and focus group discussions was only used in results explanation and formed a good basis for suggesting recommendations. The analysis was done with particular reference to the five specific objectives of the study.

4.1 Descriptive analysis

4.1.1 Socio-demographic characteristics of respondents

Table 4.1 shows the marital status of the caregiver, household characteristics, education level, and economic related characteristics. Over (90%) of respondents interviewed were mothers to these children. The study also indicated that at least 63% of the care givers had attained a secondary level of education and over 80% of them were married. This meant that the children in these families had a support system they could depend on. However, most of these children (28-30%) came from large families. This could be an indicator of compromised nutritional status

Table 4.1: Socio-demographic characteristics of the caregivers in the sampled households (N=280)

VARIABLE		PERCENT (%)
Care givers	Mother	91.4
	Father	1.4
	Grandparent	4.3
	Sibling	1.4
	Aunt/Uncle	1.4
Education level	Primary	13.6
	Secondary	63.2
	Tertiary	16.8
	University	5.0
	None	1.4
Marital status	Single	16.8
	Married	80.4
	Separated	1.8
	Divorced	1.1
Size of household	1-2 children	3.9
	3 children	15
	4 children	29.6
	5 children	27.9
	6 children	14.6
	7 children	7.5
	> 7 children	1.4
Type of dwelling	Brick/stone	16.8
	Traditional	83.2
Number of bedrooms	1	11.8
	2	73.9
	3	13.6
	4	0.7
Toilet	Pit latrine	100

Source: Field data, 2014

4.1.2 Socio-economic related characteristics.

There was need to establish the socio-economic characteristics of the households' livelihoods by exploring more on the various socio-economic indicators. The findings (Fig.4.1) revealed that a majority (38%) of the respondent's (households) monthly

income was below Ksh. 10,000 followed by those earning between Ksh. 10,000 – 20,000 at 29%. Mean weekly expenditure on food in most households is less than Ksh. 1,000.

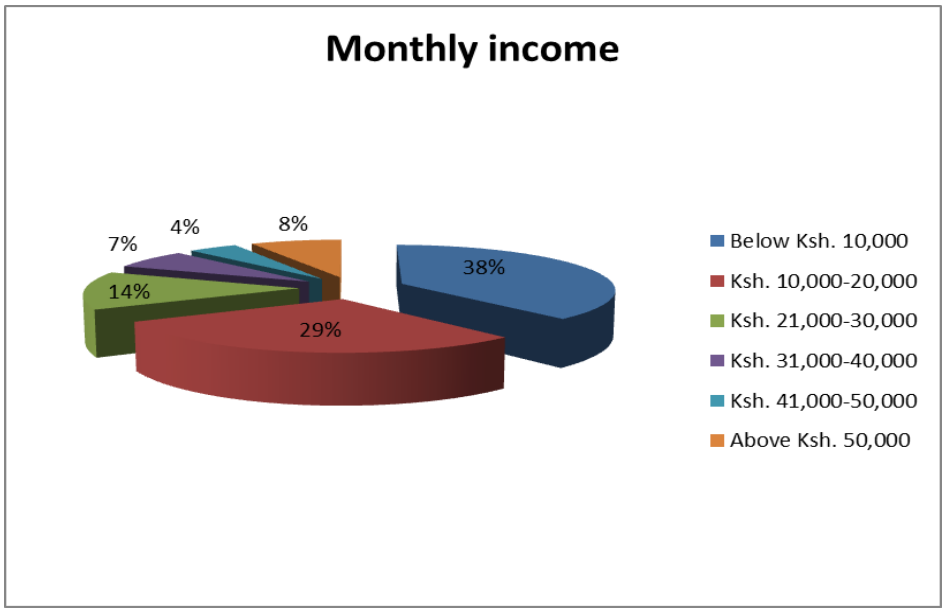


Fig 4.1: Monthly income per household

Table 4.2 revealed that the study area is inhabited by people who earn their livelihood mainly as wage earners for men (39.6%) and housewives for women (43.5%). Another significant percentage (22.5%) of fathers as the heads of the households were unemployed. Unemployment of the fathers is likely to affect the income basket of the family leading to food insecurity in the community. This shows that the many households depend on small scale farming to sustain their families.

Table 4.2: Socio-economic well-being indicators (N=280)

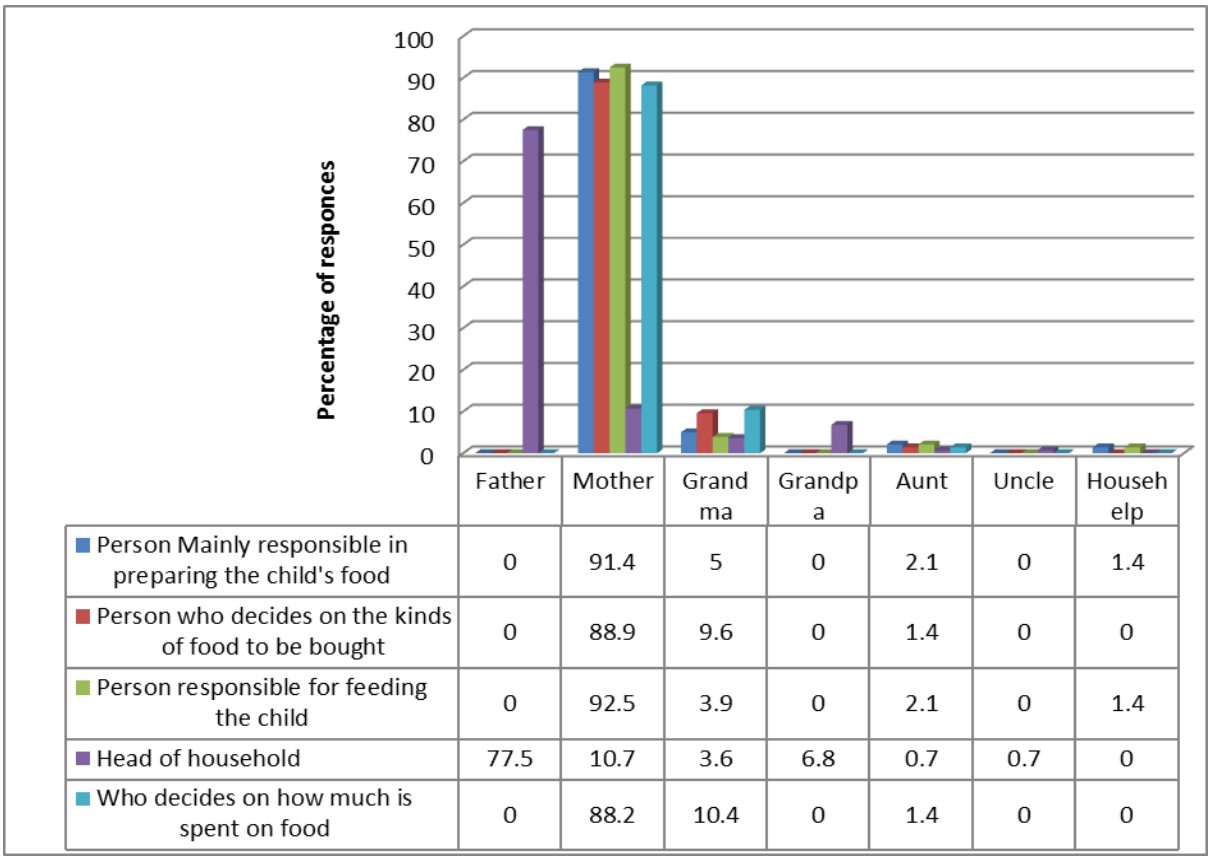
VARIABLE		**PERCENT**
Occupation of mother (father)	Unemployed	43.5(22.5)
	Self- employed	27.9(25)
	Wage earner	17.2(39.6)
	Retired	1(0.4)
	Employed	10.4(12.5)
		Percentage (%)
DRINKING WATER	No. of cases	
Own tap	28	8.9
Communal tap	11	3.5
River	269	85.9
Borehole	5	1.6
Total	313	100
FUEL		
Electricity	6	1.7
Gas	41	11.4
Paraffin	30	8.3
Wood/coal	276	76.5
Solar	2	.6
Open fire	6	1.7
Total	361	100
APPLIANCES		
Paraffin Stove	19	5.2
Microwave	2	.5
Radio	279	76.4
Television	65	17.8
Total	365	100

Accessibility to adequate, and safe water was a problem in the sampled households as most of them obtained water from either rivers (85.9%), own tap (8.9%), communal tap (3.9%) or boreholes (1.8%). However, at least all the households had the basic appliances like radio (76.4%), television (17.8%), and stove for cooking (5.2%). Since, the households sampled were in a rural set-up, they used wood/coal (76.5%)

for cooking. Other methods like use of gas, electricity and paraffin were used as fuel but in small percentages, also shown in Table 4.2.

4.1.3 Food consumption

It was necessary to establish the food consumption patterns of the children and their regular feeding habits. From the study (see fig. 4.2) it was found that even though majority of the households (77.5%) were headed by the fathers, mothers are the ones who made important decisions regarding children's' feeding. For instance, 91.4% of the mothers were found to be responsible for preparing the child's food, 88.9% decided on what kinds of foods were to be bought for the household, 92.5% were responsible for feeding the children and 88.2% decided on how much was spent on food. It was also reported that in those households headed by grandfathers, it was the grandmothers who were responsible for the children and made all the decisions pertaining to their feeding habits.



	Father	Mother	Grand ma	Grandp a	Aunt	Uncle	Househ elp
Person Mainly responsible in preparing the child's food	0	91.4	5	0	2.1	0	1.4
Person who decides on the kinds of food to be bought	0	88.9	9.6	0	1.4	0	0
Person responsible for feeding the child	0	92.5	3.9	0	2.1	0	1.4
Head of household	77.5	10.7	3.6	6.8	0.7	0.7	0
Who decides on how much is spent on food	0	88.2	10.4	0	1.4	0	0

Fig. 4.2: Responsibility and decision making over the child's feeding.

4.1.4 Consumption of banana

Table 4.3 summarizes the general feeding habits of the children in the sampled household with special reference to banana consumption. When the respondents were asked if their children did eat any banana product, 91.1% responded in the affirmative while only 8.9% of the children did not eat bananas. Of those who consumed bananas, 37.3% consumed them fried, 36% when ripe, 26.3% when boiled in their jackets and (0.4%) in their processed form. It was noted that the size of land that was owned by various households had declined as the population increased. This has resulted in the locals practicing mixed farming and intercropping all those crops that can grow in the area. As a result it was found that bananas were not grown on large scale as

plantations but rather intercropped with other crops. As summarized in table 4.3, a majority of the households (92.1%) owned <0.5 ha of land on which among other crops a variety of bananas were planted. The popular variety in the region was found to be the local variety commonly known as Kisii ndizi at 50.9%, followed by Ng'ombe at 42.8% and lastly Nusu ng'ombe at 6.4%.

Table: 4.3: Consumption of banana in Kenyenya and Keumbu Divisions (N=280)

Variable	Response	No. of cases	Percentage (%)
Consumption of a banana product			
	Yes	255	91.1
	No	25	8.9
Forms eaten			
	Processed	3	0.4
	Ripe	241	36
	Boiled	176	26.3
	Fried	250	37.3
Source of banana			
	Market	31	10.8
	Own plantation	255	89.2
Varieties grown			
	Ng'ombe	222	42.8
	Nusu Ng'ombe	33	6.4
	Kisii Ndizi	264	50.9
Land under cultivation			
	<0.5 ha	258	92.1
	0.75 ha	20	7.2
	1 ha	2	0.7

4.1.5 Factors that affect banana consumption.

Socio-demographic and household characteristics were subjected through a chi-square test to ascertain whether they relate to banana consumption by the children.

Table 4.4: relationship between banana consumption and various variables in the study

Variable	Df	Asymp. Sig. (2-sided) (significance level)
Type of dwelling	1	0.001
Fuel used for cooking	4	0.001
Education level of mother/ care giver	5	0.002
Mother's employment status	5	0.002
People contributing to the total income	1	0.001
Household income per month	5	0.002
Nutritional knowledge of the banana	6	0.002

For the relationship to be significant, the level of significance must be ≤ 0.005, from the summary in the table above some household characteristics e.g. type of dwelling (0.001), fuel used for cooking (0.001) do affect the consumption of bananas thus are significant. Other variables that have a significant relationship to the banana consumption among the children include; Care giver's educational level (0.002), mothers employment status (0.002), number of people who contribute to the household income (0.001), household income per month (0.002) and nutritional knowledge of the caregivers (0.002).

4.2 Dietary data Analysis

4.2.1 Total food consumption

To determine the contribution made by banana to the total dietary intake, the children's total food intake had to be established. From the total food intake the starchy staples contribution was established from which the banana's share was derived.

A total of 79 food items were found to be consumed by the children of the households sampled in varying proportions. These were further listed and grouped into 11 food groups namely; starchy staples, beverages, legumes, sugar/sweets, meat, eggs, additives and spreads. The food groups and their mean daily contribution to the total dietary intake are shown in Table 4.5.

As presented in summary on table 4.5, starchy staples food group where banana belongs was found to have contributed the highest mean amount in terms of weight at 631.5g (41.2%). This was followed closely by beverages with a weight of 491.8 g (32.1%). However, water and tea seemed to be the highest contributors in weight to the beverage group contributing 327 g and 121.6 g respectively though their nutrient contribution was low. This necessitated their exclusion from the calculations. When the beverage food group was excluded from the calculation of mean daily amount, the starchy staple group remained at the top as the highest contributor in terms of weight and consequently its proportion of the total dietary intake by weight increased to 60.7%. Another important finding that was noted is that second to the starchy staples group that contributed 55% of protein, legumes provided 18.5% (9.9g) of protein and the major source in this food group was found to be beans. The rest of the food groups contributed to weight in varying amounts as shown in Table 4.5.

Table 4.5: The mean amount in grams of the food groups consumed daily by children aged 2-5 yrs in Kenyenya and Keumbu Districts of Kisii County and their percentage contributions to the total dietary intake (g%/child/day) (N=280)

Food Group name	Mean amount consumed from each food group daily (g) (Standard deviation)	Percentage contribution to the total diet (g %)	Percentage contribution to the total diet when beverage is excluded (g %)
Starchy staples	631.5(46)	41.2	60.7
Beverages	491.8(13)	32.1	Excluded
Dairy	171.2(7)	11.2	16.5
Fruits	71.5(5)	4.7	6.9
Vegetables	51.1(2)	3.3	4.9
Legumes	45.3(8)	3.0	4.4
Sugar/sweets	29.4(10)	1.9	2.8
Meat	23.6(5)	1.5	2.3
Eggs	9.7(3)	0.6	0.9
Additives	3.4(1)	0.2	0.3
Spreads	3.1(1)	0.2	0.3
TOTAL	**1532**	**100.0**	**1039.8**

It was also found that 23% of proteins consumed by the households came from animal products while 77% of the proteins were animal based as shown in Figure 4.3.

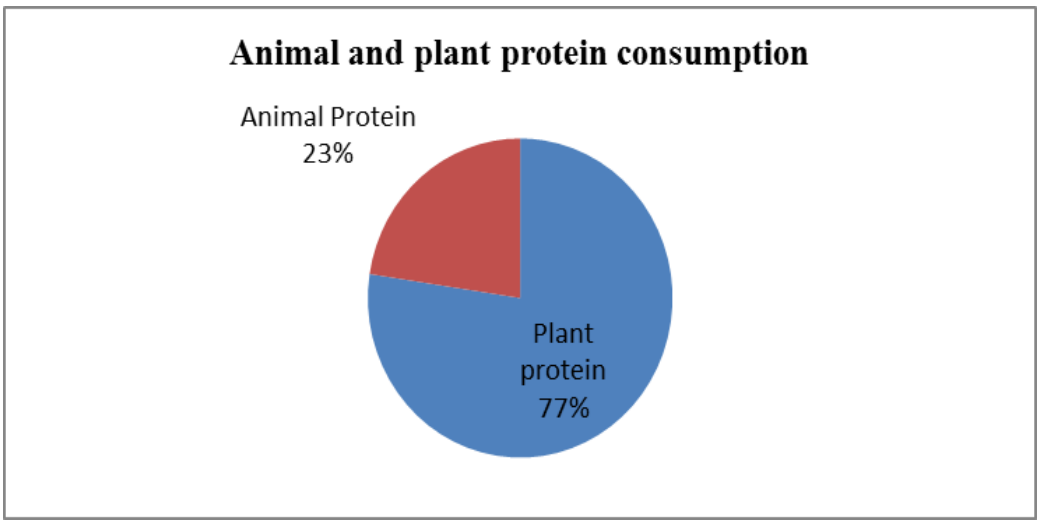


Fig. 4.3: Animal and plant protein consumption

4.2.2 Consumption of Starchy staples

Findings from the survey showed that the children's diet contained a variety of starchy staples consumed in varying proportions. Figure 4.4 presents the summary of those staples and their contribution to the group in percentage. The study indicates that banana was the most consumed starchy food item by the children followed by maize with cassava being the least consumed in the group. The mean amount of banana was 42.1% (266g), maize 26.7% (168g), wheat 10.8% (68g), Irish potatoes 9.5% (60g), rice 4.1% (26g), sweet potatoes 0.4% (2g) and lastly cassava with a contribution of 0.04% (0.3g).

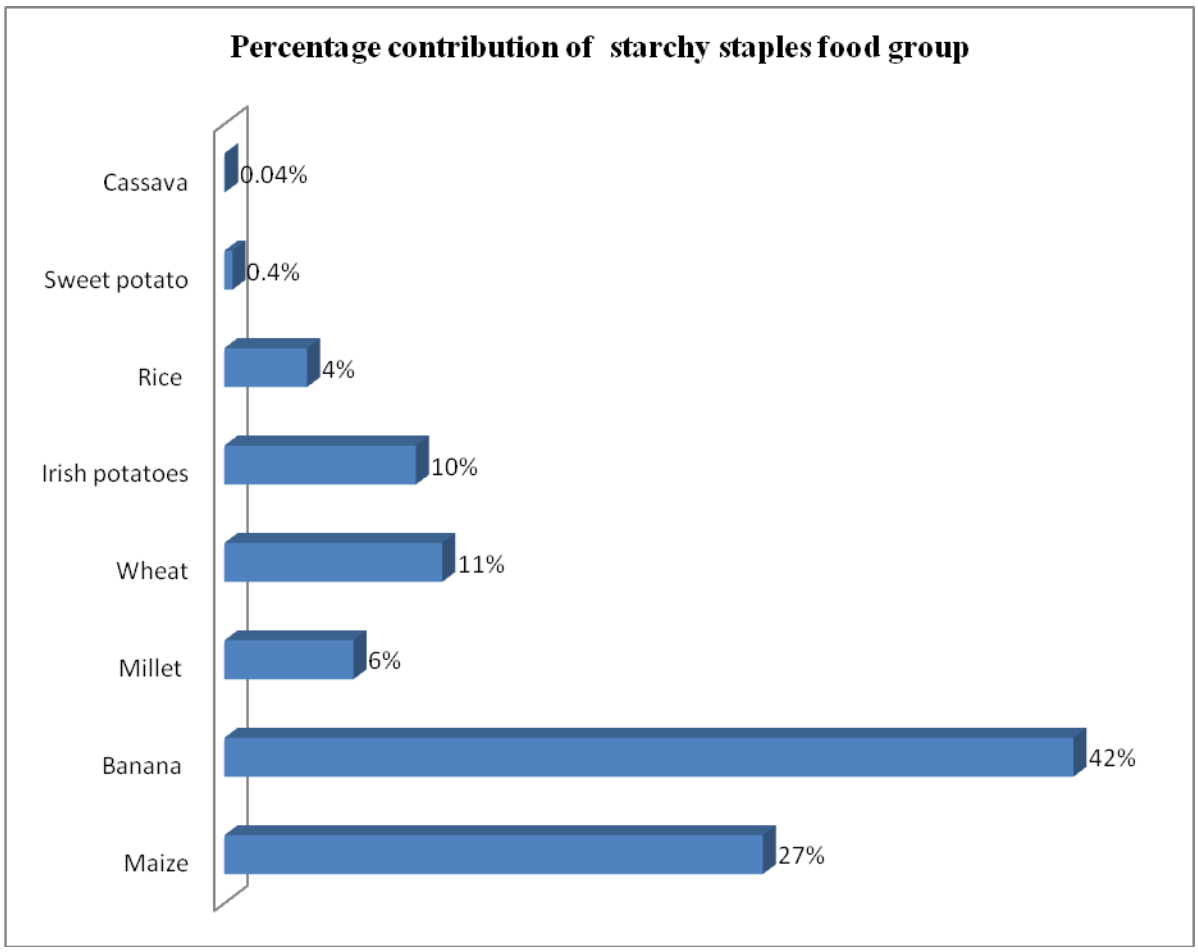


Fig. 4.4: Percentage contribution of each starch staple food to the group in the children's total diet

4.2.3 Nutrient intake

Protein Energy Malnutrition, Vitamin A and iron deficiencies are prevalent deficiencies that affect children worldwide. It was necessary that the intake of these nutrients among the children be first established from the children's diet to find out if the population under study was at risk of these deficiencies as summarized in Table 4.6 for children aged 2-3 years and Table 4.7 for children aged 4-5 years. The values for individual intake by the children were also compared against the different age groups' RDA values in order to determine if the daily intake of the nutrient meets the recommended intake for the specific age group. Findings showed that all the children in both age groups met their RDAs in all the four nutrients. Therefore, there was no need to use the Estimated Average requirements (EAR) values to establish the percentage of the population at risk for deficient intakes. Normally, the EAR is used to assess the prevalence of inadequate nutrient intake of a population (Institute of Medicine, 2000). With this finding, the figures were then compared against the Tolerable Upper Intake Levels (UL) to ascertain whether the population under study was at risk of toxicity of these nutrients.

Energy: the mean daily energy intake for all the children was 1837.8 Kcal ranging from a minimum of 1208.67 to a maximum of 2160.62 Kcal. For children aged 2-3 years the mean energy intake was 1654 Kcal (Table 4.6) and for children aged 4-5 years the mean energy intake was 1994 (Table 4.7). The starchy staples food group contributed 69.1% to the total energy intake with a mean intake of 1271.2 Kcal. Banana did contribute an average energy of 252.9 Kcal (13.8%) to the total dietary intake.

The mean energy intake for the children in both age groups met the EER. There was no section of the population of children in both age groups that had an energy intake below their EER. For children aged 2-3 years the EER range value was 992 Kcal-1046 Kcal, while that of children aged 4-5 years was 1642 Kcal- 1742 Kcal. The ranges incorporate both genders in the groups, the lower range being for girls and the higher being for boys.

Protein: the mean protein intake for all the children was 53.2 g ranging from 37.21g-68.82g. 2-3 year olds had a mean protein intake of 48 g and the mean protein intake for 4-5 year olds was 57.6 g. The starchy staple food group contributed a proportion of 55.2% to the total diet with an average intake of 29.4 g. Banana contributed an average of 5.7% (30.57g). The RDA values for both age groups i.e. 2-3 years and 4-5 years are 13g and 19g respectively. Findings show that these children met their RDA, therefore, not at risk of Protein deficiency.

Table 4.6: The mean amount of nutrients consumed from the total diet of children aged 2-3 years old in the sampled Districts of Kisii County and the mean contribution of the starchy staples food group, mainly the banana to the nutrient intake (N=280)

Nutrient	Mean (standard deviation) intake from the total diet	Range of nutrient intake (minimum-maximum)	Mean nutrient intake from starchy staples (% contribution from starchy staples in the diet)	Mean nutrient contribution from bananas (% contribution of bananas in the diet)	RDA/**EER**[a]	Surplus
Energy(Kcal)	1654 (159)	1208.67-2059.18	1062.1(64.2%)	232.3 (14%)	**992-1046**	662- 608
Protein(g)	48 (6)	37.21-59.86	23.5 (48.8%)	2.8 (5.9%)	13	35
Vit. A (µg)	583 (83)	428.49-871.13	362.6 (62.1)	92.8 (15.9%)	300	283
Iron (mg)	11.7 (1.5)	7.09-15.21	8 (68.4%)	1.3 (11.5%)	7	4.7

[a] The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level

Vitamin A: The mean Vitamin A intake for all the children was 684.1 µg ranging from 428.49 µg - 1180.19 µg. For children aged 2-3 years, their mean vitamin A intake was 583 µg and that for children aged 4-5 years was 769.4 µg. The starchy staple food group contributed a mean intake of 477 µg (69.7%) while the bananas contribute an average of 101.01 µg (14.7%) to the total diet of the children. The RDA value for 2-3 year old children is 300 µg and that for 4-5 year old children is 400 µg. In both age groups these values were met by the children. It was necessary to consider the Tolerable Upper Intake Level (UL) for this vitamin in order to determine if the children were in danger of Vitamin A toxicity. In this study it was found that 26.1% of children aged 2-3 years and 7.4% of children aged 4-5 years exceeded the UL by 13.4% and 8.9% respectively thus exposing them to possible toxicity.

Iron: the mean iron intake from the children's diet was 12.7 mg ranging from 7.09 mg- 17.53 mg. the mean iron intake for 2-3 year olds was 11.7 mg and that for children aged 4-5 years was 13.6 mg. The percentage contribution of starchy staples to iron intake was 72.2% (9.074 mg) while that of banana to the total diet was 11.6 % (1.5 mg). The RDA values for 2-3 year old children is 7 mg and that for 4-5 year old children is 10 mg an indication that all the children in this study met the RDA, thus no child was at risk of being iron deficient. As can be shown from Table 4.5, 4.6, 4.7 and Figure 4.5, banana made significant contribution to the total diet of the children.

Table 4.7: The mean amount of nutrients consumed from the total diet of children aged 4-5 years old in the sampled Districts of Kisii County and the mean contribution of the starchy staples food group, mainly the banana to the nutrient intake (N=280)

Nutrient	Mean (standard deviation) intake from the total diet	Range of nutrient intake (minimum-maximum)	Mean nutrient intake from starchy staples (% contribution from starchy staples in the diet)	Mean nutrient contribution from bananas (% contribution of bananas in the diet)	RDA/**EER**[a]	Surplus
Energy(Kcal)	1994 (95)	1723- 2152	1423.9 (89.7%)	264.9 (13.5%)	**1642-1742**	352-252
Protein (g)	57.6 (4)	49.81-68.82	32.5 (57.4%)	3.2 (5.7%)	19	38.6
Vit. A (µg)	769.4 (97)	569-1180	563.5 (74.5%)	105.8 (14%)	400	369.4
Iron (mg)	13.6 (1)	10.73-17.53	9.9 (73.5%)	1.5 (11.4%)	10	3.6

[a] The Estimated Energy Requirement (EER) represents the average dietary energy intake that will maintain energy balance in a healthy person of a given gender, age, weight, height, and physical activity level

Figure 4.5 shows a summary of the contributions in percentage made by banana, starchy staple food group and other food items to the daily nutrient intake in the diet of the children. In comparison with the other food items, it can be seen that the contribution made by banana to energy, iron and Vitamin A is significant. However it does contribute a small proportion to protein.

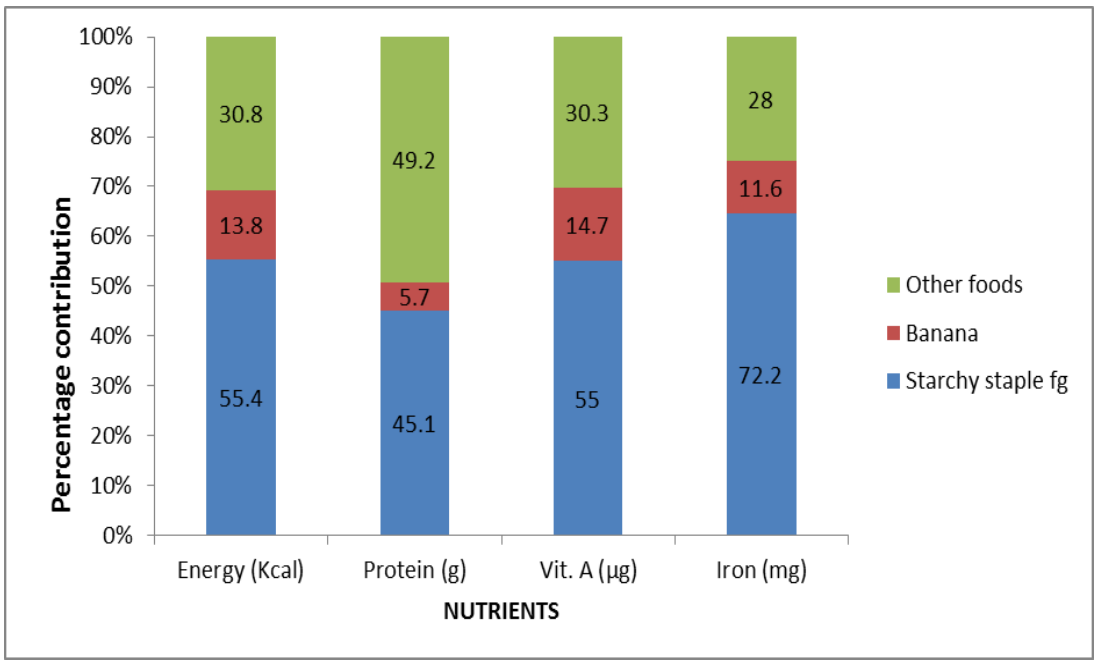


Figure 4.5: The percentage contribution of the starchy staples food group, banana and other food items to the daily intake of energy, protein, vitamin A and iron

In addition to the energy, protein, iron and vitamin A intake that were assessed for the children in Kisii County, the total fat, carbohydrate, vitamin E, B vitamins, Folic acid, vitamin C, sodium, potassium, calcium, magnesium, phosphorus and zinc intakes were also assessed. These intakes for the above mentioned nutrients are presented in Tables 4.8 and 4.9. They are further discussed in the subsequent sections.

Vitamin E

The mean intake for all the children sampled was 8.1 g. the lowest value intake range was 5.26g and the highest value intake range was 11.46g. Tables 4.8 and 4.9 show that; the mean for vitamin E of 2-3 year olds and 4-5 year old children was 6.9g and 9g respectively. 21.6% of children aged 2-3 years were found to be below the RDA of 6 mg. However, when compared with the EAR the population was not found to be at risk of being vitamin E deficient. All the children who were aged 4-5 years met their RDA value for the vitamin which was 7g.

B Vitamins

In the population sampled, vitamins B_1, B_2 and B_6 were in adequate supply. Children in both age groups met the RDA values for these Vitamins. The RDA for both vitamins was 0.5 mg in children aged 2-3 years and 0.6 mg in children aged 4-5 years. The mean intake for vitamin B_1 for all the children was 1.4 mg with a minimum value of 0.9 mg and a maximum of 1.98 mg. in the 2-3 years age group, the mean intake was 1.2 mg ranging from 0.9 mg to 1.64 mg (Table 4.8). In the 4-5 years age group the mean intake was 1.6 mg ranging from 1.33 mg to 1.98 mg (Table 4.9). The mean vitamin B_2 intake for all the children was 1.2 mg with the lowest value being 0.81 mg and the highest value being 1.8 mg. the mean intake for 2-3 years age group was 1.1 mg ranging from 0.81 mg to 1.41 mg while the mean intake for 4-5 years age group was 1.3 mg ranging from 1.01 mg to 1.8 mg.

Table 4.8: The mean amount of nutrients consumed from the total diet of the children aged 2-3 years old in Kenyenya and Keumbu divisions.

Nutrient	Mean (standard deviation) intake from the total diet	Range of nutrient intake (minimum-maximum)	RDA	surplus (deficit)	Percentage of deficient children	percentage of children that exceed UL
Vit. E (mg)	6.9(1)	5.26-10.33	6	0.9	21.6%	0
Vit. B1 (mg)	1.2(0.2)	0.9-1.64	0.5	0.7	0	0
Vit. B2 (mg)	1.1(0.1)	0.81-1.41	0.5	0.6	0	0
Vit. B6 (mg)	2.4(0.5)	1.38-3.43	0.5	1.9	0	0
folic acid (µg)	263.1(47)	157.66-400.03	150	113.1	0	19.6%
Vit. C (mg)	93.4(36)	29.72-188.27	15	78.4	0	0
potassium (mg)	2979.1(457)	1771.7-4102.4	**3000*[a]**	-21	50%	0
calcium (mg)	416.3(93)	249.41-692.4	500	-83.7	82.6%	0
magnesium (mg)	439.6(57)	288.14-571.01	80	359.6	0	0
phosphorus (mg)	1048.9(118)	838.06-1278.02	460	588.9	0	0
zinc (mg)	9.1(1.2)	6.8- 11.7	3	6.1	0	97.8%

[a.] the table presents Adequate intakes (AIs) in **bold type** with asterisk (*)

The children consumed an average of 2.7 mg of vitamin B_6 the lowest value being 1.38 mg and the highest value intake being 3.36 mg. Children aged 2-3 years consumed an average of 2.4 mg of vitamin B_6 from their diet. The lowest amount from the 2-3 years diet was 1.38 mg and the highest was 3.43 mg (Table 4.8). The 4-5 years age group had an average intake of 2.9 mg. the lowest value for this age group was 1.92 mg and the highest amount was 3.63 mg.

Folic Acid (Folate)

On average, the children consumed a high amount of folate from their diet with just a small percentage falling below the RDA. The mean intake for all the children was 280 µg with a minimum intake of 155.7 µg and a maximum intake of 404.9 µg. The 2-3 years age group consumed an average of 263.1 µg from their diet ranging from 157.7 µg to 400.03 µg (Table 4.8) while the 4-5 years age group consumed an average of 294 µg (Table 4.9) ranging from 155.7 µg to 404.9 µg. When compared to the RDA value of 200 µg all children aged 2-3 years met its value (150 µg) while 3.7% of the children aged 4-5 years were below their RDA value of 200 µg. Of the 2-3 year olds category, it was found that 19.6 % of these children and 1.9 % of the 4-5 years old children exceeded the UL values by 10.9% and 1.2% respectively.

Vitamin C

The children consumed an average of 89.1 mg of vitamin C. The intake range was between 22.75 mg- 188.27 mg. the mean vitamin C intake for 2-3 years age group was 93.4 mg with a minimum intake of 29.72 mg and a maximum of 188.27 mg (Table 4.8). The RDA for this age group was 15 mg.

Table 4.9: The mean amount of nutrients consumed from the total diet of the children aged 4-5 years old in Kenyenya and Keumbu divisions.

Nutrient	Mean (standard deviation) intake from the total diet	Range of nutrient intake (minimum-maximum)	RDA	surplus (deficit)	Percentage of deficient children	percentage of children that exceed UL
Vit. E (mg)	9(1)	1.46-7.28	7	2	0	0
Vit. B1 (mg)	1.6(0.1)	1.33-1.98	0.6	1	0	0
Vit. B2 (mg)	1.3(0.1)	1.01-1.8	0.6	0.7	0	0
Vit. B6 (mg)	2.9(0.4)	1.92-3.63	0.6	2.3	0	0
folic acid (µg)	294(42)	155.69-404.89	200	94	3.7%	1.9%
Vit. C (mg)	85.4(33)	22.75-184.95	25	60.4	1.9%	0
potassium (mg)	3436(460)	2128.94-4074.35	**3800*[a]**	-364	72%	0
calcium (mg)	414(112)	152.38-874.01	800	-386	98.%	0
magnesium (mg)	592(52)	471.01-702.66	130	462	0	0
phosphorus (mg)	1344(89)	1140.25-1563.11	500	844	0	0
zinc (mg)	12.1(1)	9.09-14.82	5	7.1	0	57.4%

[a.] the table presents Adequate intakes (AIs) in **bold type** with asterisk (*)

The mean amount of vitamin C consumed by the 4-5 years age group was 85.4 mg ranging from a minimum of 22.75 mg and a maximum of 184.95 mg with the RDA value of 25 mg. The 2-3 years age group met their RDA values but 1.9% of the children aged between 4-5 years were below the RDA value.

Potassium

The mean potassium intake for all the children was 3225.9 mg. the lowest value in the range was 1771.7 mg and the highest value was 4102.4 mg. Mean intake for children aged 2-3 years was 2979.1 mg ranging from 1771.7 mg to 4102.4 mg with an AI of 3000 mg. the mean intake for children aged 4-5 years was 3436 mg ranging from 2128.9 mg to 4074.4 mg with an AI of 3800 mg. These findings showed that half of the population of 2-3 years old children did not meet their RDA and on the other hand 72% of the population of 4-5 years old did not meet their RDA values too.

Calcium

A large number of children in both age groups were found to be deficient in calcium. Findings showed that 82.6% of 2-3 year olds and 98% of 4-5 year olds were below their RDA values which were 500 mg and 800 mg respectively. Despite those findings, the mean intake for calcium for all the children was 414 mg with the lowest and highest values being 152.4 mg and 874 mg respectively.

The mean amount intake for 2-3 years old children was found to be 416.3 mg ranging from 249.4 mg to 692.4 mg and the mean amount intake for 4-5 years old children was 414 mg ranging from 152.4 mg to 874 mg.

Magnesium

Averagely, all the children consumed a mean total of 521.9 mg ranging from 288.1 mg to 702.7 mg. the mean intake for 2-3 years old was 439.6 mg with the lowest value of 288.1 mg and the highest value of 571 mg. the mean intake for 4-5 years old children was 592 mg with the lowest value of 471 mg and the highest value of 702.7 mg. when compared to their RDAs both age groups met the RDA values. The RDA value for children aged 2-3 years was 80 mg while the RDA value for children aged 4-5 years was 130 mg.

Phosphorus

The mean intake of phosphorus for all the children was 1208.4 mg as shown in Tables 4.8 and 4.9. The mean intake of phosphorus for children aged 2-3 years and 4-5 years was 1048.9 mg and 1344 mg respectively. The lowest value of phosphorus intake in the age group of 2-3 years children was 838.1 mg and the highest intake value was 1278 mg. The lowest value of phosphorus intake in the age group of 4-5 years old children was 1140.3 mg and the highest value was 1563mg. The RDA for both groups were met. The RDA for 2-3 years old was 460 mg while that for 4-5 years old was 500 mg.

Zinc

The mean zinc intake from the children's diet was 10.7 mg with a minimum intake of 6.8 mg and a maximum of 14.82 mg. Children aged 2-3 years had a mean zinc intake of 9.1 mg (Table 4.8) a minimum intake of 6.8 mg and a maximum of 11.7 mg. For the 4-5 years age group, the mean zinc intake of 12.1 mg (Table 4.9); with a minimum intake of 9.09 mg and a maximum intake of 14.82 mg. The starchy staples food

group's zinc contribution to the children's diet was 67.8 % (7.4 g) and banana contributed only 5.5 % (0.6 g).

All the children met their RDA value. The RDA for 2-3 years age group was 3 mg while that for 4-5 years age group was 5 mg. When compared to UL for toxicity, almost all the children aged 2-3 years (97.8%) exceeded the UL while only 57.4% of the children aged 4-5 years exceeded the UL by 22.8% and 6.25% respectively. This clearly indicated that the younger population consumed high levels of zinc which can be harmful.

4.3.4 Acceptable Macro-nutrient Distribution Range (AMDR)

Three macro- nutrients contribute to total energy per day in varying proportions as given in Table 4.10.

Table 4.10: Percentage contribution of Macronutrients to Energy

Macro-nutrient	Age (Year)	AMDR (%)	% of contribution	Surplus/ deficit
Carbohydrate	2-3 years	45-65	67	2
	4-5 years	45-65	70	5
Protein	2-3 years	5-20	12	0
	4-5 years	10-30	12	0
Fats	2-3 years	30-40	21	-9
	4-5 years	25-35	18	-7

From the results of the study it was found that, carbohydrates contribute 67% of the energy in children of 2-3 years and 70% in children of 4-5 years to the total energy consumed against the AMDR of 45%-65%. The percentage contributions of protein to total energy in both age groups fell within the range provided. Children of 2-3 age

group should have an AMDR contribution of 5%-20% while 4-5 year olds should have an AMDR contribution of protein to total energy of 10%-30%. The AMDR for fats fell slightly below the recommended range. Children aged 2-3 years had an AMDR of 21% against the recommended range of 30%-40% and those aged 4-5 years had an AMDR of 18% against the recommended range of 25%-35%.

4.3 Nutritional status indicators

The three most commonly used anthropometric indices to assess the growth of children are: weight -for- height, height-for-age and weight-for-age.

Low weight for height indicates wasting or thinness. This is as a result of recent and severe process of weight loss, which is often associated with acute starvation and/ or severe disease. Provided there is no severe food shortage, the prevalence of wasting is usually below 5%, (WHO, 1995). Low height for age indicates stunted growth. This is a process of failure to reach linear growth as a result of some nutritional conditions. It is associated with poor socioeconomic conditions, increased risk of illness or inappropriate feeding practices. Low weight for age indicates an underweight child. This is a child who weighs less for his/her age.

4.3.1 Anthropometric results (based on WHO standards 2006)

Measures of height in cm and weight in kg for every sampled child were taken and recorded. The mean height, weight and BMI is shown in Table 4.11. Table 4.11 summarizes the general outlook of the characteristics of the children who were sampled. The total sample that was used was 280 except when finding their BMI when only those aged 4-5 years was used as provided in the Institute of Medicine (IOM) tables. The mean weight and height of the children was found to be 14.2 (±3.2)

and 96 (±8.8) respectively. The minimum weight that was recorded was 9 kg and a maximum of 24 kg. The minimum height recorded was 79 cm with a maximum of 117.5 cm.

Table 4.11: Mean weight, height and BMI for the sampled children.

Indicators	Observations	Mean	SD	Minimum	Maximum
Weight (kg)	280	14.2	±3.2	9	24
Height (cm)	280	96	±8.8	79	117.5
BMI (kg/m²) [a]	117	15.5	±1.4	12.9	18.8

[a] BMI for children aged 4-5 years old only.

Table 4.12 gives a summary of the number of girls and boys who were sampled in reference to their ages in months. Of the number sampled 27.5% were 2-year olds, 30.7% were 3-year olds while the majority (41.7%) were 4-5 year old children. In general, 54% (151) of the children were boys while 46% (129) were girls. The Table (4.12) also shows how the various indicators of nutritional status of the children faired as explained in subsequent paragraphs.

Table 4.12: Nutritional status of children by Z-score and percentage

	Malnutrition % distribution by gender		
Indicators	Male	Female	Both gender
Age (mo): 24-59	53.9	46.1	100
Wasting (Weight-for-height z-score <-2)	**0**	**0**	**0**
MUAC (< 125mm)	**0**	**1.6**	**0.7**
Moderate (<125mm to > 115mm)	0	1.6	0.7
Stunting (Height-for-age z-score <-2)	**1.3**	**0.8**	**1.1**
Moderate (-3 to -2 z-score)	1.3	0.8	1.1
Underweight(Weight-for-age z-score <-2)	**3.3**	**0.8**	**2.1**
Moderate (-3 to -2 z-score)	3.3	0.8	2.1

Weight-for-height z-scores

This indicator is used to reflect if there is acute malnutrition among the sampled population. In this sampled population there were no cases of acute malnutrition or wasting among the children. The prevalence of wasting based on MUAC cut-offs was 0.7% (2 cases) of the children. All these cases were girls as summarized in table 4.12.

Weight-for-age Z-scores

This indicator was used to reflect cases of underweight children in the sampled population. As indicated in the table below, 97.9% (274) of the children had normal accepted weight while 2.1% (6 cases) were reported to weigh less than their age**.** Of these, 3.3% (5 cases) of underweight children were boys. In general the population is not affected.

Height-for-age Z-scores

This indicator shows the number of children who are stunted. From the survey, only 3 (1.1%) cases of stunting were reported. Two cases (1.3%) were boys and one girl (0.8%). In summary, more boys are affected by moderate cases of malnutrition than girls among children in the selected sampled divisions of Kisii County.

4.4 Nutrient Analysis of the banana varieties commonly grown in Kisii County

The three varieties that are commonly grown and consumed in Kisii County, Kisii ndizi (local variety), nusu- ng'ombe and ng'ombe, were analyzed for fat, ash and protein content. It was found that the varieties vary in the content of these nutrients as shown in Figure 4.6.

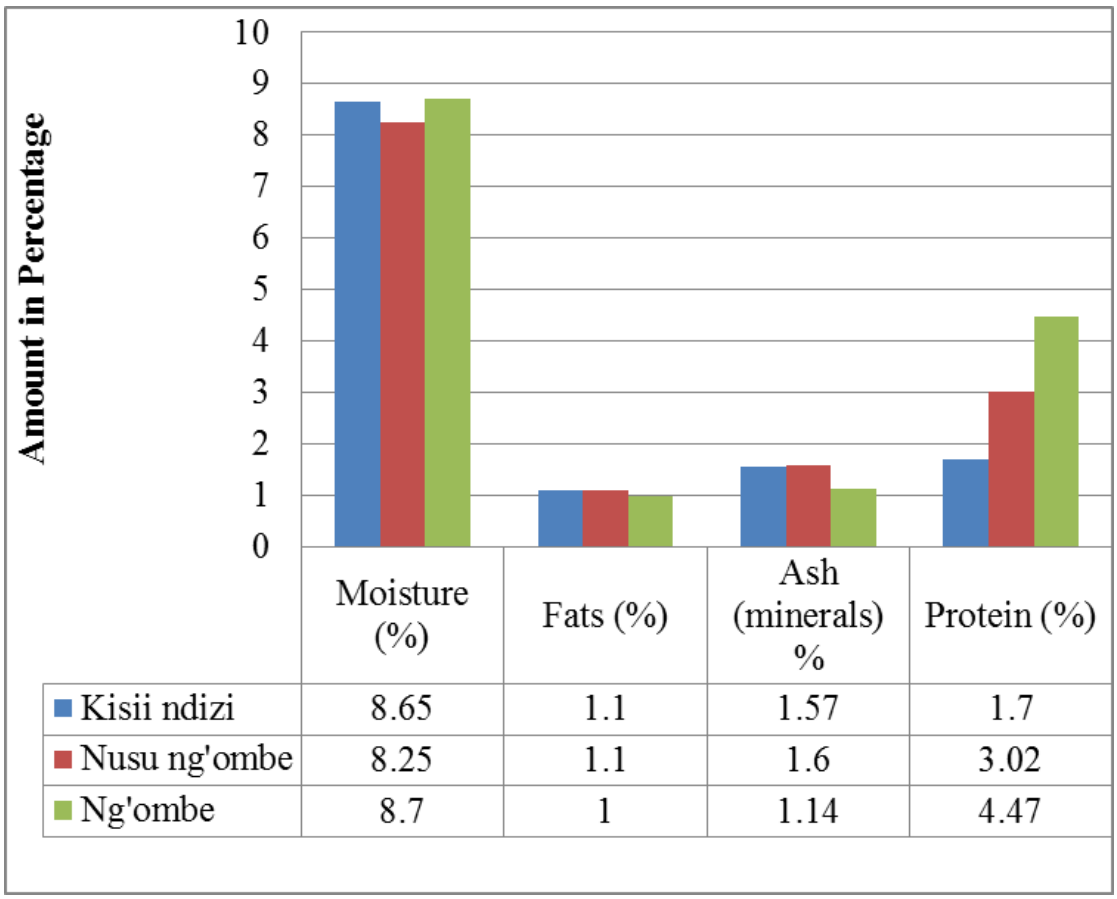


Fig. 4.6: Proximate values of moisture, fat, ash (minerals) and protein in three varieties commonly grown banana fruit in Kenyenya and Keumbu Divisions of Kisii County.

After drying, the moisture content for *Kisii ndizi, Nusu ng'ombe* and *ng'ombe* was 8.65%, 8.25% and 8.7%, respectively. Percentage for fat in all the varieties was very low, generally 1.0%. Ash content for *Kisii ndizi* and *nusu ng'ombe* was similar 1.57% and 1.6%, respectively, while *Ng'ombe* was much lower with 1.14%. Lastly, the percentage protein content in *Kisii ndizi, nusu ng'ombe* and *ng'ombe* was 1.7%, 3.02% and 4.47%, respectively.

4.5 Qualitative analysis: Focus Group Results

4.5.1 Introduction

After each interview session, the researcher with the help of the moderator and other research assistant would sit down and compare notes taken for each question asked during the interviews. Specific words related to banana production and consumption was picked up under each topic in the guide and was used as themes from which the discussion was based on.

4.5.2 General food and banana production

What crops do you commonly grow in your farm?

The responses to this question were varied. However, the most common response was, “It depends on the size of land someone has”. It was also mentioned that crops planted were almost the same every year. Maize and beans were identified by the participants as the crops planted twice a year. These crops are always intercropped with each other in the farm. The respondents also said that at least every homestead has several banana trees around the farm mostly planted in a line to subdivide the land into smaller portions. Therefore, most homesteads do not practice large scale farming of bananas as they are spread throughout the farm at various points. The respondents were quick to point out though that crops like sweet potatoes, vegetables, and sugarcane and avocado trees are planted in some homesteads but they are grown on smaller portions of land when compared with maize and bananas. These crops are normally planted very close to the houses in the compound.

How much land is under banana cultivation?

When the respondents were asked about size of land they simply said statements like "we don't have big lands", "The ancestral land has been subdivided into small pieces", "it's a shame that we can only talk of less than an acre". The majority said that it's hard to rightly quantify the land under banana cultivation unless the land in question is for large scale farming.

Generally, the respondents agreed that the production of banana has reduced significantly in the recent years. The approximated average of land cultivated by bananas per homestead is about 0.4 ha. However the respondents said that outsiders who have bought their lands have large pieces of land, i.e. more than 1 ha. These are the ones who reap the benefits of the bananas after-sale for they practice large scale farming of these bananas for commercial purposes.

Fig 4.7: A farm with banana trees intercropped with other plants (Source: Author, 2014)

Averagely, how much is harvested annually?

From the responses received, averagely, 25-30 bunches can be harvested yearly per homestead. Many respondents indicated that this number was dependent on the fertility of the land, if the banana sucker was planted using the correct procedure and most important is the size of the land. They also mentioned that bananas were more of a staple crop to them since it is not seasonal. It's an all-year-round crop contributing to the food security in the region. The participants however were keen to say that even though more bananas were planted compared to the minor crops, more land was used for planting maize.

What varieties of cooking bananas do you commonly grow and why?

When asked about the most popular varieties, both group discussions ranked the local type (*Kisii ndizi*) as number one, *Ng'ombe* coming in second. "But this variety *Ng'ombe* is slowly but surely overtaking the production of our local type". Another variety planted by some farmers though not so common is the *nusu ng'ombe.* This is normally smaller than *ng'ombe* in size but bigger than the local type.

Some participants said that they preferred ng'ombe above all other varieties. On being asked why, one respondent from Keumbu division said as follows, "Simply put, it has value for money. Ng'ombe is big, so I get a lot of money from it upon selling. Our local variety is the best for cooking though, but it cannot fetch a lot of money if sold" Therefore it can be concluded that bananas produced in these regions are both for selling and home consumption. The crop is slowly translating from a subsistence crop to a cash crop.

(a)Nusu ng'ombe (b) Kisii ndizi (local variety) (c) Ng'ombe

Figure 4.8: Banana varieties commonly planted in the area of study (Source: Author, 2014)

4.5.3 Banana processing

Do you have a banana processing factory in the area?

Upon the moderator asking this question there was an emphatic NO which later the respondents added that there was one proposed to be constructed off Kisii town (Kisii-Keroka route) but it has remained un-developed. On further responses to this question, the respondents expressed their disappointment on the leaders in charge of the project. This is because the respondents believed that the money for its construction had been disbursed by the government for the construction of the banana factory. "This can boost the living standards of people in this region, especially, those who depend on it as an income generator", one respondent said. Others observed that the project could have encouraged more people to produce bananas but now "we are forced to sell our produce at a throw-away- price to the brokers".

What processes do bananas go through?

The respondents simply stated that, "we don't know. We only harvest from the farm and sell it while still green or ripen it"

Do you know of any banana processed product?

On this question there were no much discussions since they have never seen any processed product. “We only hear that you can mill it to make flour and even dry it once it is ripe to be eaten as a snack but we haven’t seen these products”.

4.5.4 Food and banana consumption

What forms of banana is frequently consumed?

All the members seemed to be familiar with how they prepare the bananas. Most respondents indicated that they fried the bananas in onions and tomatoes to form a banana stew. This banana form is mostly consumed during the day for lunch or breakfast. A small number said that sometimes the banana can be boiled with the jackets and consumed with a drink especially for breakfast. This is not common though because this form of cooking does not produce tasty products.

“Ripe bananas are also part of our heritage” one respondent commented as they went on to describe how to ripen a banana. “After harvesting, the banana can either be hanged in a room for slow ripening, put in a special pot covered with specific leaves (*emeroka*) which are believed to quicken the process of ripening evenly or just put in a polythene paper to ripen.

What is the preferred banana variety for cooking?

One participant observed that both varieties earlier mentioned can be cooked; however, the local variety (*Kisii ndizi*) is the sweetest of them all. “We prefer to grow our local type of banana for home consumption while the other varieties are for sale but this does not prevent one from cooking those other varieties”. They also indicated

that although the *ng'ombe* variety is being preferred commercially, *Kisii ndizi* is still the choice of many households.

Who are the largest consumers of the banana in the household?

To this question, participants in both groups agreed that it is the children. This is so because it's the food that is commonly and easily available. It is also believed that it is good for the children as they grow. The respondents indicated that the children can consume it throughout the day unlike *ugali*. "I can say then that without reservations that green cooked bananas are the staple food for the children while *ugali* is the staple food for adults", one respondent commented at the focus group discussion in Kenyenya division.

They reported that mashed bananas are for the much younger children, i.e. less than two years old. The older children consume the bananas whole. Some respondents said that the adults don't get to consume a banana meal since they are hardly home till evening when they eat *ugali*. Probably, the adult get to eat the stewed bananas on weekends when they are at home.

Who is responsible for meal preparation and purchase of food items at home?

Often the first response without any hesitation given when they were asked who decides what should be prepared and how much was: "the mother decides"' or "I do". They indicated that it was the duty of women in the family to make sure that there is food for the whole family. However, some participants mentioned that there were some situations where the women have to go to their husbands and ask for money to

buy foods. In some families with under age mothers, the grandmothers are forced to take up the responsibility.

Do bananas have any traditional/cultural value in the community?

All the participants said that they see bananas as a traditional crop. Most of them mentioned that even though the area bananas take is not large enough as maize, it was still part of their tradition to have some banana trees on their farms. The conclusion was reached that apart from it being a traditional crop, it had no significance culturally.

How is the banana perceived in the community?

Most participants agreed that bananas are an important part of the children's diet. Also these same bananas have grown to become an income earner in the households. Most households are opting to sell the banana especially the *ng'ombe* variety which fetches more money. "A bunch of *ng'ombe* can sell out for Ksh. 1000", indicated one respondent. In summary, bananas in Kisii County are usually consumed direct from the farm as fried, stewed or boiled. They can make a meal on their own for the households but it's frequently used as a daytime food for the young children.

CHAPTER FIVE

DISCUSSION OF RESULTS

5.0 Overview

This chapter discusses the study results with reference to the study's specific objectives. A baseline study was done on the consumption patterns of banana in Kenyenya and Keumbu Divisions in Kisii County using a QFFQ. Determination of deficient nutrients in the population under study and the nutritional status of the children were also conducted by using anthropometric measurements. The aim of the study was to establish the extent to which bananas are consumed in Kenyenya and Keumbu Divisions and also provide insight on the nutritional contributions of banana in Kisii County. A nutrition intervention strategy to help improve the nutrition situation would then be recommended if need be.

5.1 Food consumption

The study found that children's diets in the two divisions, Kenyenya and Keumbu in Kisii region which is to the south of western Kenya had a variety of foods such as fruits, legumes, vegetables, dairy products and meats which complemented the staple food, the banana fruit. This may be explained by the favorable climate that prevails in this region, allowing large cropping diversification in small holder farms under natural conditions (Jaetzold & Schmidt (1982). A similar study by Abele et al., (2006) also found a relatively diverse diet among households in Western Kenya making them food secure. These researchers also attributed this to the rich fertile soils and a favorable climate all year round compared to other parts of the country. For example, the diets of people in the Arid and Semi-Arid Lands (ASAL), is limited to either cereals or meat and milk (MOH, 2000).

Due to the diversity in the children's diet, it was also realized that the composition of the diet, in the sampled locations and by extension Kisii County, conforms to the WHO guidelines. The food pyramid is a tool that is widely used to illustrate the quantities of foods to be consumed by an individual from the food groups to achieve optimal nutrition. These food groups from which food included in the diet should be derived are the cereals/starchy staples, fruits, vegetables, meats and oils in that order (WHO/FAO, 2003). Some of the notable foods in each of these groups as identified in this study include bananas and maize among the starches, avocadoes, oranges and green leafy vegetables for fruits and vegetables, beef, goat and fish for meats. Researchers have found that some populations are unable to balance the intake of foods from each of these groups in adequate amounts to meet the WHO recommendation. For instance, a study in China among adolescents on their food group intake compared with the Chinese dietary guidelines found that most adolescents living in Guangzhou city were not meeting the current recommendations for intakes of the various food groups (Zhang et al., 2012).

The results in this study indicate that in comparison to the other eleven food groups, the starchy staples contributed the highest quantity by weight to the children's diet intake (631.5 g/day). This may be attributed to the lower cost of starchy staples in comparison to foods from the other food groups. Thompson & Amoroso (2009) found that there is a shift from a varied diet rich in micronutrients to one that is derived predominantly from high-carbohydrate staples in the Sub-Saharan region. This is a common response to declines in income. They further justified that it is because most staple foods (e.g. rice, maize, cassava) are much cheaper than fruits, vegetables and animal source foods.

The findings in this study show that banana was the highest consumed starchy staple and food item by the children in the two divisions at 266 g/day, followed by maize, wheat and potatoes in varying proportions. According to FAO (2009), maize is the national staple food in Kenya. Ofwona (2013) analyzed the consumption of different foods among households in Kenya and found that in the starchy staple group, cereal consumption was the highest among other foods with maize at the top of the list. Additionally, the researcher also found that bananas were consumed much less than maize. Similarly, another study conducted in Western Kenya found that the banana crop did not play a major role in the diet of the studied households (Abele et al, 2006). The high consumption of bananas by the study population may be attributed to growth of the cooking and sweet bananas by small holder farmers in this region as a permanent crop, comparable to tea and coffee (Jaetzold and Schmidt, 1982). This makes them available all year round, compared to maize, other cereals and foods which are annual or semi-permanent and may fail due to bad weather.

It was established that beans were the major food source of protein in the children's diets. It is recommended that a larger portion of protein be provided by animal source foods (ASF) since they provide high quality protein (Bwibo & Neumann, 2003). However, in this study, the starchy staples food group contributed 55% of the protein while legumes provided 18.5% (9.9 g) with minimal contribution from animal sources. This may be attributed to the high cost of animal sourced foods. A review by Bwibo & Neumann (2003) on the need for animal food consumption among Kenyan children confirmed that most households had limited consumption of animal foods because they are too expensive to buy. Though plant proteins are considered inferior due to the anti-nutritional factors such as trypsine inhibitors that affect the

bioavailability of some nutrients, they are very often the main source of protein for populations with low income. An assessment by Akibode (2011) on trends in the production, trade, and consumption of food-legume crops in Sub-Saharan Africa found that food legume crops are a cheap source of protein and minerals and represent an important component of the food crops consumed. Also, Broughton et al., (2003) found that beans are important source of dietary proteins among the Kisii community where on average the yearly bean consumption is 66 kg per person.

Individually, the fruits and vegetables food groups contribute less than 10% of the total daily intake of the children resulting in low intake. Findings from two Food Consumption Surveys (FCS), in India (Government of India, 1998) and South Africa (Labadarious et al., 2005) also indicated a low fruit and vegetable consumption by children of this age. According to Ruel et al., (2004), the demand for fruits and vegetables increases with higher incomes, although the share of total expenditure allocated to it tends to decline. This implies that the demand for fruits and vegetables at low income levels is much lower probably because low income households must prioritize the fulfillment of their basic energy requirements to avoid hunger. Fruits and vegetables tend to be an expensive source of energy. A study in Rwanda showed that tomatoes were 12 times more expensive than starchy staples such as sorghum, cassava, sweet potatoes and cooking bananas which were the cheapest source of energy (Minot, 1992). A similar, study in Cambodia found that the cost of vegetables was between 10-40 times more per Kcal than rice (Prescott & Pradham, 1997). Therefore, rural households with low income levels tend to consume less of fruits and vegetables unless they grow that variety in their farms.

5.2 Factors that affect banana consumption

Banana is highly consumed in Kisii County especially among the children rendering it the major staple food for the children. Prior to this study it was assumed that household characteristics such as socio-demographic and socio-economic could largely affect the consumption of banana in the Kisii region. In order to find the interactions between the interdependent variables and banana consumption, these household characteristic correlates were identified by running chi-square tests. Only a few variables were found to affect the consumption of banana. Type of dwelling, household assets, monthly income, nutritional knowledge, and educational levels were identified as major correlates of banana consumption.

This study found that income levels affect the consumption of bananas. Children in households with low income earnings consumed a lot of bananas while children from households with higher income tended to consume less of the cooked banana. This may be attributed to the fact that the banana fruit is easily and cheaply available. A study carried out in Egerton University by Milu et al., (2005) contradicts the findings of this study. They found that consumption of cooking bananas was not strongly correlated with income.

It was found that, households that had learned mothers who had attained at least a secondary education knew how to balance well the foods that were available to the children unlike their less learned counterparts whose highest education level was primary or less and mostly fed their children on the easily acquired cooking banana. Education is assumed to be a social capital that can positively impact on the general food consumption habits of a household by making individual members (of the

households) , especially the mother to make good production and nutritional decisions. Therefore, the higher the education level of the mother/caregiver the lesser the consumption of the banana in their households. Similar relationship of Education with household consumption patterns was found by Sekhampu, (2012) in South Africa. He found that the educational attainment of the household head significantly influenced food consumption. The results discussed in this section suggest that socio-economic and demographic characteristics must be considered as important predictors of food consumption patterns across all populations.

5.3 Nutrient intake

Lack of food diversity is a severe problem among poor populations in the developing world where diets are based predominantly on starchy staples (Arimond & Ruel, 2004). In this study there was a diversified diet in the population. Consumption of this varied diet by the children resulted in them meeting the requirements for all the nutrients except calcium and potassium. A diversified diet improves energy, nutrient intake in households and is an indicator of overall diet (Jayawardena et al., 2013). Higher diet variety is associated with increased intake of fiber and vitamins (Hatloy et al., 1998). In her study, Ruel (2003) found that household dietary diversity is strongly associated with household calorie availability while diet composition is associated with the consumption of particular micronutrients as well as diet quality. Similar findings on the importance and effects of dietary diversity in improving children's nutritional status have been reported for Kenya (Onyango et al., 1998).

It was found that a significant percentage of children had a nutrient intake below the recommended intake in a number of nutrients such as folic acid, Vitamin E, calcium

and potassium. This indicates that some households may have been food insecure or consumed very small amounts of food from the varied diet. Household characteristics such as family size, child spacing and nutrition knowledge among other factors, may have contributed to diets low in nutrient content. As indicated by Gibson & Ferguson, (1998), the quality of foods offered is compromised by watering down the food to increase quantity of the meal resulting in relatively low energy content thus low micronutrient availability. It can therefore, be suggested that those whose nutrient intake was below the recommended measure were at risk of being deficient of those very nutrients. However, to be absolutely sure whether they were at risk or not, their intakes were compared with the Estimated Average Requirements (EAR) (IOM, 2000).

Energy

According to this study, the population was found to have adequate caloric intake. It did meet the Estimated Energy Requirement as recommended by Institute of Medicine (IOM), (2000). The reason for this outcome could be alluded to the sufficient intake of carbohydrates, proteins and fats which are the main sources of energy. Also the diversified diet of the children might have contributed to the increased energy intake. This reasoning is supported by a study done in rural Malawi among preschoolers. It was found that the consumption of a diversified/ modified diet was associated with an increased caloric intake (Hotz and Gibson, 2001). Contrary to this finding, a study done on Kenyan children indicated that generally the children were deficient in energy (Bwibo & Neumann, 2003). A study in Uganda also reported energy deficits in children between 12-35 months (Bridge et al., 2006).

It was found that, the starchy staple food group contributed the highest mean amount (1271.2 Kcal) of energy among other food groups. This could be because of a significant amount of cereals consumed in the diet. Studies carried out in Kenyan populations on their consumption patterns identify the cereal group as being the number one contributor to energy. An example is a food consumption survey among children aged 2-5 years in Western Kenya that identified cereals as the highest contributor to energy (Nokuthula, 2009). A review of earlier studies on the need for animal sourced foods by Kenyan children concurred with the earlier finding that cereals provide the highest amount of energy in children's diet (Bwibo & Neumann, 2003).

Maize was the highest contributor in terms of energy, followed by banana and millet in that order. The reason for maize topping the list may be due to its low fiber content and the high digestibility of its starch. It is notable that all these energy providing food items fall in the starchy staple food group. Findings by both Nokuthula (2009) and Bwibo and Neumann (2003) found that maize contributes a great percentage to energy as compared to other cereals. However, Nokuthula found that the second highest contributor to energy among Western children was rice.

The population was generally found to be at risk of being overweight or obese since their caloric intake was beyond the recommended intakes for both age groups. This could be as a result of high intake of energy dense foods. It is important to note that excesses in caloric intake are converted to fat which is stored in the body. Excess fat stored will lead to overweight or obesity cases in children. According to Bray, Paeratakul & Popkin (2004), increasing the macronutrients in the diet, that is,

probably by increasing the intake of energy dense foods is associated with increased prevalence of obesity.

Protein

On average, the children had a protein intake that met the required amounts of 13 g/day and 18 g/day for children aged 2-3 and 4-5 years respectively. This means the population under study was not at risk of being protein deficient. This is contrary to a study done by Likimani, 1973 in which he found that the major nutritional problem in Kenya was inadequacy of protein foods. The study found that Inclusive of the banana, the starchy staple food group contributed above half of the protein. Of this, 5.7% (3 g) of the proteins were derived from banana intake. This indicates that bananas have low protein content. This is in agreement with a FAO (1997b) that states that both green and ripe bananas have low crude protein content and is particularly deficient in lysine. In this study, the proximate analysis of the banana fruit varieties commonly grown in Keumbu and Kenyenya Divisions had protein content ranging from 1.7% to 4.5%.

The largest percentage of protein in the children's diet under study was plant based and that beans were the highest contributors to protein intake. Since the community in which the research was carried out is a farming community, most of their produce is plant based. This must have also affected their consumption pattern since they are easily available. Another reason could be because of the high cost of animal sourced foods so as to vary the protein sources. Neumann & Harris (1999) reported that when animal products are priced out of reach of poor households, people are forced to rely more heavily on staple grains, legumes or starchy roots.

There was a low intake of animal protein (Fig. 4.4). The major reason could be that animal protein is not readily available as the community does not rear many animals for consumption. The finding is in accordance with the findings of Sigman, Neumann, Bakshi, Bwibo & McDonald (1989), in a study among school children in Embu, Kenya. He found that children obtain more than 90% of the protein from plant sources. Meat and eggs were found to be consumed in a Ugandan population but not to significant amounts (Bridge et al., 2006). The same was observed in a study carried out in Kathonzweni, Makueni District by Macharia et al., (2005). Since most homes had domestic animals like chicken and cows, parents could be encouraged to incorporate these animal foods in their diets. Animal foods supply high quality protein and readily digestible protein energy. They are also a dense and efficient source of readily available micronutrients (Neumann, Harris & Rogers, 2002).

Animal sources consumed by the children were eggs, milk, fish, beef and chicken. The main animal protein source that was consumed by the children for their protein intake was the dairy products. This could likely be because at least every household owned a cow. The milk therefore though in small quantities was given to the children making it an important animal source protein. The milk was either taken fresh or *Mala* (coagulated milk) accompanied by either, ugali, bananas, potatoes or other staples that may be consumed. FAO, (1992) highlights a study done by De Souza and Bressani on animals in which they found that, when animals are fed a high protein food based on maize, soybeans and skimmed milk there is effective supplementation and improved protein utilization. They qualified these results by saying that diets with animal foods and high quality foods are effective because they are able to provide nutrients still deficient in diets based on maize and beans. Therefore, any food of

animal origin and some foods of vegetable origin such as, soybean and green leafy vegetables, would improve the quality of such diets (FAO, 2005).

It was found that on average, the protein intake of the children was 2 times above the requirements with a 12% contribution to the total energy intake. Protein intake becomes excess when it exceeds about 15% of the total calories (Srinivasan, Irz & Shankar, 2006). A study by Michaelsen (2000) investigated the negative effects of excessive protein intake. He found that intakes that are more than 5 times the requirements might impair water homeostasis during illness and it cannot be excluded that they have adverse effects immediately or later in life. Another study among 18 year old Swedish males suggested that a high protein intake during early life increases the risk of developing obesity later in life (Rolland-Cachera, Deheeger & Bellisle, 1999). Though the population is not at risk of protein toxicity now, the mothers should be advised against its consistent high consumption. However, the protein may not have been excess because the population consumed mainly plant based proteins which are less bio-available and may be complexed with anti-nutritional factors such as trypsine inhibitors and phytic acid.

Iron

It was found that all the children of both age groups met the recommended intake (7 mg/day and 10 mg/day for children aged 2-3 and 4-5 years old) meaning the population was not at risk of being anemic. It can be concluded then that the diets comprised of sufficient iron in relation to the children's diets. The finding could be attributed to the consumption of a varied diet which contains cereal, legume, fruits and vegetables which attenuates the effects of enhancers and inhibitors. This is

contrary to a report by FAO/WHO (2001) which states that a diet which is predominantly plant based results in the poor intake of bio-available iron. Heme iron has higher bioavailability than non heme iron and other dietary components such as phytate present in grains and beans and certain polyphenols in some non-animal foods such as cereals and legumes have less effect on the bioavailability of heme than non heme iron (Hurrel & Egli, 2010). The intake of both forms of iron (haem and non-haem) from these food items can be enhanced by the presence of ascorbic acid, meat, poultry and fish in the diet (FAO/WHO, 2001).

Another reason for high intakes of iron could have been because of fish consumption in the diet. In a study carried out in Cambodia and Bangladesh to determine the importance of fish to nutrient intake, it was found that fish contributed a significant amount of absorbable iron (Roos, Wahab, Chamnan & Thilsted, 2007). The consumption of a variety of fruits, vegetables and fish was expected to result in a sufficient iron intake among the children. The starchy staple food group contributed the highest percentage of iron (73%) to the whole diet. The banana contribution was significant too at 1.5 g/day (11.5%). The highest contributing food item was millet, followed by maize, legume and banana respectively. The improvement of iron absorption depends on the effects of a counterbalance between ascorbic acid from fruits and vegetables and phytic acid from cereals not forgetting the levels of other iron inhibiting factors in the diet such as tannins from tea (FAO/WHO, 2001). The habit of eating fruits with meals should be encouraged among the children this enhances the effects of ascorbic acid on iron absorption (Murphy et al., 1992). It is probable that those factors mentioned above did balance well to have enough iron available for absorption.

Vitamin A

Children in the sampled locations were not at risk of being vitamin A deficient. It was found that they all met their recommended intakes. This could have been so because of the high consumption of banana and maize which are the main vitamin A sources in this study. Also, there was a high intake of local green leafy vegetables which were consumed daily. In contrast, children in western, the Nyanza and Busia regions of western Kenya were found to be deficient of vitamin A (Nokuthula, 2009). This can be explained by the different climate in these zones that is dry which inhibits the production of diverse crops from the small holder farms. Generally, fruits and vegetables are known to provide vitamin A. Factors which may also influence Vitamin A intake include availability of finances, seasonality of foods, preparation methods and beliefs about consumption can affect vitamin A levels in the diets. If the starchy staple food group is excluded vitamin A is derived from vegetables, dairy products, eggs and fruits in that order. It was found that the daily mean intake of Vitamin A for both age groups was one times more than the recommended Dietary Allowances (RDAs). Studies on toxicity of the vitamin conducted in both developed and developing countries suggest that signs of toxicity are associated with long term consumption of vitamin A in excess of ten times the RDA (Olson, 2001; Hathcock et al., 1989).

It was also found that 26% of 1-3 year olds and 7.4% of 4-5 year olds exceeded their ULs of 600 µg and 900 µg respectively but their total dietary vitamin A intake did not reach or exceed their LOAEL of 6000 µg/d and 9000 µg/d. However, these levels of intake cannot cause toxicity in that they are below the lowest level of intake at which adverse effects have been reported for children in this age range. The lowest-

observed-adverse-effect level (LOAEL) is 6000 μg/d for children 1–3 y of age and 9000 μg/d, based on daily consumption of this amount for several months (IOM, 2001).

Calcium and Potassium

It was noted that a large population of the children did not meet their intake requirements. Probably this is attributable to low dietary calcium and potassium intakes, which are characteristic of starchy staple food-based diets and little access to dairy products. Even with a varied diet it is possible that some households consumed less of the foods that provide for these minerals e.g. milk, meat, fish, vegetables and fruits. According to FAO, 2005, limited supplies of animal products imply low intakes and low bioavailability of calcium and if less fruits are consumed there is less potassium in the diet. In most parts of Africa the traditional diet is low in calcium (Pettifor, 2008). A study in Nigeria in children found that low dietary calcium intake is common in Nigerian children (Graff et al., 2004). Also in Kenya, children in the greater Rift Valley region have been found to be at risk of Calcium deficiency which is one of the causes of rickets (Rombo & Muoki, 2012).

Other nutrients

Vitamin C, vitamin E, vitamin B1, B2 and B6, folate, zinc, phosphorus and magnesium were assessed. On average, the children in both age groups met the specific recommended intakes. However, there were some children who were below the Recommended Dietary Allowances for, vitamin E, Vitamin C and folic acid. When compared against their EARs no child was below. This implies that the population under study was not at risk of being deficient of these nutrients.

5.4 Nutritional status

Nutritional status of children is influenced by diet. Better dietary diversity helps ensure adequate intake of essential nutrients especially for growing school going children (Hooshmand & Udipi, 2013). In the present study, cases of wasting (0.7%), underweight (2.1%) and stunting (1.1%) were reported. This may be as a result of not having frequent food deficits caused by either floods or droughts like other regions of the country (FAO, 2005) resulting in the diversified food production and consumption in the region. According to Darapheak et al., (2013), consumption of a diverse diet was associated with a reduction in stunting and also animal source food was a protective factor of stunting and underweight. Arimond & Ruel, (2004) found that there is an association between child dietary diversity and nutritional status.

In general, this study found that boys were more susceptible to malnutrition than girls. These results concurred with a study done in Kenya by Ngare & Muttunga, (1999) and in Botswana (Mahgoub et al., 2006). In addition, global data by World Bank, (2012) also suggests that girls either have lower prevalence malnutrition rates or are at par with the boys. This indicates that girls are at an advantage in malnutrition over the past decade. Contrary to these findings some populations indicate that girls are more susceptible to malnutrition. Some of those cases are studies from Indian populations and a Hispanic population where there is still gender segregation i.e. the woman is considered an inferior gender. Here, the male gender receives more attention and care especially on how they feed (Iriat et al., 2013).

In the current study it was observed that in general, the cases of malnutrition were prevalent in households that had either lower income levels, large family size with

poor spacing of children or the caregivers had little or no education. Studies by Veena et al., 2012 and Abuya et al., 2012 point out that education is a strong correlate of malnutrition among other variables. Therefore, this is in agreement with the results from this study which found that children in households with illiterate mothers were more at risk of malnutrition.

A general observation from both anthropometric and dietary results is that the population is well fed and not at risk of malnutrition. This means that lack of sufficient food could not be the reason for the few cases of detected malnutrition. A study done by (Bloss et al., 2004) in Western Kenya gives insight into some factors that may be attributed to malnutrition. They argue that children tend to be underweight if they are introduced to food earlier than the recommended after six months. They also observed that stunting cases are high among children who are living with non-biological parents. These reasons sufficiently explain the presence of malnutrition in varied levels in some households.

5.5 Proximate composition of moisture, fats, ash (minerals) and protein in three varieties commonly grown in Kenyenya and Keumbu Divisions.

The fat content was quite low in a range of 1%-1.1% for the three varieties of banana fruit, close to the recorded value of 0.33 g/100 g of USDA (2013) food composition tables. This result probably explain the reason why bananas, though contributing the most in terms of weight do not provide the highest energy to the children's diet in Kenyenya and Keumbu Divisions. It was found that maize gives the highest energy. The fat content for maize is 5.09 g/100 g (USDA, 2013)

According to USDA (2013) ash content for banana fruit is (0.82%). The three varieties commonly grown in Kenyenya and Keumbu Divisions had values close the USDA value for ash content. Nusu ng'ombe had the highest value (1.6%), followed by Kisii ndizi (1.57%) and ng,ombe had the least value (1.14%).

It was found that Kisii ndizi variety had a value (1.7%) close to the one given by USDA (1.09%). The rest of the varieties had high protein contents. Ng'ombe had the highest (4.5%) while Nusu ng'ombe had 3.02%. Therefore, all the varieties contributed significantly to protein intake in the diet of the children. In addition to a diversified diet, these results indicate why the children had sufficient protein intake.

5.6 Focus Group Discussions

Based on the observations made during the visits to the different locations where the two focus group interviews were conducted, it was observed that there was high production of banana in the area. Nearly every household had at least a couple of banana plants around the homestead. Banana was usually part of a diversified cropping pattern commonly known as intercropping. This means that the farming of banana in this region is small scale in nature. Likewise, Quaim, (1999), reported that generally, the prevalence of smaller farms is higher in the Western parts of Kenya. The crop is usually grown in small patches throughout the farm.

General food and banana production

It was found that there were a variety of crops grown in the region such as, maize, beans, bananas, sweet potatoes, vegetables, fruits e.g. avocadoes, loquats, guavas and finger millet . This can be attributed to the tropical equatorial climate, which is

suitable for a variety of crops (Ministry of Planning and National Development, 2002).

Maize and beans were the main annual crops grown in Kisii County. These crops according to the participants, occupied the majority of the cultivated land. They also have to be cultivated every planting season which is twice a year. A study by Nokuthula, (2009), on sorghum consumption in Western Kenya, the focus group participants identified maize, cassava and sorghum as the main crops grown there. In a study conducted to determine the role of agricultural biodiversity on dietary intake and nutritional status of pre-school children in Western Kenya, the main crops produced in order of importance were maize, beans, sweet potatoes, cassava, sorghum and finger millet (Ekesa, Walingo & Abukutsa-Onyango, 2008).

When participants were asked about the main food crop produced in their farms, they all agreed that it was maize. However, they were quick to mention that, though maize was the main crop, children's diets contained more of banana products than maize. This outcome on the importance between the two staples (Banana and maize) was in line with the information that was gathered from QFFQ. The amount and portion size of banana consumed daily by a majority of the children compared to maize intake gave the idea that banana was more important.

Other crops that were considered by participants as important even though their production was low were beans, sweet potatoes and local green leafy vegetables. These crops assisted in contributing to the diversity of the diet in the area and also improved nutritional status. The participants when discussing about the importance of

the banana crop stated that, apart from it forming the basic diet of children, it is an all-year-round crop (permanent) unlike maize. Therefore, it contributes to the food security of the households and since it cushions hunger, there is a need to improve its nutrient content, (Nungo et al., 2012).

Banana processing and consumption

It is unfortunate that though the Kisii highlands enjoy the privilege of producing huge quantities of banana, little has been done by the Government to initiate a project that can benefit the community. Commercial processing of bananas is not done in Kisii region unlike Uganda where bananas can be processed into crisps, chips, traditional bear, flour and dried banana, then sold into the market (Dijkstra & Magori, 1994).

The most common form being consumed in the households include fried, ripe or boiled bananas in that order. The respondents reported that the banana was given to the children throughout the day. It can be consumed in the morning for breakfast, lunch and supper.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

1. The banana is the most consumed food item in terms of weight in the diet of children in Kenyenya and Keumbu, making it the best vehicle for fortification, and maize is the highest contributor of energy and other nutrients.
2. Educational level of caregivers, mother's employment status, household income per month and nutritional knowledge of the caregiver influenced the consumption of the banana fruit among children of different households.
3. The children consume a variety of foods which provide sufficient nutrients to complement the banana resulting in a highly diversified diet.
4. The diet for 2-5 year old children is deficient in calcium and potassium but not Vitamin A, iron, energy and protein.
5. The overall nutritional status of the children is good except for a few cases of moderate malnutrition in low income households.
6. All the three varieties of bananas commonly grown in Kenyenya and Keumbu Divisions contributed very little to the protein intake in the diet if the children.
7. Consumption of banana as a starchy staple food for children is not the main cause of malnutrition in Kenyenya and Keumbu the area. Factors like diseases such as malaria, child feeding practices, child spacing, family size and socioeconomic factors could be the underlying factors for malnutrition.

6.2 Recommendations

Based on the findings of this study, the following recommendations were made:

1. In case there is need to improve the nutrient status or quality of diet (for example increasing calcium and potassium) for 2-5 year old children in Kisii County, the banana fruit can be fortified by addition of micronutrients or its nutrient composition improved through plant breeding or genetic engineering because it is consumed in the largest amounts.
2. Nutrition education programs on effective use and combination of the variety of foods available in the study area should be developed and information disseminated to the people. This is to make mothers/caregivers to be more knowledgeable and take control and responsibility on the health of their children.
3. There is need to promote use of animal source foods or to provide calcium and potassium supplements to the children.
4. Ng'ombe Variety commonly used for commercial purposes should be promoted for consumption as well since it provides the highest protein content as opposed to the local variety which most consumers prefer.

6.3 Suggestion for further study

1. Further research on causes of malnutrition in Kenyenya and Keumbu in Kisii County should be conducted since the study established that high consumption of the banana does not cause malnutrition because the diet is very highly diversified diet.

REFERENCES

Abele, S., Twine, E. & C. Legg (2006): Food security in Western Kenya. C3P Food Security Briefs No.3. Ibadan, Nigeria (IITA). http://c3project.iita.org/ Accessed on 1st May 2013

Abuya, B.A., Ciera, J. & Kimani-Murage, E. (2012). Effect of mother's education on child's nutritional status in the slums of Nairobi. *Biomedical Central Pediatrics*, Vol. 12, pp. 80

Africa Bio-fortified Sorghum. (2013). "*The Africa Bio-fortified Sorghum Project*". www.biosorghurm.org/abs_prj.php Accessed on 4th June 2013.

Aghamirzael, M., Heydari-Dalfard, A., Karami, F. & Fathi, M. (2013). Pseudo-cereals as a functional ingredient: effects on bread nutritional and physiological properties- Review. *International Journal of Agriculture and Crop Sciences*, Vol. 14, pp. 1574-1580

Ahuja, J.K.A., Montville, J.B., Omolewa-Tomobi, G., Heendeniya, K.Y., Martin, C.L., Steinfeldt, L.C., et al., (2012). *USDA Food and Nutrient Database for Dietary Studies*, 5.0. U.S. Department of Agriculture, Agricultural Research Service, Food Surveys Research Group, Beltsville, MD.

Akhtar, S. & Ashgar, A. (2011). *Mineral Fortification of Whole Wheat Flour: An Overview.* Flour and Breads and their Fortification in Health and Disease Prevention. Pp. 263–271.

Akibode, C.S. (2011). *Trends in the production, trade, and consumption of food-legume crops in Sub-Saharan Africa*. Unpublished thesis.

Alaimo, K., Olson C.M & Frongillo E.A. (2001). Food Insufficiency and American School-Aged Children's Cognitive, Academic, and Psychosocial Development. *Journal of Pediatrics*, Vol. 108, pp. 44-53.

Allen, L. H. (2003). Interventions for micronutrient deficiency control in developing countries: past, present and future. *Journal for Nutrition*, Vol. 133(11 Supplement 2), pp. 3875S-3878S.

American Society of Hematology (ASH). (2010). *Anaemia*. http://www.hematology.org/Patients/Blood-Disorders/Anemia/5225.aspx Accessed 2nd January 2014.

Ammar-khodja, R. (2000). *Bananas. International Network for the improvement of Banana and Plantain.* International Plant Genetic Resources Institute. http://www.inibap.org Accessed 21st March 2013

Andang'o, P.E.A., Osendarp, S.J.M., Ayah, R., West, C.E., Mwaniki, D.L., De Wolf, C.A., Kraaijenhagen, R., Kok, F.J. & Verhoef, H. (2007). Efficacy of iron-fortified whole maize flour on iron status of schoolchildren in Kenya: a randomized controlled trial. *Lancet*, Vol. 369, pp. 1799–806.

Arimond, M. & Ruel, M.T. (2004) Dietary diversity is associated with child nutritional status: Evidence from 11 Demographic and Health Surveys. *Journal of Nutrition*, Vol. 134, pp. 2579–2585.

Bachou, H. & Labadarious (2002). The nutrition status in Uganda. *Journal of Nutrition*, Vol. 18, pp. 356-358.

Baltussen, R., Knai C. & Sharan, M. (2004). Iron Fortification and Iron Supplementation are Cost-Effective Interventions to Reduce Iron Deficiency in Four Sub regions of the World, *Journal of Nutrition*, and Vol. 134 (10), pp. 2678-2684.

Black, R.E., Lindsay, H.A., Zulfiqar, A.B., Laura, E.C., Mercedes de Onis, Majid, E., Colin, M. & Juan, R., (2008). Maternal and Child Malnutrition: global and

regional exposures and health consequences. *The Lancet*, Vol. 371 (9608), pp. 243-160.

Bloss, E., Wainaina, F. & Bailey, R.C. (2004). Prevalence and Predictors of Underweight, Stunting, and Wasting among Children Aged 5 and Under in Western Kenya. *Journal of Tropical Pediatrics,* Vol. 50(5), pp. 260-70.

Bouis, H.E., Hotz, C., McClafferty, B., Meenakshi, J.V. & Pfeiffer, W.H. (2009). *Bio-fortification: A New Tool to Reduce Micronutrient Malnutrition*. Paper prepared for presentation at the 19th International Congress of Nutrition to be held in Bangkok, Thailand.

Bray G.A., Paeratakul, S. & Popkin B.M. (2004). Dietary fat and obesity: a review of animal, clinical and epidemiological studies. *Journal of Physiology and Behaviour*, Vol. 83, pp. 549-555.

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

Broughton, W.J., Hern´andez, G., Blair, M., Beebe, S., Gepts, P. & Vanderleyden, J. (2003). Beans (Phaseolus spp.) – model food legumes. *Journal of Plant and Soil*, Vol. 252, pp. 55–128.

Bwibo N.O. & Neumann C.G. (2003). Animal source foods to improve micronutrient nutrition and human function in developing countries: the need for ASF by Kenyan children. *American. Society for Nutrition Science,* pp. 3936s-3940s.

Cauthen, J., Jones, D., Gugerty, M.K. & Anderson, C.L. (2013). *Banana and plantain value chain: West Africa*. EPAR Brief No. 239, Wevans School of Public Affairs.

Centers for Disease Control and Prevention(CDC). (2011). *Iron and iron deficiency*. http://www.cdc.gov/nutrition/everyone/basics/vitamins/iron.html

Central Bureau of Statistics (CBS). Kenya Demographic and Health Survey (KDHS) (1998). *National Council for Population and Development*, Ministry of Planning and National Development, Nairobi Kenya. Macro International Inc. Calverton, Maryland USA 1999: 9-124.

Copenhagen Consensus 2012: *Solving the world's challenges*. http://www.copenhagenconsensus.com/projects/guide-to-giving/combating hunger/micronutrient-fortification/the-research

Darapheak. C., Takano, T., Kizuki, M., Nakamura K. & Seino, K. (2013).Consumption of animal source foods and dietary diversity reduce stunting in children in Cambodia. *International Archives of Medicine*, Vol. 6, pp. 29.

Delislie, H. (1990). *Patterns of urban food consumption among households in Kenya: Perspectives from the 1980s*. Department de Nutrition, Universite de Montreal in consultation with the Food and Nutrition Division, FAO, Rome.

De Steur, H., Gellynck X., Storozhenko S., Liqun G., Lambert W., Van Der Straeten D. & Viaene J. (2010). Willingness-to-Accept and Purchase Genetically Modified Rice with High Folate Content in Shanxi Province. *Journal of China*, Vol. 54, pp. 118-125.

Dewey, K.G. & Adu-Afarwuah S. (2008). Systematic review of the efficacy and effectiveness of complementary feeding interventions in developing countries. *Journal of Maternal & Child Nutrition*, Vol. 4 (1), pp. 24-85.

Dijkstra T. & Magori T.D. (1994). *Horticultural Production and Marketing in Kenya, Part 4: Kisii and Nyamira District. Food and Nutrition Studies Program,*

Report No. 52. Ministry of Planning and National Development, Nairobi, African Studies Center, Leiden- book.

Ekesa,B.N., Walingo, M.K. & Abukutsa-Onyango,M.O. (2008). Influence of agricultural biodiversity on dietary diversity of preschool children in Matungu Division, Westrn Kenya. *African Journal of Food, Agriculture, Nutrition and Development,* Vol. 8(4), pp. 391-404.

Faber, M. & Wenhold, F. (2007). Nutrition in contemporary South Africa. *Journal of Water South Africa*, Vol. 33, pp. 393-401

FAO, (2012). *The state of food insecurity in the world 2012*. Food and Agriculture Organization of the United Nations. Rome. http://www.fao.org/docrep/016/i3027e/i3027e00.htm Accessed 1st February 2013

FAO (2010). *The state of food insecurity in the world*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/013/i11683e/i1683e.pdf. Accessed 1st May 2013

FAO (2009). *FAO Stat Production, Consumption, and Trade online database*. Food and Agriculture Organization of the United Nations, Rome. http://faostat.fao.org/site/291/default.aspx. Accessed 3rd May 2013

FAO (2005). *AQUASTAT country profile Kenya: Land and Water Division*. Food *and Agriculture Organization of the United Nations, Rome.* http://www.fao.org/ag/agl/aglw/aquastat.html. Accessed 23rd December 2013

FAO (2004). *FAO statistical year book 2004 volume 1/2 FAO Rome*. http://www.fao.org/docrep/008/y5473m/y5473m00.htm. Accessed on 21st March 2013.

FAO (2004). *Uses of food consumption and anthropometric surveys in the Caribbean: How to transform data into decision making tools*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/008/y5825e/y5825e00.htm. Accessed 3rd May, 2013

FAO (2003). *The world banana economy 1985- 2002*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/007/y5102e/y5102e00.HTM. Accessed 3rd May, 2013

FAO (1997). *Preventing micronutrient malnutrition: A guide to food- based approaches. A manual for policy makers and program planners*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/x0245e/x0245e00.HTM Accessed 3rd May, 2014

FAO (1997b). *Feeding pigs in the tropics*. FAO animal production and health paper 132. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/docrep/003/w3647e/w3647e00.HTM Accessed 3rd May, 2013

FAO (1992). *Maize in Human Nutrition.* Food and Agriculture Organization of the United Nations , Rome. http://www.fao.org/docrep/t0395e/t0395e00.HTM Accessed 24th January, 2014

FAO/WHO (2001). *Human Vitamin and mineral requirements.* Report of a joint FAO/WHO Expert consultation Bankonk, Thailand. Food and Agriculture Organization, Rome. http://www.fao.org/docrep/004/y2809e/y2809e00.htm Accessed 23rd January, 2014

FAO/WHO, (1998). *Preparation and use of food based dietary guidelines: Report of a joint FAO/WHO Consultation*. WHO Technical Series 880. Geneva. http://www.who.int/nutrientrequirements/WHO_TRS_880/en/ Accessed 26th August, 2014

FAO/WHO, (1992). *World Declaration on Nutrition, FAO/WHO Joint Secretariat for the Conference, 1992*. Food and Agriculture Organization of the United Nations, Rome. http://www.fao.org/ag/agn/nutrition/ICN/icndec.htm. Accessed 20th May 2013

Fungo, R. (2009). *Potential of bananas in alleviating micronutrient deficiencies in the great lakes region of East Africa*. African Crop Science Conference Proceedings, Vol. 9, pp. 317-324

Gibson, R.S. & Ferguson, E.L. (1998). Nutrition intervention strategies to combat zinc deficiency in developing countries. *Nutrition Research Reviews*, Vol. 11, pp 115-131.

Gitau, G.N., Kimiywe, J.O., Waudo, J.N. & Mbithe, D. (2013). Effects of Nutrition Education on nutrition knowledge and iron status in Primary school pipils of Gatanga District, Murang'a County, Kenya. *Journal of Current Research in Nutrition and Food Science*, Vol. 1(2), pp. 115-123.

GOK (2011). *National Food and Nutritional Security Policy*. Agricultural Sector Coordination Unit (ASCU) Kenya.

Government of Kenya (2008). *Guidelines for Nutrition Assessments in Kenya: Data collection, analysis and interpretation*. 1st Edition. KNBS, UNICEF & MoPH

Government of India, (1998). *India nutrition profile 1998*. New Delhi, Department of Women and Child Development, Ministry of Human Resource Development.

Hambridge, K.M. (2000). Human zinc deficiency. *Journal of Nutrition*, Vol. 130, pp. 1344-1349.

Hotz, C. & Gibson, R.S. (2001). Complementary feeding practices and dietary intakes from complementary foods amongst weanlings in rural Malawi. *European Journal of Clinical Nutrition*, Vol. 55(10), pp. 841-849

Graff, M., Thacher, T.D., Fischer, P.R., Stadler, D., Sunday, D.P., Pettifor, J.M., Isichei, C.O., & Abrams, S.A. (2004). Calcium absorption in Nigerian children with rickets. *American Journal Clinical Nutrition*, Vol. 80(5), pp. 1415-1421.

Harrison G.G. (2010). Public health interventions to combat micronutrient deficiencies. *Public Health Reviews*, Vol. 32, pp. 256-266.

Hatloy, A., Torheim, L.E. & Oshaug, A. (1998). Food variety–a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*, Vol. 52, pp. 891–898

Hathcock, J.N., Hattan, D.G., Jenkins, M.Y., McDonald, J.T., Sundaresan, P.R. & Wilkening, V.L. (1989). Evaluation of vitamin A toxicity. *American Journal Clinical Nutrition*, Vol. 52, pp. 183-202.

Hokanson, K.E., Ellstrand, N.C., Ouedrago, J.T., Olweny, P.A., Schaal, B.A., & Raybould, A.F. (2010). Bio-fortified sorghum in Africa: using problem formulation to inform risk. *Journal of Nature and Biotechnology*, Vol. 28 (9), pp. 900-903.

Hongo, T.A. (2003). Micronutrient Malnutrition in Kenya. *African Food Journal of Agriculture Nutrition and Development*, Vol. 3(2).

Hoorweg, J. & Niemeijer, R. (1986). *Intervention in Child Nutrition: evaluation studies in Kenya. London*: Routledge & Kegan Paul; England.

Hooshmand, S. & Udipi, S.A. (2013). Dietary Diversity and Nutritional Status of Urban Primary School Children from Iran and India. *Journal of Nutritional Disorders Therapy*, Suplement 12

Hossain, S.M. & Mohiuddin, A.K.M. (2012). Study on biofortification of rice by targeted genetic engineering. *International Journal of Agriculture Research Innovation & Technology*, Vol. 2(2), pp. 25-35

Hurrel,R. & Egli, I. (2010). Iron bio-availability and dietary reference values. *American Journal of Clinical Nutrition*, Vol. 91, pp. 1461S-7S.

ICRISAT, (2008). *Food Consumption Survey and the potential impact of biofortification. The west and central Africa semi-arid-tropics (WCA-SAT*). Regional Research Project 2: Agricultural diversification and sustainable agro-ecosystems. www.icrisat.org Accessed 3rd May, 2014

International Institute of Tropical Agriculture, (1992). *Sustainable food production in Sub-Saharan Africa. IITA's contribution*. IITA. Ibadan, Nigeria, pp. 208.

International Rice Research Institute (2013). *Golden Rice*. www.irri.org. Accessed 20th April 2013.

Institute of Medicine (IOM), (2000). *DRI Dietary Reference Intakes: Application in Dietary Assessment*. National Academy Press, Washington, DC, pp. 73-105.

Iriat, C, Boursaw B, Rodrigues, G.P. & Handal, A.J. (2013). Obesity and malnutrition among Hispanic children in the United States: double burden on health inequities. *Review Panam Salud Publica*, Vol. 34(4), pp. 235–43.

Jaetzold, R. & Schmidt, H. (1982). *Farm Management Handbook of Kenya: Natural conditions and farm management information*. Vol. 11/A. Ministry of Agriculture, Kenya.

Jayawardena, R., Byrne, N.M., Soares, M.J., Katulanda, P., Yadav, B. & Hills, A.P. (2013). High dietary diversity is associated with obesity in Sri Lankan adults: an evaluation of three dietary scores. *Bio-Medical Central Public Health*, Vol. 13, pp. 314.

KNBS and ICF Macro. (2010). *Kenya Demographic and Health Survey 2008-09*. Calverton, Maryland: KNBS and ICF Macro.

KBNS (2010). *The 2009 Kenya Population and Housing Census*. Republic of Kenya.

Kothari, C. (2004). *Research Methodology: Methods and Techniques*2nd ed. New-Delhi: New Age International

Kruger, R., Van de Spuy E. & Viljoen, T (2004). *Nutrition in the rural context. In: Micronutrient Malnutrition Course for Southern Africa. ARC- Animal Nutrition and Animal Production.* Unpublished chapter. University of Wageningen, The Netherland

Kwach, J.K., Makworo, S., Nasambu, O. & Onyango, M. (2000). Performance of banana cultivars in South Western Kenya. *Acta Horticulturae*; (540) Leuven: International Society for Horticultural Science (ISHS); 239-243

Kwena, A.M., Terlouw, D.J., de Vlas, S.J., Phillips-Howard, P.A., Hawley, W.A. et al., (2003): Prevalence and severity of malnutrition in pre-school children in a rural area of western Kenya. *American Journal of Tropical Medicine and Hygiene*, Vol. 68, pp. 94–99.

Labadarios, D., Steyn, N.P., Maunder, E., MacIntryre, U., Gericke,G., Swart, R. et al., (2005). The National Food Consumption Survey (NFCS): South Africa, 1999. *Public Health Nutrition*, Vol. 8(5), pp. 533–543

Latham, M.C., Stephenson, L.S., Kinoti, S.N., Zaman, M.S. & Kurz, K.M. (1990). Improvements in growth following iron supplementation in young Kenyan school children. *Journal of Nutrition*, Vol. 6(2), pp. 159-165

Lee, R.D. & Nieman, D.C. (2003). *Nutritional Assessment*. New York: McGraw Hill.

Likimani, J.G. (1973). *Nutrition status of Kenya. Kenya freedom from hunger. Council for Nutrition Development*. Nutrition seminar report, Nairobi. Kenya

Lividini,K., Fiedler, J., Bermudez, Odilia., Zulu, R., Kabaghe, G. & Tehinse, J. (2012). *Estimating Adoption and Impact of Bio-fortification Using Household Consumption and Expenditure Surveys (HCES):* The Zambia Optimal Micronutrient Portfolio Study Keith. 8th International Conference on Diet and Activity Methods

Macharia, C.W., Kogi-Makau, W. & Muroki, N.M. (2005). A comparative study on the nutritional status of Children (6-59 months) in a world vision project area and a non-project area in kathonzweni division, Makueni district, Kenya. *African Journal of Food Agriculture and Nutritional Development (AJFAND)*, Vol. 5(1)

Mahgoub, S., Nnyepi, M. & Bandeke, T. (2006). Factors affecting prevalence of malnutrition among children under three years of age in botswana. *African Journal of Food Agriculture and Nutritional Development (AJFAND)*, Vol. 6(1)

Mangusho, G. (2013), Socio-economic manifestations of hidden hunger in school children in Sub-Saharan Africa. *International Journal of Nutrition and Food Sciences*, Vol. 2 (1), pp 17-23.

Mann, A.J. & Truswell, S. (2001). *Essentials of Human Nutrition*. 2nd Edition. Oxford University Press,NewYork.

Maoga, W.N. (2010). *Nutrition and mortality survey Kisii Central District*. Ministry of Public Health and Sanitation.

Mayer, J.E., Pfeiffer, W.H. & Beyer, P. (2008). Bio-fortified crops to alleviate micronutrient malnutrition, *Journal of Current Opinion in Plant Biology*, Vol. 11(2), pp. 166-170.

Mclntyre, B.D., Bouldin, D.R., Urey, G.H. & Kizito, F. (2001). Modeling cropping strategies to improve human nutrition in Uganda. *Journal of Agricultural Systems*, Vol. 67(2), pp. 105-120.

Michaelsen, K.F. (2000). Are There Negative Effects of an Excessive Protein Intake? *Journal of the American Academy of Pediatrics*, Vol. 106, pp. 1293

Milu, M., Jayne, T.S., Argwings-Kodhek, G. & Ariga J. (2005). *Staple food consumption patterns in urban kenya: Trends and policy implications*. Tegemeo Institute of Agricultural Policy and Development. Working paper 16.

Minot, N. (1992). *Distributional effects of currency devaluation on household in Rwanda*. PhD Dissertation. Department of Agricultural Economics, Michigan State University. E. Lansing. Michigan.

Mirmiran, P., Azadbakht, L. & Azizi F. (1996). Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women. *Journal of American College Nutrition*, Vol. 25, pp. 354–361.

MOH (2000). *Report of Nutrition Survey in North and West Wajir District, North Eastern Province Kenya.* Ministry of Health, Kenya.

Mugenda, O. & Mugenda, A. (2003) *Research Methods: Quantitative & Qualitative Approaches*. Nairobi: Acts Press

Murphy, S.P., Rose, D., Hudes, M. & Viteri, F.E. (1992) Demographic and economic factors associated with dietary quality for adults in the 1987-88 Nationwide Food Consumption Survey. *Journal of American Diet Association*, Vol. 92(11), pp. 1352-7.

Muyanga, M., Jayne, T.S., Argwings-Kodhek, G. & Ariga. J. (2004). *Staple food consumption patterns in urban Kenya: Trends and Policy Implications*. Working Paper 16. Tegemeo Institute of Agricultural Policy and Development, Egerton University, Kenya.

Mwaniki, A. (2007). *Biofortification as a Vitamin A Deficiency Intervention in Kenya*. In: Per Pinstrup-Andersen and Fuzhi Cheng (editors), Food Policy for Developing Countries. http://cip.cornell.edu/dns.gfs/1200428157. Accessed 4th April, 2013.

Nabakwe, E.C. & Ngare, D.K. (2004). Health and nutritional status of children in western Kenya in relation to vitamin A deficiency. *East African Journal of Public Health*, Vol. 1, pp. 1.

Nabarro, D. (2010). *Introducing the policy brief. "Scaling up nutrition: a framework for action*". New York: United Nations, 2010.

Namanya P. (2011), *Towards the Biofortification of banana fruit for enhanced micronutrient content*. Queensland University of Technology. Unpublished thesis.

Nestel, P., Bouis, H. E., Meenakshi, J.V. & Pfeiffer W. (2006). Biofortification of staple food crops. *The Journal of Nutrition*, Vol. 131, pp. 1064- 1067

Neumann, C.G., Harris, D.M. & Rogers, L.M. (2002). Contribution of animal source foods in improving diet quality and function in children in the developing world. *Journal Nutrition Resources*, Vol. 22, pp. 193–220.

Neumann, C. & Harris, D.M. (1999). *Contribution of animal source foods in improving diet quality for children in the developing world*. The World Bank Washington, D.C.

Ngare, D.K. & Muttunga, J.N. (1999). Prevalence of malnutrition in Kenya. *East African Medical Journal*, Vol. 76, pp. 376-380.

Ngare, D.K, Muttunga, J.N. & Njonge, E. (2000). Vitamin A deficiency in pre-school children in Kenya. *East African Medical Journal*, Vol. 77(8), pp. 421-4.

Institute of Medicine (2001). *Plasma carotenoid response to chronic intake of selected foods and β-carotene supplements in men*. Dietary Reference Intakes: Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc National Academy Press Washington, DC.

Nguthi F., Onyango M., Muniu F., Muthamia J. & Njuguna M. (1999). *Biotechnology to Benefit Small-Scale Producers in Kenya*. Annual Report, 1999, KARI. Nairobi, Kenya.

Nokuthula, V. (2009). *Food consumption in selected rural communities in Western Kenya with special reference to sorghum. University of Pretoria*. Unpublished thesis.

Njuguna J., Nguthi F., Wepukhulu S., Wambugu F., Gitau D. & Karuoya M. (2007). *Evaluation of Introduced Superior Banana Cultivars at Thika in Central Kenya*. KARI. Thika, Kenya

Nungo, R. A., Okoth, M.W. & Mbugua, S. K. (2012). Nutrition Status of Children Under-Five Years in Cassava Consuming Communities in Nambale, Busia of Western Kenya. *Food and Nutrition Sciences*, Vol. 3, pp. 796-801

Nyoro, J.K., Kirimi, L. & Jayne, T.S. (2004). *Competitiveness of Kenyan and Ugandan Maize Production: Challenges for the Future.*

O'Brien-Place, P. & Frankenberger, T.R. (1989). *Food availability and consumption indicators*. AID. Evaluation Occasional Paper No. 36, United States Agency for International Development, Washington, DC.

Ofwona, A.C. (2013). An analysis of the patterns of food consumption among households in Kenya. *Journal of Emerging Trends in Economics and Management Sciences*, Vol. 4, pp. 111- 113.

Ogutu, A.C. (2012). *Long-term challenges to food security and rural livelihoods in sub-Saharan Africa*. Paper presented at Workshop organized by Global Development Network Global Research Project: Supporting Policy Research to Inform Agricultural Policy in Sub-Saharan Africa and South Asia.

Olivares, M., Walter, T., Hertrampf, E., & Pizzaro, F. (1999). Anaemia and iron deficiency diseases in children. *British America Bulletin*, Vol. 55, pp. 534-543.

Olson, J.A. (2001). *Vitamin A.* In: Ziegler EE, Filer LJ Jr, eds. Present knowledge in nutrition. 7th ed. Washington, DC: International Life Sciences Institute Press, pp. 109-19.

Ongosi, A.N. (2010). *Nutrient Intake & Nutrition Knowledge of Lactating Women (0-6 months postpartum) in a Low Socio-Economic Area in Nairobi, Kenya*. University of Pretoria. Unpublished thesis.

Onyango, M., Haymer, D., Keeley S. & Manshardt, R. (1998). *Analysis of Genetic Diversity and Relationships in East African 'Apple Banana' (AAB genome) and 'Muraru' (AA genome) Dessert Bananas* Using *Microsatellite Markers*

Oski, F.A. (1993). Iron deficiency in infancy and childhood. *The New England Journal of Medicine*, Vol. 329, pp. 190-193.

Pettifor, J.M. (2008). Vitamin D &/or calcium deficiency rickets in infants & children: a global perspective. *Indian Journal of Medicine Research*, Vol. 127, pp. 245-249.

Pinstrup-Andersen, P. & Schioler, E. (2001). *Seeds of Contention. World hunger and global controversy over GM crops*

Piechulek H, Aldana J.M & Hasan, N. (1999) Feeding Practices and Malnutrition in Rural Bangladesh. *Food Nutrition Bulletin*, Vol. 20(4), pp. 395-400.

Prescott, N. & Pradham, M. (1997). *A poverty profile of Cambodia*. Discussion Paper No. 373. Washington D.C: the World Bank.

Qaim M. (1999). *Assessing the Impact of Banana Technology in Kenya*. ISAAA Briefs No. 10.

Ramalingaswami, V. (1998). Challenges and opportunities- one vitamin, two minerals. *Journal of Nutrition Research*, Vol. 18, pp. 381-390.

Rao, V.G., Yadav, R., Dolla, C.K., Kumar, S., Bhondeley, M.K. & Key, M.U. (2005). Undernutrition and childhood morbidities among tribal preschool children. Indian *Journal of Medical Research*, Vol.122, pp. 43-47

Rolland-Cachera, M.F., Deheeger, M. & Bellisle, F., (1999). Increasing prevalence of obesity among 18 year old males in Sweden: evidence for early determinants. *Acta Paediatrician*, Vol. 88, pp. 365-367

Rombo, G.O. & Muoki, M. (2012). Rickets in rift valley: A review of manifestation and links with fluoride contents of drinking water supplies and food. *Global Advanced Research Journal of Biochemistry and Bio informatics*, Vol. 1(2), pp. 019-025.

Roos, N., Wahab, M.A., Chamnan, C. & Thilsted, S.H. (2007). The role of fish in food based

strategies to combat vitamin A and mineral deficiencies in developing countries. *Journal of Nutrition,* Vol. 137, pp. 1106–1109.

Roy, S.K., Fuchs, G.J., Mahmud, Z., Ara, G., Islam, S., Shafique, S. et al. (2005) Intensive nutrition education with or without supplementary feeding improves the nutritional status of moderately-malnourished children in Bangladesh. *Journal of Health, Population, and Nutrition*, Vol. 23, pp. 320–330.

Roy, S.K., Tomkins, A.M., Akramuzzaman, S.M., Chakraborty, B., Ara, G.; Biswas, R., Islam, K.E., Khatun, W. & Jolly, S.P. (2007). Impact of Zinc Supplementation on Subsequent Morbidity and Growth in Bangladeshi Children with Persistent Diarrhea. *Journal of Health, Population and Nutrition*, Vol. 25(1), pp. 67-74.

Ruel, M. T.,Minot, N & Smith, L. (2004). Patterns and determinants of fruit and vegetable consumption in sub- Saharan Africa. Background paper for the Joint FAO/WHO workshop, Kobe, Japan

Ruel, M. T. (2003). Operationalizing Dietary Diversity: A Review of Measurement Issues and Research Priorities. *The Journal of Nutrition,* Vol. 133, pp 3911S-3926S

Ruel, M. T. & Levine, C.E. (2000). *Assessing the Potential of Food Based Strategies to Reduce Vitamin A and Iron Deficiencies: A Review of Current Evidence*. International Food Policy Research Institute, Washington, DC.

Sayre, R.T. et al., (2011). The BioCassava plus program: biofortification of cassava for sub-saharan Africa. *Annual Review of Plant Biology*, Vol. 62, pp. 251-72

Scrimshaw, N.S. & San Giovanni, J.P. (1997). Synergism of nutrition, infection and immunity: an overview. *American Journal of Clinical Nutrition*, Vol. 66(2), pp. 464S-477S.

Scrimshaw, N.S., Taylor, C.E. & Gordon, J.E. (1968). *Interactions of nutrition and infection A monogram*. Interactions of Nutrition and Infection World Health Organization Geneva, Switzerland.

Sekhampu, T.J. (2012). Poverty in a South African township: the case of Kwakwatsi. *African Journal of Business Management*, Vol.6 (33), pp. 9504- 9509.

Shah, M.M. & Frohberg, H. (1980). *Food consumption pattern- rural and urban Kenya*. International Institute for Applied Systems Analysis, Laxenburg. Working Paper 80-13

Shankar, A.H. (2000). Nutritional modulation of malaria morbidity and mortality. *Journal of infectious diseases*, Vol. 182, pp. 531S- 553S

Sharrocks, S, & Frison. E. (1998). *Musa production around the world-trends, varieties and regional importance*. INIBAP Annual Report, 42-47.

Sheeran, J. (2008). The challenge of hunger. *The Lancet*, Vol. 371(9608), pp. 180-81.

Shekar, M., Heaver, R., & Lee, Y.K. (2006). *Repositioning nutrition as central to development: A strategy for large scale action*. Washington, DC: World Bank.

Sigman, M., Neumann, C.G., Baksh, M., Bwibo, N.O. & McDonald, M. (1989). Relationship Between Nutrition and Development in Kenyan Toddlers. *Journal of Pediatrics*, Vol. 115, pp. 357-364.

Solomons, N.W. (2001). *Vitamin A and Carotenoids*. In: Bowman, BA. & Russel, RM.(ed). Present Knowledge in Nutrition. ILSI Press, Washington, DC, pp. 127- 145.

Srinivasan C.S., Xavier, I. & Shankar, B. (2006). An assessment of the potential consumption impacts of WHO dietary norms in OECD countries. *Food Policy*, Vol. 31, pp. 53–77

Standing Committee on Nutrition. (2011). *Scaling Up Nutrition: A Framework for Action*. New York. SCN News 39 (Supplement): 20–21.

Stein, A.J., Qaim, M., Meenakshi,J.V., Nestel, P., Sachdev, H.P. & Bhutta, ZA. (2008). Potential impacts of iron bio-fortification in India. *Journal of Social Science and Medicine*, Vol. 66, pp. 1797-1808

Stein, A.J. & Qaim, M. (2007). The human and economic cost of hidden hunger. *Food and Nutrition Bulletin*, Vol. 28, pp. 125–134.

Storozhenko, S., De Brouwer, V., Volckaert, M., Navarrete, O., Blancquaert, D., Zhang, G.F. et al., (2007). Folate fortification of rice by metabolic engineering. *Journal of Nature Biotechnology*, Vol. 25, pp. 1277-1279.

Sunguya, B.F., Koola, J.I. & Atkinson, S. (2006) Infections associated with severe malnutrition among hospitalised children in East Africa. *Journal Tanzania Health Research Bulletin*, Vol. 8(3), pp 189-92.

Suri, D., Strutt N. & Ghosh S. (2012). Protein and amino acid bio-fortification of staple crops has potential to reduce population risk of protein inadequacy in Sub-Saharan Africa. *The FASEB Journal*, Vol. 26, pp 636-645

Taylor, S.R., Weaver, B.D., Wood, W.C. & Santen Van Edzard. (2005). Nitrogen Application increases yield and early dry matter accumulation in late-planted soybean crop. *Science Journal*, Vol. 45 (3), pp. 854-858.

Thompson J.L., Manore M.M, & Vaughan L.A. (2011). *The Science of Nutrition*, 2nd Edition. Pearson Education, Inc.

Thompson, B. & Amoroso, L. (eds) (2009). *Combating Micronutrient Deficiencies: Food-based Approaches*. Rome: FAO.

UBOS. (2007). *Uganda Demographic and Health Survey 2006*. UBOS, Kampala, Uganda & Calvelton, Maryland, USA; Uganda Bureau of Statistics & Macro-International Inc.

UN/SCN (United Nations Systems Standing Committee on Nutrition) (2004). *UN/SCN 5th report on world nutrition situation: Nutrition for improved development outcomes*. Geneva, Switzerland. pp. 27-30.

UNICEF/WHO/World bank (2012). *UNICEF/WHO/world bank Joint Child Malnutrition Estimates*.

UNICEF (2011). *Levels and Trends in Child Mortality*. McGraw-hill Higher Education

UNICEF & GOK (2010). *2009 Situation Analysis of Children, Young People and Women in Kenya.* "Securing Kenya's Future in the Hands of Children and Young People". United Nations Children's Fund (UNICEF) and the Government of Kenya. http://www.unicef.org Accessed 23rd March, 2013

UNICEF 2009. *Nutrition in Health Sector in Kenya 2009. Nutrition situation update and rationale for financing nutrition within the health sector in Kenya.* http://www.unicef.org Accessed 23rd March, 2013

UNICEF (2002). *UN Special Session on Children 8-10 may 2002 Newsletter No. 5.* http://www.unicef.org/specialsession/docs_new/documents/newsletter-no5.pdf. Accessed on 20th March 2013.

UNICEF (1998). *The Situation Analysis of Children and Women in Kenya, Nairobi*. Ministry of Planning and National Development and UNICEF, Kenya Country Office 1998: 11-195.

UNICEF (1990). *Strategy for improved nutrition of children and women in developing countries*. A UNICEF Policy Review, New York

UNICEF/MI. (2004). *Vitamin & Mineral Deficiency. A Global Progress Report*. Micronutrient Initiative; Ottawa, Canada [http://www.micronutrient.org/reports/

UNICEF-WHO-The World Bank (2011). *Joint child malnutrition estimates - Levels and trends.* World Health Organization. http://www.who.int/nutgrowthdb/estimates/en/ Accessed 3rd march, 2013

Unnevehr, L., Pray, C. & Paarlberg, R., 2007. Addressing micronutrient deficiencies: Alternative interventions and technologies. *The Journal of Agro-biotechnology Management and Economics*, Vol. 10, pp. 124-134

USAID, (2006). *Understanding nutrition data and the causes of malnutrition in Kenya*. A special report by the Famine Early Warning Systems Network (FEWSNET). USAID.

USAID (1996). *Understanding nutrition data and the causes of malnutrition in Kenya*. A special report by the Famine Early Warning Systems Network (FEWS NET). USAID.

USDA. (2013) *Nutrient Values for raw banana fruit. USDA national nutrient database for standard reference,* release 26. USDA. http://www.ndb.nal.gov/ndb/foods/show/2260 Accessed 26th August, 2014

Van Lieshout, M. & West, C.E. (2004). *Introduction to malnutrition.* In: Micronutrient Malnutrition Course for Southern Africa. ARC- Animal Nutrition and Animal Production Institute, Pretoria, Centre for Nutrition, University of Pretoria, Pretoria, Micronutrient initiative education, Hellen

Keller International, Dhakar, Bangladesh in cooperation and support from Ghent University, Belgium.

Veena, A., Yadavannavar, M.C. & Patil, S. (2012). Assessment of nutritional status of under five children in urban field practice area. *International Journal of Current Research Review*, Vol. 4(22), pp. 122-126

Wardlaw, G.M., Hampi, J.S. & Disilvestro, R.A. (2004). *Perspectives in Nutrition*, 6th edition.

Weaver C.M, Hearney R.P, Proulx W.R, Hinders S.M. & Parkard P.T. (1993) Absorbability of calcium from common beans. *Journal of Food Science*, Vol. 58, pp. 1401-1403

Weaver C.M, Hearney R.P. & Proulx W.R. (1999). Choices for achieving adequate dietary calcium with a vegetarian diet. *The American Journal of clinical Nutrition* Vol. 70(3 Suppl), pp. 543S-548S

West, C.E. (2000). Meeting requirements for vitamin A. *Nutrition Reviews*, Vol. 58(11), pp. 341-345

Whitney, E.N. & Rolfes, R.S. (2002). *Understanding Nutrition*, 9th Edition Wadsworth, London pp 179-191.

Whitney E. & Rolfes, R.S. (2011). *Understanding Nutrition*, 12th Edition.USA.

WHO (2014). *Vitamin and Mineral Nutrition Information System: WHO global database on Vitamin A Deficiency.* World Health Organization. http://www.who.int/vmnis/database/vitamin/en/ Accessed 27th August, 2014

WHO (2004). *Iodine status worldwide: WHO global database on iodine deficiency*. World Health Organization. Geneva. http://www.who.int/nutrition/publications/micronutrients/iodinedeficiency/9241592001/en/ Accessed 26th August, 2014

WHO/FAO Expert Consultation (2003). *Diet nutrition and the prevention of chronic diseases*. WHO Technical Report Series 916. Geneva.

WHO, World Food Program & UNICEF (2007), *Preventing and controlling micronutrient deficiencies in populations affected by an emergency*. Geneva, Switzerland: WHO. http://www.who.int/nutrition/publications/WHO_WFP_UNICEFstatement.pdf . Accessed on 17th March 2013.

World hunger (2012). *2012 World Hunger and Poverty Facts and Statistics*. www.worlhunger.org/articles/Learn/world%20hunger%20facts%202002.htm. Accessed 21st May, 2013

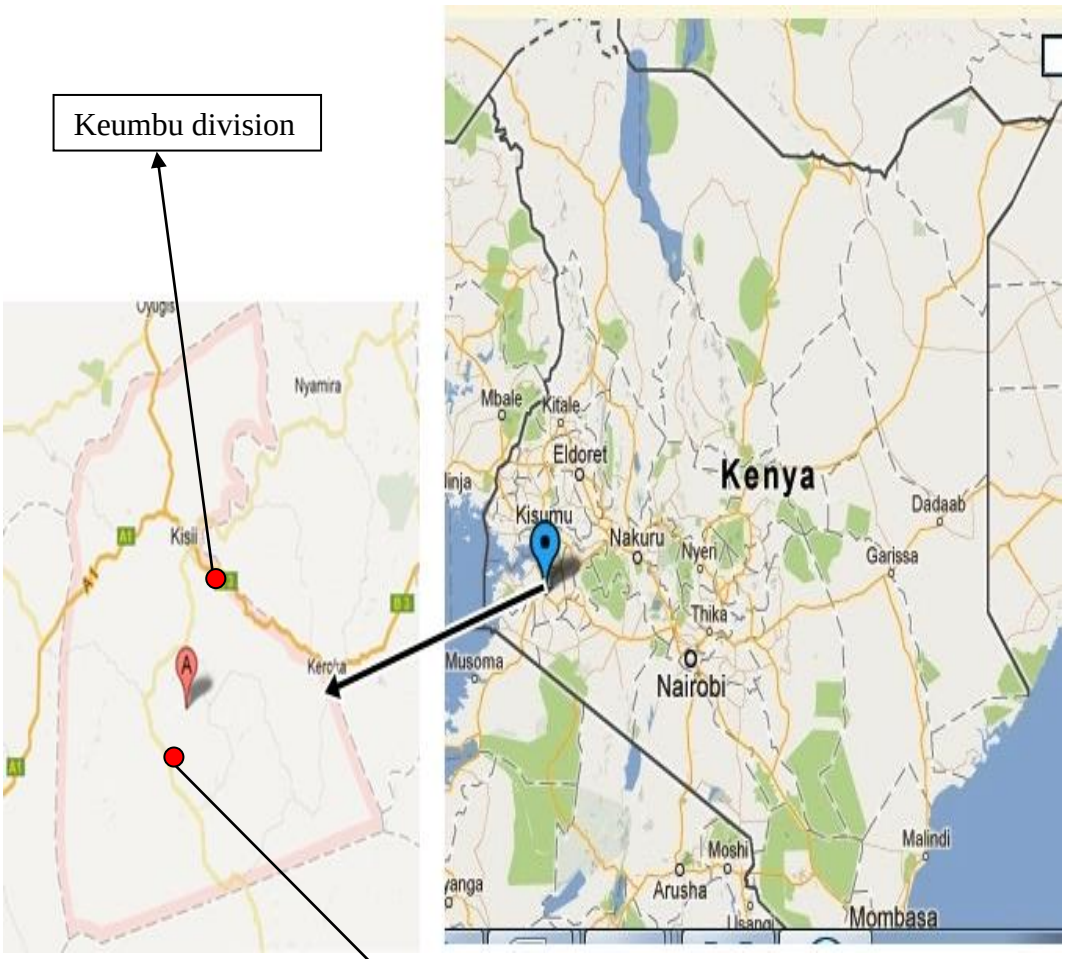
World Vision (2011). *Global Child Health*. http://www.worldvision.org/resources.nsf/main/press-health/$file/Child-Health-Now_WVUS-Fact-Sheet_Oct2011.pdf?open&lid. Accessed on 20th May 2013

Zhang, C.X., Chen, Y.M., Chen, W.Q., Su, Y.X., Wang, C.L. & Wu, J.N. (2012). Food group intake among adolescents in Guangzhou city compared with the Chinese dietary guidelines. *Asia Pacific Journal of Clinical Nutrition*, Vol. 21(3), pp. 450-6.

Zimmermann, M.B. & Hurrell, R.F. (2007). Nutritional iron deficiency. *Lancet*, Vol. 370, pp. 511-520

APPENDICES

APPENDIX I: MAP OF KENYA SHOWING THE LOCATION OF KEUMBU AND KENYENYA DIVISIONS



The map of Kisii County **The map of Kenya**

(Source: Ministry of planning, Kisii County)

APPENDIX II: FOCUS GROUP QUESTIONS.

FGD question guide for mothers and caregivers of children aged between 2-5 yrs from the selected locations in Kisii County.

General food production

What crops are commonly grown in this area?

How much land is under cultivation with the banana plantation?

Averagely, how many bunches do you harvest annually from your piece of land?

Which variety is commonly planted in this area?

Banana fruit consumption.

In what form is banana fruit consumed or used after harvest?

What processes does the banana fruit undergo before consumption? Describe the procedure.

Who is responsible for meal preparation in your family?

Which age group is the largest consumer of banana fruit?

What is the common banana fruit form that you normally serve children (2-5 yrs) and how are they served?

What status do banana fruit hold in this area (culturally/traditionally)?

How is banana fruit perceived in the area?

APPENDIX III: CONSENT FORM

A FOOD CONSUMPTION SURVEY IN KISII COMMUNITY WITH SPECIAL REFERENCE TO BANANA.

DECLARATION BY PARTICIPANT

I, the undersigned, …….hereby accept to take part in the above mentioned research study.
I have been informed that the purpose of this study is to establish the contribution by banana fruit to the usual food intake of 2-5 year old children in my community, with reference to influence on quality of diet, nutritional status and potential effect of biofortification. I believe this is of potential importance to the future of my community especially the children.
I have been duly made aware that I will be required to do the following:

Provide information about myself and my living conditions.
Provide information on the eating habits of the family and that of the child for the past six months to one year.
I will give consent for my child's weight, height and MUAC measurements to be taken by the researcher.
That I may be requested to participate in a group discussion for about 45minutes-1hour. This discussion will be centred on the general food and banana production, means and methods of banana processing, storage and food consumption.

I understand that the results of this study based on the information given will be used to come up with interventions which will improve food quality and also help alleviate the problem of malnutrition in the children of this community.

I understand that:

I have voluntarily agreed to take part in the study
I retain the right to withdraw from the study at any stage without any consequences.
My identity and information given will be kept confidential

Signature …… Date ……..
(Participant)

Signature …… Date ……..
(Researcher)

Witness …….. Date ……
(Witness)

APPENDIX IV: QUANTITATIVE FOOD FREQUENCY QUESTIONNAIRE

FOOD CONSUMPTION SURVEY QUESTIONNAIRE FOR CHILDREN 2-5 YEARS OLD IN KEUMBU AND KENYENYA DIVISIONS IN KISII COUNTY – KENYA

Subject code		Date of birth:	Interview Date:
Location		Interviewer's Name:	

SECTION A: SOCIO-DEMOGRAPHIC INFORMATION

Child's name: ……..

Address ……

Gender: … M ☐ F ☐

Religion ……..

Mother's language ……...

Telephone No. ……

Relationship to child:

Mother ☐ Father ☐ Grandparent ☐ Sibling ☐ Aunt/uncle ☐

Marital status of mother **(tick one**)

1	2	3	4	5	6	7	8
Unmarried	Married	Divorced	Separated	widowed	cohabiting	traditional	Other: please specify

Tick one block only for every question	father	mother	sibling	Grandma	Grandpa	Aunt	Uncle	Cousin	Friend	Other
Who is mainly responsible for food preparation in the house	1	2	3	4	5	6	7	8	9	10
Who decides on the kinds of food to be bought in the house?	1	2	3	4	5	6	7	8	9	10
Who is mainly responsible for feeding the child?	1	2	3	4	5	6	7	8	9	10
Who is the head of this household?	1	2	3	4	5	6	7	8	9	10
Who decides how much is spent on food?	1	2	3	4	5	6	7	8	9	10

Type of dwelling (**you can tick more than one block if necessary)**	1	2	3	4	5
	Brick, concrete	Traditional, mud	Tin	Plank, wood	Other specify
Number of people sleeping in the house?					
Number of bedrooms in the house?					

Number of people per living/sleeping room? (**tick one**)		1	2	3		
		0-2 persons	3-4 persons	More than 4		
Where do you get your drinking water from most of the time? (**Tick one**)		1	2	3	4	5
		Own tap	Communal tap	river	borehole	Other specify
What type of toilet does this household have? (**Tick one**)		1	2	3		
		Flush	Pit latrine	Other specify		
What fuel is used for cooking most of the time? (**you can tick more than one**)	1	2	3	4	5	6
	Electric	Gas	Paraffin	Wood/ coal	Solar	Open fire
Does the child's home have the following appliances? (**you can tick more than one**)	1	2	3	4	5	6
	Refrigerator	Freezer	Paraffin stove	Microwave	Radio	Television
Educational level of mother/ caregiver (**Tick only one**)	1	2	3	4	5	6
	None	Primary school	Secondary school	Tertiary	University	Don't know
Mother's employment status (**Tick only one**)	1	2	3	4	5	6
	Housewife	Unemployed	Self-employed	Wage-earner	Other specify	Don't know
Father's employment status (**Tick only one**)	1	2	3	4	5	6
	Un-employment	Self-employed	Wage- earner	Retired	Other specify	Not applicable e.g. dead
How many people contribute to the total income? (**Tick only one)**	1	2	3	4	5	
	1 person	2 persons	3-4 persons	5-6 persons	More than 6	
House income per month						
	Below Ksh. 10,000	Ksh. 10,000-20,000	Ksh. 21,000-30,000	Ksh. 31,000-40,000	Ksh. 41,000-50,000	Above Ksh. 50,000
Is this the usual income of the household?	1	2	If NO, what other income is available, specify			
	Yes	No				
How much money is spent on food weekly? (**Tick only one)**	1	2	3	4	5	
	Less than Ksh. 500	Ksh. 500-Ksh.1,000	Ksh. 1,000- Ksh. 2,000	Ksh. 2,000-Ksh. 5,000	Above Ksh. 5000	

Now you have to weigh and measure the child.

SECTION B: ANTHROPOMETRY

Weight ☐☐,☐ Kg ☐☐,☐ Kg Height ☐ ☐☐☐ ☐☐☐☐

m

MUAC ☐☐, ☐cm ☐☐, ☐ cm

In the case you weigh the child with the mother/caregiver, use the following tables:

Weight of Mother/Caregiver ☐☐☐.☐ kg ☐☐☐.☐ kg

Weight of Mother/Caregiver & child ☐☐☐.☐ kg ☐☐☐.☐ kg

Difference ☐☐☐,☐ kg ☐☐☐,☐ kg

FOOD CONSUMPTION SECTION

In this part of the questionnaire we would like to find out what children the general feeding habits of children 3 to 5 years old and living in this area. This information is important to know as it will tell us if children are eating enough, of the right foods, and if they are healthy.

SECTION C: INFORMATION ON THE CHILDS FEEDING PRACTICES

Does the child consume any banana product?	1 Yes	2 No		
If yes, in what form is the banana usually eaten in the household?	1 processed	2 Ripe	3 Boiled with peels	4 Fried
How often does your child eat any product of a banana fruit?	daily	weekly	monthly	Other specify
In your own knowledge what nutritional benefits does a banana fruit contribute to your child's growth?				
Where do you get your bananas from?	1 Market	2 Own plantation	3 Others specify	4 Don't know
If you have a plantation of bananas, what variety is it?	1 Ng'ombe	2 Nusu Ng'ombe	3 Kisii Ndizi	4 Don't know

SECTION D: DIETARY INTAKE INFORMATION

In this section you are required to fill in the amount eaten for each food in the categories outlined and also tick the frequency to which the food item is consumed. The quantities are reported either cup (c); teaspoon (t); tablespoon (T); serving spoon (SP): medium (med)

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per wk	Per mnth	Per yr	never
PORRIDGE	Ugali	White	1c stiff = 250 g 1T = 75g							
		Brown								
	Porridge (Uji)	White (maize meal)								
		Brown (Wimbi)								
		With milk	little =30g med =60g much =125g							
	Is sugar added to porridge? If YES, specify	None	1t = 6g							
		White/brown								
		Honey	1t= 15g							
CEREALS	Cereals	Cerelac	1t = 2g 1T = 8g ½c = 20g							
		Weetabix								
		Cornflakes								
		Cerevita								
		White Oats								
	Githeri (Maize and beans)		1T = 50g 1SP = 125g							
	Bananas	Boiled with skin	S/s = 60g; m/s = 90g							
		Mashed	1T=50g; 1SP = 115g;							
		Processed								

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Never
STARCHES	Rice	White	1T = 25g; 1SP = 60g;							
		Brown								
	Potatoes	Mashed	1T=50g; 1SP = 115g;							
		Boiled	S/s = 60g; m/s = 90g							
	Sweet potatoes	Boiled	1T = 50g; 1SP = 110g;							
	Chapatti	White	Medium = 90g							
		Brown								
	Pastas	Macaroni	1T = 35g; 1SP = 70g;							
		Spaghetti								
		Spaghetti and Tomato Sauce	1T =45g; 1SP =80g;							
		Other: Specify								
SPREADS	Bread	White	1S/s = 15g 1M/s = 28g 1L/s = 40g							
		Brown								
	Spreads	Margarine	Thin= 5g Med= 7g Thick= 10g							
		Jam/ Honey	1t = 15g							

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Never
	Doughnut	60mm diameter	45g							
		Small	7g							
	Mandazi	Med	20g							
		Large	30g							
	Kangumu		30g							
	Pizza	Med wedge	40g							
		Large wedge	160g							
	Hotdogs	Bread	40g							
		Frankfurter	28g							
	Samosa	Small	42g							
		Large	150g							
PROTEINS	Chicken	Boiled with skin	Breast+ skin = 125g							
		Boiled without skin	Thigh = 80g							
		Fried coated	Drumstick = 42g							
		Fried not coated	Foot = 30g							
		Roasted/grilled with skin	Wing = 30g							
		Roasted/grilled without skin	Offal (matumbo) = 20g							
			Liver = 30g							
		Pie	Med = 150g							
	Chicken stew	With vegetables	1SP = 90g							
		With tomato and onion	½c = 125g							
	Beef/ mutton / goat	Stewed/boiled with vegetables	1SP = 105g							
		Mince with tomato and onion	1T = 40g 1SP = 85g							
	sausage	Fried	Thin= 45g Thick= 90g							

PROTEINS	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Never
	Cold meats	Viennas	100mm = 30g 150mm = 40g							
	Meat pie		120g							
	Legumes :	Stew	1T = 60g 1SP = 120g							
	Beans									
	peas									
	soybeans									
	Lentils									
	Fried fish		SmalI= 60g Med= 120g							
	Omena									
	Eggs	Boiled/ poached	1 egg = 50g							
		Scrambled in oil	1T = 35g; 1SP = 80g; ½c=115g (approx. 2 eggs)							
		Scrambled in margarine								
	Eggs	Fried in oil								
		Fried in Margarine	1 egg = 52g							
	Are there any other foods that the child eats in this category? If yes please list them				YES	NO				
	food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten(g)	Times eaten				
						Per day	Per week	Per month	Per year	Never

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Ne
VEGETABLES	Cabbage	Fried	1T = 30g 1SP = 55g							
		Boiled								
	Spinach	Boiled/ fried	1T=40g; 1SP=105g;							
	Managu									
	Chinsaga									
	Emboga									
	Rikuneni									
	Risosa									
	sukuma									
	Enderema									
	Kunde									
	Pumpkin (Specify Type	Boiled	1T = 45g; 1SP = 85g							
	Carrots	Raw, salad	1T = 25g							
	Corn on Cob	Boiled	SmalL=75g; Med= 135g; Large=150g							
	Potatoes	Boiled/Baked with Skin	S/s = 60g; m/s = 90g							
		Mashed	1T=50g; 1SP= 115g							
		Roasted	1 med = 70g							
		French fries	½ c = 50g; med = 80g							
		Salad	1T = 45g; 1SP= 105g							
	Egg plant	Fried in oil	1 slice =)+ batter=30g							
		Stew (onion, tomato, oil)	1T=50g; 1SP=100g;							
	Mushroom		1T=30g; 1SP = 65g;							
	Onions	Sautéed in oil	1T = 50g							
	Salad Vegetables	Raw Tomato	Med=120g slice = 15g							
		Cucumber	Med= 10g; thick= 15g							
		Avocado	¼ =40g							
		Lettuce	1 med leaf = 30g							

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Never
FRUITS	Apples		1T=60g; ½c=120 g 1 med = 150g							
	Pears		1med =165g							
	Oranges		Med = 180g							
		1 med	75g							
		Large	90g							
	Sweet bananas	1 piece	25g							
	Mangoes		small = 90g							
			Med= 200 g							
			Large= 350g							
	Pawpaw	Wedge 165 x 26 x 27	=90g							
	Pineapple	1 slice (85 x 10mm)	40g							
	Guavas (mapera)	Med(6cm)	95g							
		Small	50g							
	Water Melon		Wedge= 110g							
	Other fruits;									
DRINKS	Tea		Teacup =180ml; mug= 250ml							
	Sugar Per Cup of Tea/ coffee	White	1t sugar (heaped) = 6g (level) = 4g							
		Brown								
	Milk per Cup of Tea	Fresh	20ml – tea in cup							
	Drinking Chocolate		1t = 5g							

	Food	Description	Quantity (g/ml)	Amount eaten (HHM)	Amount eaten (g)	Times eaten				
						Per day	Per week	Per month	Per year	Never
DRINKS	Fruit Juice (squash)		1c = 250ml							
	Fizzy Drinks (e.g. Coke,Fanta)		S/s bottle = 300ml L/s bottle = 500ml							
SWEETS	Sweets									
	Biscuits		4g							
	Cake	1 Wedge	75g							
	Queen cake	Small	20g							
		Med	30g							
		Large	35g							
	Groundnut	¼c	40g							
		⅛c	80g							
	Chocolates									

In the table below, list the foods commonly consumed by the child more than once per week that have not been included in the previous sections.

Food	Description	`

THANK YOU FOR YOUR CONTRIBUTION

APPENDIX V: RESEARCH PERMIT

INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE (IREC)

MOI TEACHING AND REFERRAL HOSPITAL
P.O. BOX 3
ELDORET
Tel: 33471//2/3

MOI UNIVERSITY
SCHOOL OF MEDICINE
P.O. BOX 4606
ELDORET

Reference: IREC/2014/28
Approval Number: 0001216

10th July, 2014

Edna Kwamboka Onyono,
University of Eldoret,
P.O. Box 1125-30100,
ELDORET-KENYA.

INSTITUTIONAL RESEARCH & ETHICS COMMITTEE
10 JUL 2014
APPROVED
P. O. Box 4606-30100 ELDORET

Dear Ms. Onyono,

RE: FORMAL APPROVAL

The Institutional Research and Ethics Committee has reviewed your research proposal titled:-

"A Needs Assessment for Biofortification of the Banana Fruit on Nutritional Status of Children, 2-5 Years Old in Kisii County".

Your proposal has been granted a Formal Approval Number: ***FAN: IREC 1216*** on 10th July, 2014. You are therefore permitted to begin your investigations.

Note that this approval is for 1 year; it will thus expire on 9th July, 2015. If it is necessary to continue with this research beyond the expiry date, a request for continuation should be made in writing to IREC Secretariat two months prior to the expiry date.

You are required to submit progress report(s) regularly as dictated by your proposal. Furthermore, you must notify the Committee of any proposal change (s) or amendment (s), serious or unexpected outcomes related to the conduct of the study, or study termination for any reason. The Committee expects to receive a final report at the end of the study.

Sincerely,

PROF. E. WERE
CHAIRMAN
INSTITUTIONAL RESEARCH AND ETHICS COMMITTEE

cc Director - MTRH Dean - SOP Dean - SOM
Principal - CHS Dean - SON Dean - SOD