

**NUTRITION EDUCATION ON IRON STATUS OF PRIMARY SCHOOL
PUPILS OF GATANGA SUB-COUNTY, KENYA**

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**A THESIS SUBMITTED IN FULL FULFILMENT OF THE
REQUIREMENTS FOR THE AWARD OF THE DEGREE OF DOCTOR OF
PHILOSOPHY (FOOD, NUTRITION AND DIETETICS) IN THE SCHOOL
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APRIL, 2015

DECLARATION

This thesis is my original work and has not been presented for a degree in any other University or any other award.

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DEDICATION

To our God Almighty, my entire family, more so grand-children: Alma, Nina, Bethel
Zara, Gabriel and Kemuel.

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ABBREVIATIONS AND ACRONYMS

ASL	-	Above Sea Level
SCAO	-	Sub- County Agricultural Officer
SCC	-	Sub-County Commissioner
SCEO	-	Sub-County Education Officer
FAO	-	Food and Agriculture Organization
FGD	-	Focus Group Discussions
FNS	-	Food and Nutrition Security
GOK	-	Government of Kenya
Hb	-	Haemoglobin
Hbc	-	Haemoglobin Concentration
Hct	-	Haematocrit
HH	-	Household
HPES	-	Havard Peer Education Systems
IDA	-	Iron Deficiency Anaemia
ICF/MACRO	-	Inner City Fund MACRO(Large Firm)
IQ	-	Intelligent Quotient
KDHS	-	Kenya Demographic and Health Survey
KEMRI	-	Kenya Medical Research Institute
KHCP	-	Kenya Horticulture Competitiveness Project
KIBHS	-	Kenya Integrated Household and Budget Survey
mg	-	Milligrams
M&E	-	Monitoring and Evaluation
MMWR	-	Morbidity and Mortality Weekly Report
MOA	-	Ministry of Agriculture

MOE	-	Ministry of Education
MOH	-	Ministry of Health
MOP&S	-	Ministry of Public Health and Sanitation
NCHS	-	National Centre for Health Statistics
NE	-	Nutrition Education
NGO	-	Non-Governmental Organization
RBCs	-	Red Blood Cells
RDA	-	Recommended Daily Allowance
RDI	-	Recommended Dietary Intake
SD	-	Standard Deviation
SMC	-	School Management Committee
sTfR	-	Serum Transferrin
UNESCO	-	United Nations Educational, Scientific & Cultural Organization
UNESS	-	UNESCO National Education Support Strategy
UNICEF	-	United Nations Childrens' Education Fund
URTI	-	Upper Respiratory Tract Infection
USAID	-	United States Agency for International Development
WFP	-	World Food Programme
WHO	-	World Health Organisation
4K	-	Kuungana, Kufanya, Kusaidia, Kenya

OPERATIONAL DEFINITION OF TERMS

Anaemic children: Children whose haemoglobin levels is <12g/dl for girls and <13g/dl for boys as defined by WHO (2002) for the reference group.

Bio-availability: The extent to which a nutrient is capable of being absorbed to be utilized within the body.

Dietary modification: The art of changing the routine diet by introducing other foods in addition to the traditional ones, increasing the amounts consumed per person in a meal or serving the usual diet/ meal with foods that will enhance absorption.

Enhancer: Substances that promote the absorption and also bio-availability of micro-nutrients such as vitamin C in iron absorption and are necessary for non-heme iron absorption.

Inhibitors: Are anti- nutrients, which bind and form insoluble compounds with micro-nutrients hindering absorption and thus making these micro-nutrients unavailable for use in the body. Examples include phytates, oxalates and tannins.

Micronutrients: A natural or synthesized vitamin, mineral or trace element required in the body in small amounts that is essential for normal growth, development and maintenance of life and whose deficiency will cause characteristic biochemical or physical changes.

Nutrition education facilitation: A content delivery method used to teach the learners; for this study it was through the researcher, peer and agriculture extension officer facilitation.

Nutrition practice: An adopted way for food selection, preparation, consumption, processing, preservation, hygiene and sanitation for food safety.

Public health measure: An activity aimed at improving the health of a population by preventing diseases, prolonging life or promoting health.

Technologies: Home improvement projects that enhance health and nutrition.

Intervention: It is something that changes the course of something with the intent of modifying the outcome.

Dietary Diversity Score: It is the number of unique foods consumed by the household members over a given period of time and is a useful approach for measuring household food access.

Caregivers/Respondent: Is an unpaid person who helps another with her activities of daily living.

Household head: Is an individual in one family setting who provides actual support and maintenance to one or more individuals who are related to him or her through adoption, blood or marriage.

Project: It is a task requiring considerable effort by pupils' to be able to own it.

ABSTRACT

Anaemia can affect the cognitive function, motor performance and educational achievements of school age children as they grow and learn. Nutrition education has not been given priority in primary schools due to the busy school curriculum. Nutrition Education is concerned with changing an individual's behaviour. It is in this light that this study was designed. The main objective of this study was to evaluate the effects of three main nutrition education facilitators on nutrition knowledge. The facilitators used were the researcher, 5 peer educators and an Agriculture Extension official using the FAO curriculum chart. A baseline survey was conducted in 12 randomly selected schools for 601 class six pupils and 67 households. All pupils' (154) in class six in the intervention schools participated in nutrition knowledge at pre and post-test, with a random sample of 89 proportionate pupils' for each school for biochemical data at baseline and 79 pupils' at endline. Questionnaires and an interview schedule were used to collect data with pre and post tests. Dietary intake, biochemical data on haemoglobin levels and stool among others were assessed. The experimental schools were Mabanda, Kigio and Kirwara and the control Gakurari. Baseline data were analyzed by use of Nutri-Survey software for nutrient analysis and Statistical Package for Social Sciences (SPSS) version 17 for descriptive and inferential statistics. The data were coded to search for emerging themes. This led to the identification of variables and concepts of iron deficiency in the children, which was crucial to the design of the corrective measures model for the interventions. On average, the mean mark in nutrition knowledge at baseline was 30.05% which was low. In the post-tests; all experimental schools significantly improved in nutrition knowledge. The peer facilitated school performed best with (51.52+24.79) marks, researcher facilitated scored (49.67+22.23), and the agriculture staff facilitated scored (39.29+9.87). The pre-test post- test improvement in the control school (29.6+14.0 to 31.21+12.74) was however not significant ($p>0.05$). A total of 31.4 % pupils were found to be anaemic after altitude adjustments at a calculated factor 0.5 for Gatanga altitude (2237m ASL). The prevalence of intestinal parasites was 63.1%; *Entamoeba histolytica* accounted for 61.3% and *Ascaris lumbricoides* 1.8%. Improvement in the adoption and use of the projects that enhance nutrition and health significantly occurred in the experimental schools as opposed to the control school. Pupils' haemoglobin status were not significantly different ($p>0.05$) between the experimental and control schools at baseline. However, notable differences in haemoglobin levels occurred in the experimental schools after the interventions. The relationship between nutrition knowledge and nutrient intake was positive and there was a significant relationship between nutrition knowledge and haemoglobin levels at $p<0.05$ ($r=0.253$, $p=0.025$). Anaemia and parasitic infestation were found to be a significant problem and the need for comprehensive intervention strategies by all stakeholders like deworming and growing of iron rich foods. The study findings would contribute towards operationalization of the national school health policy and guidelines, the national food security and nutrition policy in prevention and control of IDA by enhancing nutrition education.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Iron Deficiency Anaemia (IDA) is a problem of serious public significance and affects more than 2 billion people worldwide. Of this population, 48.1 % are children of school going age (4-14 years) in the developing countries (Kakunted, 2008; WHO, 2002). It is estimated that 53% or 210 million school-age children suffer from IDA. The highest prevalence in school children is reported in Asia at 58.4%, followed by Africa at 49.8% (Nederveen, 2010; www.schoolsandhealth.org, 2013). In young children, IDA may impair physical growth, cognitive development and immunity; while in school-aged children IDA may affect school performance. Overall, global estimates show 46% of school age going children are anaemic (UNICEF, 2008). IDA is the only nutrient deficiency which is also significantly prevalent in industrialized countries (WHO, 2013).

A study by Kaya *et al* (2006) in Turkey had shown prevalence of anaemia among school children by hemoglobin (Hb) concentration to be between 16.3% and 61.1%. Iron deficiency anaemia is a frequent laboratory abnormality in children. As many as 20% of children in the United States and 80% children in the developing countries risk being anaemic at some point by the age of 18 years (Ramzan *et al.*, 2009). Kimiywe (1999) established that 49.6 % of the children in the poorest households in the USA consume less than 100% of RDA for iron.

In developing countries, half of all the young children suffer from anaemia, which is attributed to iron-deficiency. A study done in Cote d'Ivoire by Kakunted (2008)

revealed 50% prevalence of anaemia in school children and women. Iron deficiency anaemia affected 30% of school children in Egypt and was by far the most common nutritional disorder according to a study by Ismail (2004). In another study carried out in Zanzibar on iron status, it was found that 62.3% of children were anaemic (hemoglobin < 110 g/L) and 82.7% of the anaemia was associated with iron deficiency (Stoltzfus *et al.*, 2009). A baseline survey conducted in India by Kapil & Kaur (2007) reported anaemia rates of 57% among elementary school children. The school years are therefore an opportune time to intervene and interventions must be based on sound epidemiological understanding of the problem in this age group (Stoltzfus *et al.*, 2009).

According to data from Ministry of Public Health and Sanitation surveys, at least 33% of Kenyan children are anaemic and that a large number of children are not able to enjoy their right to nutrition (MOPHS, 2012). Unacceptable levels of over-nutrition and under-nutrition in Kenya, including chronic under nutrition and micronutrient deficiencies are responsible for high rates of illnesses and deaths nationally (KNBS, 2010). From the 1999 Kenya national micronutrient survey, iron deficiency was high with 43% of pre-school children and 42% of school going children suffering from iron deficiency. In a study by UNICEF and Ministry of Public Health and Sanitation, the prevalence of anaemia among pre-school children in Kenya stood at 73% and 56% among school-aged children (UNICEF, 2009; MOPHS, 2012). The regional distribution of anaemia among children in Central and Midwest Highlands of Kenya was 8.6-89.5% (UNICEF, 2009). Many children are anaemic due to food insecurity and poverty. Minimal coverage of nutrition content and over emphasis on health education in primary school curriculum is another

contributor of anaemia (Gunde, 2004). Overall, it is the most vulnerable, the poorest and the least educated that are disproportionately affected by iron deficiency (Jukes *et al.*, 2007).

Schools provide a social context in which children learn and develop, thus making schools a desirable environment for nutrition education promotion (Gunde, 2004). Pupils spend over three quarters of the year in the school environment and therefore are in constant contact with the teachers and peers who are their main models. School children are at an exploratory learning stage. This is an opportunity that can be taken advantage of to instil positive behaviour through classroom learning and hands on practical experiences. Habits and attitudes formed in early life are translated into the future adults' lifestyles. It is therefore important that the school environment enable and reinforce healthful eating and healthy behaviours through behavioural focused classroom instruction (Hongo, 2004). The school children stand to gain the most through nutrition education strategies that are developed (WHO, 2007).

Iron deficiency anaemia is frequently exacerbated by infectious diseases such as Malaria, HIV and AIDS and hookworm infestation. Other infections such as tuberculosis are also important factors contributing to the high prevalence of anemia in some areas (MOE, 2007; WHO, 2007; WHO, 2013). Another cause of IDA is dietary intake based mainly on grains that contain anti-nutrients such as phytates that bind iron, and therefore iron is not released in the gastrointestinal tract. The body absorbs only 5% of all the iron in plant food and the rest is excreted by the body (Andang'o *et al.*, 2007). Children, who make up 50% of the total population, suffer varying but significant degrees of ill health, nutritional deficiencies and morbidity

that unequivocally impede effective learning and realization of their full productive potential. The health consequences are devastating, invisibly eroding the development potential of individuals, societies and national economies.

The main strategies for the prevention and control of IDA are nutrient supplementation and food-based strategies of fortification and dietary diversification, deworming, malaria control and nutrition education (Sifri *et al.*, 2002). Nutrition education should target both the pupils and mothers/caregivers and should focus on good eating habits (Kaya *et al.*, 2006). In view of these facts this study was aimed at determining the iron status of the pupils and designing a viable model for intervention to mitigate against IDA through nutrition education.

1.2 Statement of the Problem

In developing countries, school-age children are often a neglected group in terms of micronutrient interventions. This is because they are not reached by the intervention strategies targeted at preschool children (Gunde, 2004). From Ministry of Education reports, school children face many health challenges such as, pneumonia, malaria, measles, micro- and macronutrient deficiencies. Since these young children frequently suffer one or several of these problems concurrently, health and nutritional programmes focusing on this age group are extremely valid. Iron deficiency renders children restless, in-attentive and uninterested in learning (MOE, 2007). Over 33% of children in Kenya are already intellectually compromised by permanent brain damage caused by lack of the necessary micro-nutrients, short-term hunger and anaemia (Kigotho, 2009). School feeding programmes in Kenya only target the Arid and Semi Arid Lands (ASAL) forgetting the other areas which are

said to be high potential but are equally experiencing food poverty due to scarcity of land (Lannginger, 2011). School-based programmes can directly use peer pressure by harnessing its power to reinforce healthy eating habits (MMWR, 1996). At present, education systems in Kenya at various levels do not transfer adequate nutrition knowledge aimed at influencing life-long dietary practices. Improving nutrition will require enhancing knowledge, awareness and practices of all stakeholders and of the general public (MOA, 2007).

Boys and girls need support as they enter puberty to understand the importance of nutrition and health especially the role of iron as a micro-nutrient (MOE, 2009a). Since nutrition education is concerned with changing an individual's behaviour, it would be worthwhile to use different change agents including pupils as a vehicle also to change. Primary schools are particularly suitable vehicles for nutrition education because nutrition education is necessary for children whose habits are still being formed in order to change them for better nutritional practices (FAO, 2005b). The various extension agents, researchers and communities should work hand in hand with these children in addressing malnutrition. However, the methods employed in content delivery and dissemination must be appropriate and acceptable socially and culturally to the target audience.

Some of the objectives of the Kenya National Nutrition Plan of Action (2011-2017) are to improve knowledge, attitudes and practices on optimal nutrition, improve nutrition in schools and reduce the prevalence of micronutrient deficiencies in the population. One of the Ministry of public health and sanitation strategic issue is

premised on the recognition of information as a precursor to adoption of positive attitude and hence, practices about optimal nutrition by Kenyans. This is realized through development, dissemination and implementation of a National Nutrition Information, Education and Communication/Behaviour Change Communication. This strategic issue contributes to improved nutrition practices in the lifespan (MOPHS, 2011).

Although nutrition information and action are present in all relevant government sectors including agriculture, education, water and health, nutrition education is not adequately prioritized. Consequently, resources dedicated to nutrition are limited, leading to low impact of nutrition interventions in schools. Generally, there is low understanding of linkage between national food security, basic education and water and sanitation strategies on one hand and nutrition on the other. Further, programme strategies are vertical in nature and lack nutrition as an outcome indicator. The food security and nutrition and school health policies and guidelines, recognize the importance of involving stakeholders in the reduction of malnutrition in school children (MOPHS/ MOE, 2009; MOA, 2012).

Gatanga Sub-County is a coffee growing area with highly sub-divided parcels of land whereby very little land is left for food crop production. Coffee payments are also irregular and hence many farmers are not well endowed with the necessary food resources. Due to over cultivation, the soils have become very poor resulting in low yields. Increased population and fragmentation of farming land has been an issue to most households. Over dependence on erratic rains for agricultural production and

low uptake of modern food production technologies has also worsened the situation resulting in poor crop harvests and therefore affecting food adequacy and diversity. This may compromise the nutritional status of the population. The poverty levels in Muranga County stood at 36.6% (MOA, 2009a).

According to Thika Sub-county Health Services Annual Report (2008), a high burden of anaemia exists among children of all ages and is ranked number eleven among diseases causing morbidity (MOH, 2009). The health consequences are devastating, invisibly eroding the development potential of individuals, societies and national economies. This need not be so because solutions are available and known (WHO, 2007). The stakeholders who were supportive in the study were, the Ministry of health, Agriculture, Education, Provincial administration and a Non-governmental organisation (YARD). Iron deficiency anaemia can compromise school pupils learning capacity.

1.3 Purpose of the Study

The purpose of the study was twofold. First, it was to determine the demographic and socio-economic state of pupils' households, health and nutrition status of school children and level of dietary intake of iron rich foods among children through a participatory baseline survey. Secondly, it was to design and implement a viable model for intervention to promote and intensify the consumption of iron rich foods such as local vegetables and small livestock in-order to improve the iron status of the children. An impact assessment was undertaken after the intervention to measure the impact of the intervention.

1.4 Objectives of the Study

1.4.1 Broad Objective

The broad objective of the study was to evaluate the effects of three Nutrition Education facilitations on iron status of primary school pupils in Gatanga Coffee growing zone primary schools. The facilitators included; Participatory peer-, Researcher and Agriculture extension officer in nutrition education intervention on iron status, knowledge, skills and acceptability of modified local foods among primary school children in Gatanga Sub-County.

1.4.2. Specific Objectives

Phase 1: Baseline Survey

Objectives for the baseline survey were to;

1. Assess the level of nutrition knowledge, attitude and practice of pupils of the 12 baseline primary schools in the coffee growing area of Gatanga Sub-County.
2. Determine the demographic and socio-economic characteristics of pupils' households in the coffee growing area of Gatanga Sub-County.
3. Establish the health and sanitation practices of the primary schools and pupils' households in the coffee growing area of Gatanga Sub-County.
4. Identify the projects available that enhance nutrition and health of primary school pupils in the coffee growing area of Gatanga Sub-County.
5. Determine pupils' household food consumption patterns and preference in the coffee growing area of Gatanga Sub-County.

6. Determine before intervention the nutrition knowledge, dietary iron intake, technologies available, worm infestations, hemoglobin levels, and malaria status of pupils of the intervention schools in coffee growing area of Gatanga Sub-County.

Objectives for intervention study were to;

1. Determine after intervention the status of nutrition knowledge, dietary iron intake, technologies adopted, worm infestation, hemoglobin, and malaria status of study pupils of the coffee growing area of Gatanga Sub-County.
2. Assess the impact of the three nutrition education facilitators namely; peer, Researcher and Agriculture extension officer facilitated nutrition education intervention on acquisition of nutrition knowledge among the study pupils compared to the controls in the coffee growing area of Gatanga Sub-county.
3. Assess the effectiveness of the different nutrition education facilitations among the study pupils compared to the controls in the coffee growing area of Gatanga Sub-county.
4. Establish the relationship among variables: - nutrition knowledge, consumption of iron rich foods and the iron status of primary school children across the three nutrition education facilitations.

1.5. Hypotheses

The hypotheses were:

H₀₁. There is no significant difference between pupils' nutritional knowledge in the experimental schools across the three nutrition education facilitations and the control school in Gatanga Sub-County.

H02. There is no significant difference between pupils' iron status in the experimental schools across the three nutrition education facilitations compared to the control schools in Gatanga Sub-County.

H03. There is no significant relationship between pupils' nutrition knowledge and the consumption of iron rich foods in the experimental schools (Kirwara, Kigio, Mabanda) across the three nutrition education facilitations compared to the control school (Gakurari) in the coffee growing area of Gatanga Sub-County.

1.6 Significance of the Study

The findings of the study will contribute towards the operationalization of the National School Health Policy and Guidelines and also the National Food Security and Nutrition Policy in prevention and control of micro-nutrient malnutrition through enhancing Nutrition Education in schools as they are being implemented by all stakeholders. The findings of the study will benefit other areas experiencing similar problems by informing them to concert efforts with other stakeholders to solve the problems. It will also benefit various organizations that develop policies such as the Ministry of Education, Ministry of public Health and Sanitation, private health institutions, Ministry of Agriculture, and Non-Governmental Organizations, such as, Micronutrient Initiative (MI) and community based organizations. The organisations are involved in nutrition education and other community development programmes such as planning intervention programmes that help school children understand causes, effects, consequences and solutions to iron deficiency anaemia. The study will contribute to the existing knowledge regarding anaemia among this age group and also benefit other researchers.

1.7 Delimitations of the Study

The study was carried out in Gatanga Sub-County and covered class six (6) pupils. The pupils were chosen because this is a critical time in their development both age wise (11-14 years) and class wise as they enter puberty to understand micronutrient malnutrition and how to solve it. From age 11 upwards (the “formal operations” stage), terms such as “nutrients” are understood by the pupils. Food choices and their consequences are not only linked to beliefs and values, but also to taste.

Children learn more about their own eating habits, what influences their choices and how to evaluate their own eating habits. Eventually they consciously adopt healthy eating habits as part of a lifestyle. They are able to recognize what it is within them (internal pressures) and in the outside world (external pressures) that makes it difficult to follow a lifestyle. At this age, they are also able to understand the effects of their choices on their health, as well as that of their family, community and the environment. We worked with these pupils, teachers and their parents during a nine month research period, equivalent to one school calendar year.

1.8 Limitation of the Study

The study took 3 school terms of three months each and was limited to only one Sub-county of Muranga County namely Gatanga Sub-County. Nutrition education lessons were only implemented after classes when extra-curricular clubs undertook their extra-curricular activities and during the holidays. This at times over-lapped with the school’s planned activities hence was adjusted accordingly to fit into the schools’ programme. Home follow-ups took place over the weekends, public holidays and

during school holidays of August and April in the year 2012 to avoid interfering with the pupils' schooling.

1.9 Conceptual Frame Work

The study was based on a conceptual frame work adopted from WFP/UNICEF (2006). It highlights the contributing factors to healthy growth of children in society as shown in Figure 1.1.

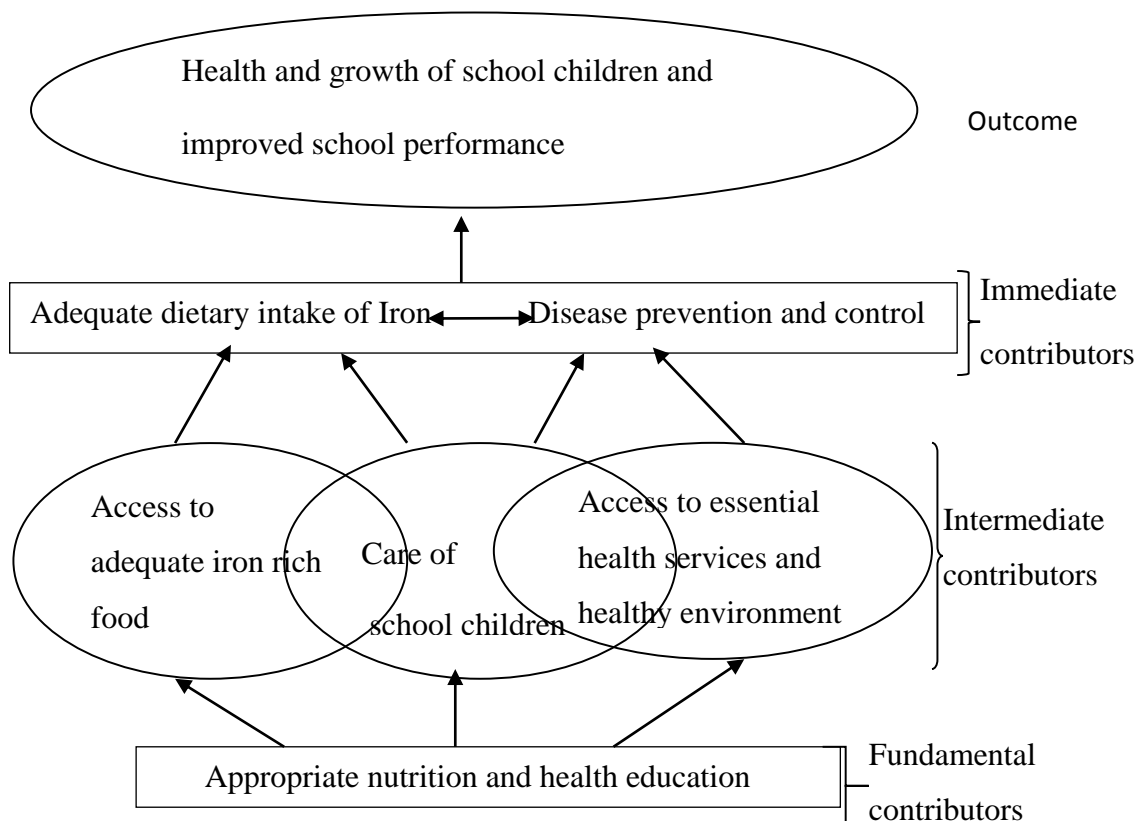


Figure 1.1: Factors Contributing to Healthy Growth of Children in Society

Adopted and modified from WFP/UNICEF (2006).

The model illustrates key factors that contribute to a child's health and growth. Fundamentally, a child's growth and health are affected by the political, economic, social and cultural environment in which he or she lives. The environment affects how effectively and equitably resources are used to ensure a population's access to food, health and care. The conceptual framework recognises that human and

environmental resources, economic systems and political and ideological factors are basic causes that contribute to malnutrition. Education, especially in nutrition and health affects a community's and child's food selection and their care.

This model relates the causal factors for under-nutrition with different social-organisational levels. The immediate causes affect individuals, the underlying causes relate to families while the basic causes are related to the community and the nation. As a result, the more indirect the causes are, the wider the population whose nutritional status is affected. Issues of household food security, family care and feeding practices, clean water, environmental sanitation and health care all need to be addressed to ensure good nutrition (WFP/UNICEF, 2006). According to this framework, malnutrition occurs when dietary intake is inadequate and health is unsatisfactory. The framework promotes an inter-disciplinary approach to ensuring food and nutrition security.

This study was aimed at using three nutrition education facilitations namely; Peer, Researcher, and Agriculture extension officer facilitated nutrition education intervention to address iron deficiency anaemia while interacting with various related stakeholders. The stakeholders included: parents, teachers, agriculture staff, the Ministry of Education, the Ministry of Public Health and Sanitation, the Ministry of Health and a local NGO and Local Administration. The study was aimed at linking the resources of the health, NGO, local administration, agriculture, education, Public health and sanitation sectors in an existing infrastructure: the school. School-based nutrition education can improve dietary practices that affect a young person's ' health, growth and intellectual development due to reduced IDA.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview of Iron Deficiency Anaemia

Iron is a micronutrient that is required in the tissues of the body for basic cellular functions and is critically important in the muscle, brain and red blood cells. Iron is a component in many proteins including enzymes and haemoglobin, the latter being important for the transport of oxygen to tissues throughout the body. School children are dramatically affected by anaemia and parasitic infections with adverse impact on their nutritional status as well as on their cognitive development and school performance. Unfortunately, the paucity of nutrition information on this vulnerable population makes it difficult to define appropriate intervention strategies. Demographic and Health Surveys which provide nutritional status data at national level do not include school children (Dabone *et al.*, 2011).

Nearly 30% of Kenyan children (1.8 million children) are classified as undernourished and micro-nutrient deficiencies are widespread (GOK, 2012). Iron deficiency emerges as an important condition among non target groups with the prevalence of the deficiency among adolescents in refugee camps estimated at 46% and 21.1% among school girls in western Kenya (MOPHS, 2011). Iron deficiency anemia is characterized by low levels of haemoglobin in combination with abnormal levels of other iron indicators such as transferrin saturation (i.e. iron stores). IDA can lead to weakness, poor physical growth, increased morbidity, impaired cognitive performance and delayed psychomotor development. In particular, iron deficiencies early in life are thought to potentially inhibit the function of neurotransmitters, thus compromising brain function (Bobonis *et al.*, 2004). Impaired gastrointestinal

function, altered patterns of hormone and metabolism and reduced DNA replication and repairs have also been noted as other consequences of iron deficiency anaemia (Kakunted, 2008). Anaemia is simple to measure and has been used as a marker of iron deficiency severe enough to affect tissue functions. However, iron deficiency is not the sole cause of anaemia in most populations. Even in an individual, anaemia may be caused by multiple factors such as food access and health status (Gunde, 2004).

2.2 Iron Status of School Children, Demographic and Socio Economic Factors

Iron deficiency anaemia affects both sexes of pupils equally at primary school age (Ramzan *et al.*, 2009). Iron deficiency anaemia arises from a combination of several factors such as economic, cultural and religious constraints (Nair, 2001). The basic cause of iron deficiency anaemia is poverty. Anaemia is the number one nutritional problem at school age. In a study carried out in Ouagadougou, Burkina Faso, it was observed that several school children stayed at school during lunchtime. This is because they did not have pocket money to buy any street food or did not have enough pocket money to eat an adequate meal. This may have played a role in the observed prevalence of micronutrient deficiencies noted in school children of Ouagadougou (Dabone *et al.*, 2011).

Lack of access to food due to poverty is one of the major underlying causes of malnutrition. There is a strong correlation between national product and the level of malnutrition. The poor strata in developing countries have a lack of purchasing power and spend a large percentage of their income on staple food. Animal products and fruits that are important sources of micro-nutrients are often more expensive and

unaffordable (Ramakrishnan *et al.*, 2008). Similar to other types of undernutrition, iron deficiency is usually prevalent in resource poor areas. Overall, it is the most vulnerable, the poorest and the least educated that are disproportionately affected by iron deficiency and they stand to gain the most by its reduction (WHO, 2013).

The prevalence of iron deficiency in Malaysian rural school children, who come from low-income households, was found to be as high as 50%. There are communities whereby food choice is a problem due to religious beliefs in combination with poverty. In India, poverty and religious beliefs preclude adequate intake of micronutrient containing foods such as meat and poultry products (Bhutta & Dewraj, 2007). Other factors associated with Iron deficiency anaemia include family size and a mother's iron status and is associated with a two-fold increase in childhood anaemia (MOPHS/UNICEF, 1999).

2.3 Iron Status, Infestations and Infectious Diseases

Infectious diseases and parasitic infestations are important contributors of IDA. Iron deficiency is caused by increased losses from hookworm infestation, increased destruction and dyserythropoiesis from malaria and the haemoglobinopathies (Sandoval, 2013; WHO, 2013). Intestinal protozoa and faeco-oral transmitted helminths constitute major health problems especially in the tropical and sub-tropical region. About 350 hookworms in the intestines can cause a loss of 10ml of blood daily, equivalent to 2mg of iron. The WHO estimates that over one billion of world's population is chronically infested with soil-transmitted helminthes and 200 million are infested with schistosomes. This is closely correlated with poverty, poor environmental hygiene and impoverished health services. Intestinal helminth

infestations are common among school age children. The helminthic infestations lead to nutritional deficiencies and impaired physical development which may have negative consequences on cognitive function and learning ability (Chandrashekhar *et al.*, 2005). An average IQ loss per worm infection is 3.75 points (Guiney, 2010). Amoebas generally have a two phase lifecycle: the infective dormant cyst and trophozoite, a later one which is motile and active. The trophozoite penetrates through intestinal lining and invades the liver, lungs, brain, and heart. Subclinical symptoms include upper-right quadrant pain, cramps, occasional nausea and loose stool. In more serious cases, pronounced abdominal distention, dysentery, fever and hepatitis may result. Extreme infection can cause abscesses in the liver, the lungs and the brain. Chronic diarrhoea, gas and massive food and environmental allergies have been reported when amoebas are found in the system (www.innvista.com, 2012). In addition, malaria infection and diarrhoea have been associated with a two-fold increase in childhood anaemia (UNICEF, 2009).

In a study undertaken in primary schools all over Kenya, malaria prevalence was found to markedly vary by school and by province between 0-70.9% (Gitonga *et al.*, 2010). Malaria prevalence was highest in Western Province (21.6%) and lowest in Central and North Eastern provinces, where no child was found to be infected. In the same study, it was found 2.3% of the schools had more than 40% parasite prevalence. The schools with high parasite prevalence were located around Lake Victoria. The same authors reported anaemia prevalence of 14.1% and a mean haemoglobin concentration of 128.8 g/L with anaemia being more common among children aged 15 years and above (38.6%) than among children aged 10-14 years (14.9%). There was no difference in prevalence of anaemia among males and females (13.3% for

both sexes). Anaemia varied markedly by school (0-75%) and was highest in Coast Province and least common in Central Province (Gitonga *et al.*, 2010).

A study by Ullah *et al* (2009) revealed that intestinal helminthiasis was common among children in developing countries particularly rural areas. Infections causing chronic blood loss such as infestation with hookworm, malaria, *Amoeba histolytica*, viral and bacterial infections interfere with food intake, absorption, storage and use of nutrients like iron. A study in Thika, by Ngonjo *et al* (2012) showed that intestinal parasites were prevalent in varying magnitude among school children in Thika district in Central Kenya. In the study, prevalence in the different schools varied with the rural and slum school having the same worm prevalence (48.9%) and high overall prevalence of protozoa infection (37.8%). Repeated episodes of infection may thus contribute to the development of iron deficiency and anaemia and complicate micronutrient treatment (Munasinghe and Broeke, 2005).

2.4 Iron Status and Dietary Intake

Iron deficiency may, however occur throughout the lifespan where diets mainly consist staple foods and little of animal products. The cause is a one-sided diet based mainly on grains. These contain phytates, substances which bind the nutrient iron from plant sources as insoluble salts (Andang'o *et al.*, 2007). In Kenyan households, studies have been undertaken and diets are mainly cereal-based with tubers and a variety of vegetables and fruits when available. White maize, sorghum and millet are high in phytate and fiber, which inhibit the absorption of micronutrients such as zinc and iron. Communities growing cash crops such as coffee have little land for food crops. Although households may own cattle, goats and poultry, these are not

commonly consumed but sold in order to earn income. In addition, products of these animals are sold to earn income (Bwibo & Neumann, 2003).

There are multiple sources of dietary iron including heme and non-heme iron, contamination iron and fortification iron. Heme iron is usually of animal origin and of high bio-availability with sources including meat, fish and blood products. Dietary intake of heme iron is negligible in developing countries while iron status and health status (infection, mal-absorption) are the host factors influencing iron absorption (Ramzan *et al.*, 2009). Iron deficiency could also be due to inadequate folic acid, riboflavin, copper, vitamin A, & B₁₂ and zinc intake (WHO, 2005). Micronutrients such as vitamin A, zinc and iron interact with each other to promote appetite which leads to increased food intake and intake of other macro-nutrients and micro-nutrients (Ramakrishnan *et al.*, 2008).

According to Gunde (2004) in a study in Egypt, it was revealed that teachers perceived that the unhealthy feeding habits of the school children especially lack of breakfast, affected the interaction between the school children and the teachers. Food security coupled with nutrition education is an important factor that should be considered and addressed in tackling malnutrition (Mbithe *et al.*, 2008). In Kenya, school feeding programs have not been implemented in high potential areas with success (Langinger, 2011).

2.4.1 Food Sources

Children require iron for their expanding red cell mass and growing body tissue. In

addition, iron is needed in increased amounts by girls as they begin to menstruate. Children have lower total energy requirements and therefore eat less and thus at a greater risk of developing iron deficiency, especially if their dietary iron is of low bio-availability (WHO, 2007). The best food sources of easily absorbed iron are animal products which provide heme iron. Vegetables, fruits, grains and supplements provide non-heme iron which is of low bio-availability.

Food sources of high bioavailability iron include liver, lean red meat (especially beef), poultry, fish, iron fortified cereals, dried fruits and dark leafy green vegetables. Reasonable amounts of iron are also found in lamb and pork. Non-heme iron is found in whole grains such as wheat, millet, oats and brown rice; legumes (beans, *dolicos lablab*, soybeans and peas); dried fruits (prunes, raisins, and apricots); vegetables (broccoli, spinach, kale, beetroots, collards) (www.4collegewomen.com, 2007). Meat, fish, poultry, ascorbic acid (vitamin C) and organic acids are all thought to enhance non-heme iron absorption (Reddy *et al.*, 2006). Tea, coffee, phytates (storage form of phosphate and minerals) and calcium hinder the absorption of non-heme iron and may contribute to the overall lower bioavailability of non-heme iron compared with heme iron (Reicks, 2006).

2.4.2 Individual Dietary Diversity Score

Individual dietary diversity scores aim to reflect nutrient adequacy. Studies in different age groups have shown that an increase in individual dietary diversity score is related to increased nutrient adequacy of the diet. Dietary diversity for age/sex groups are proxy measures for macro and/or micronutrient adequacy of the diet. Scores have been positively correlated with adequate micronutrient density of foods for children, adolescents and adults (FAO, 2013a).

For young children, greater dietary diversity has been found to be associated with nutritionally adequate diets which meet energy and micro-nutrient needs (UNICEF, 2005). One of the many nutrition challenges facing Kenyans is having adequate food of sufficient diversity to meet nutrient needs. Even where households have adequate access to food, many family diets reflect inappropriate choices of the dominant foods that in turn, lead to nutrition related disorders (MOA, 2007). Dietary diversity scores can be used to assess changes in diet before and after an intervention. Indicators for special food groups can be created at population level. For example, it is useful at individual level to include indicators on percentage of individuals consuming food groups that are good sources of micronutrient, like iron which can be calculated and expressed in percentages. In general, if there are low percentages of individuals or households consuming iron as a micronutrient on a given day, it may be indicative of seriously inadequate diets that lead to morbidity related to iron deficiency (FAO, 2013a).

2.4.3 Food Guide Pyramid for Meal Planning and RDA

The food guide pyramid is an excellent tool to help make healthy food choices. It assists in selection of foods in order to provide the body with nutrients needed and at the same time the right amounts of calories to maintain a healthy weight. The food guide pyramid is used for food servings and meal plans. The food guide will assist one to organize foods according to the energy and nutrients that they supply, so that the prepared meals are balanced and nutritious. The food guide illustrates how foods should be selected and indicates the foods that should be eaten more (at the base of the food guide), moderately and generously (center) and in small amounts (at the top of the food guide). The food guide also recommends consumption of a minimum of 8

glasses of clean safe water per person per day. It serves as a general guide that lets one choose a healthy diet that is right for them with adequate macronutrients and micronutrients (MOA, 2009b; USAID, 2013). Figure 2.1 shows a food guide pyramid.

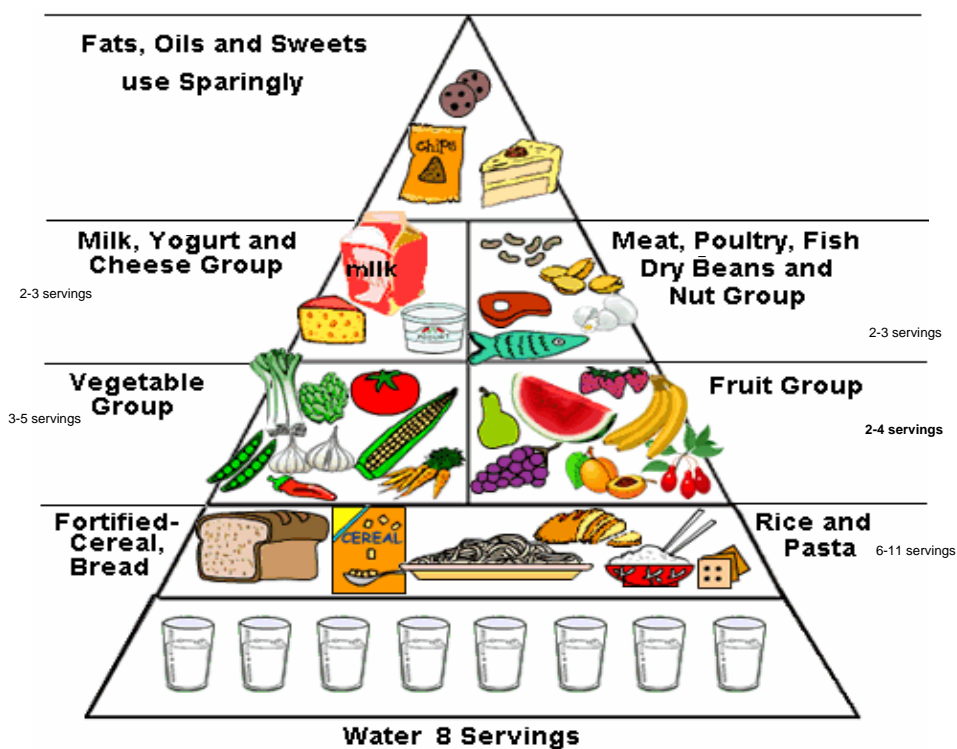


Figure 2.1: The Food Guide Pyramid, Source: MOA 2009b

The Recommended Dietary Allowance for Iron is, 8-13 mg for 10-18 years old pre-adolescent and adolescent children both girls and boys (UNICEF, 2008). An average school lunch must contain at least 3mg of iron in primary schools (www.schoolfoodtrust.org.uk, 2012). A modification of culturally acceptable foods to include iron-rich foods may provide a sustainable approach to controlling and

preventing iron deficiency in the population of school aged children (Duncan and Mcdade, 2006).

2.5. Development and Indicators of Iron Deficiency Anaemia

The World Health Organization identifies haemoglobin levels $< 12\text{g/dl}$ of blood for girls and $< 13\text{mg/dl}$ of blood for boys of school age 10-18 years as being anaemic (Mayo, 2011 and WHO, 2008). The degree of anaemia is grouped as severe ($<7\text{g/dl}$), moderate ($7\text{-}10\text{g/dl}$) and mild ($10\text{-}12\text{ g/dl}$). The WHO has suggested haemoglobin $< 12\text{g/dl}$ for girls ages 11 and above and $< 13\text{g/dl}$ for boys to be anaemic while $12\text{-}16\text{g/dl}$ and $13\text{-}16\text{g/dl}$ for girls and boys respectively of ages 11-18 years is normal (WHO, 2008 and Sangeetha *et al.*, 2010). Half of the iron (50%) in the body is present in the red blood cells in form of haemoglobin. In the absence of acute hemolysis and frank blood losses, development of IDA takes an insidious stage wise progression (Table 2.1). Iron stores in form of hemosiderin and ferritin progressively diminish and no longer meet the needs of normal iron turnover (WHO, 2002). Table 2.1 shows the biochemical indicators of progressive development of IDA.

Table 2.1: Biochemical Indicators of Progressive Development of IDA

Indices of iron status	Early stage: (depleted iron stores)	Intermediate Stage: (iron deficiency without anaemia)	Late Stage: (iron deficiency anaemia)
↓ Serum ferritin	-----	-----	-----▶
↓ Transferrin saturation		-----	-----▶
↑ Transferrin receptor		-----	-----▶
↑ Erythrocyte protophorphyrin		-----	-----▶
↓ Haemoglobin			-----▶
↓ Mean corpuscular volume			-----▶

Key: Elevated ↓ Depressed ↑

Source: WHO, 2002.

Functionally, the lack of mobilizable iron stores will eventually cause a detectable change in classical laboratory tests, including measurement of haemoglobin, mean corpuscular haemoglobin concentration, mean corpuscular volume, total iron-binding capacity, transferrin saturation and zinc-erythrocyte protoporphyrin (WHO, 2002).

In the early stages (pre-latent phase), depletion of iron stores takes place and serum ferritin is a reliable marker of depleted depot iron as well as iron overloads. An intermediate phase that is characterized by diminished transport iron, unsaturated transferrin and iron deficit erythropoiesis (latent phase) follows the transport system. However, sTfR (serum transferrin) levels could be affected by haemolytic anaemia, polycythaemia, haemoglobinopathies, aplastic anaemia and chronic renal failure. The late stage of IDA is characterized by decreased haemoglobin production and mean corpuscular volume (MCV) that manifests in microcytic and hypochromic red cells. Since low haemoglobin concentration characterizes the final stage, it is realistic to base large scale surveys on haemoglobin measurements as an indicator of absolute (storage) depletion (MOPHS/UNICEF, 1999). The haemoglobin estimations cutoffs are more reliable in diagnosing anaemia than the haemocrit (hct) and therefore recommended for screening large population (Kaya *et al.*, 2006).

The prevalence of anaemia, defined by low haemoglobin or haemocrit, is commonly used to assess the severity of iron deficiency in a population. Iron deficiency occurs when iron stores are exhausted and the supply of iron to tissues is compromised. Anaemia is a severe stage of iron deficiency in which hemoglobin or hematocrit levels fall below the percentage levels recommended by WHO. Table 2.2 describes the criteria for assessing the public health severity of anaemia in any population.

Table 2.2: Criteria for Assessing the Public Health Severity of Anaemia in Any Population

Severity of Anaemia as a Public Health Problem	Prevalence (% of the anaemic in any population)
None	- < 4.9
Mild	- 5.0-19.9
Moderate	- 20.0-39.9
Severity	- > 40

Source: MOPHS, 2008

2.6 Nutrition Knowledge, Attitude and Practices of School Children

Nutrition Knowledge

Improving health and nutrition brings greatest benefits to the poor and the most vulnerable especially school going children. According to a Food and Agriculture Organization report (FAO, 2013a), it is important to incorporate nutrition and health education into the curriculum of primary education which considers priority nutrition issues affecting children and their families in the country. It is also coherent with the national health and nutrition policy. Children may reject food, however healthy, because it is strange, unfamiliar, “poor” or because they want to be thin. They may accept it, however unhealthy, because it has status, is eaten by admired peers or role-models or above all, it is what they regard as normal (FAO, 2005b). Children are eager to learn, are role models for their peers and schools can stimulate and support children to develop skills and knowledge to face daily challenges now and in the future (Guiney, 2010).

By incorporating food and nutrition education into the curriculum of primary education in Argentina, there was improvement of school age children's health and nutritional status and better school performance. Nutrition education was not incorporated systematically in the primary school curriculum in Argentina. Existing

initiatives to teach nutrition in primary schools were sporadic with limited coverage and had also not been evaluated. The main factors that limited the full implementation of nutrition education in schools were: lack of trained nutrition teachers, lack of appropriate educational materials for teachers and children and few opportunities for children to practice good nutritional habits. There was need for review of the nutrition education contents in the National Primary School Curriculum and recommendations on the need to include or enhance the education contents on food and nutrition, including the development of new educational materials in this area (FAO, 2013b).

In Kenya, the same trend has been observed such that nutrition is integrated into science or other subjects; as such children do not realize how important it is to their health (MOE, 2009a). In a study in Zambia in the year 2005, successful health-related interventions in project schools which included annual treatment for intestinal worms and schistosomiasis, annual vitamin A, iron supplementation and health education were successful (Freund, Graybill and Keith, 2005).

A family's knowledge, attitudes, beliefs and practices have important effects on the nutrition, health, and psychosocial condition of their children. Constricted by economic factors, parents make decisions about feeding and diet, preventive and curative health care and about the frequency and quality of psychosocial interactions they will have with their children. Knowledge is necessary for practice of proper hygiene and good nutrition in the school environment and households. Practices like hand-washing, use of soap and drying of utensils in the sun are necessary to prevent transmissible diseases (Vivas *et al.*, 2011).

Most health problems are directly or indirectly associated with the quality of water and environmental sanitation. Most illnesses could be associated with personal hygiene and sanitation of the pupils. Provision of leaky tins, dish-racks and energy saving devices are methodologies that promote health and can be used to mitigate against diseases. Without adequate nutrition, health and hygienic education, school nutrition programme seem to be less effective (Taylor, 2011). Freund *et al* (2005), in their study in Zambia reported that little was actually known about health and nutrition of children from 6-15 years and much still remains to be learned. Research now shows that risk of poor health continues throughout childhood and children's health status especially of girls, which actually worsens from age 5-15 years. Carefully monitored school programs in health and nutrition have shown that stunting continues to occur during the school years and that this stunting can be reversed by appropriate health and nutrition interventions.

Hygienic Practices

In Kenya, the likelihood of faecal contamination of the school environment is high because many schools have few latrines, inadequate water supplies, poor quality of available water sources, water storage in containers that permit hands to touch and contaminate stored water and lack of hand-washing facilities (MOE, 2009a). Besides impacting on school attendance, the resulting burden of diarrhoeal diseases and parasitic infestations has a negative impact on students' growth, nutritional status, physical activities, cognition, concentration and school performance (O'reilly *et al.*, 2006). There is a need to design novel strategies for preventive interventions that could allow inclusion of school children as well as adults in an effort to reduce force of infection and re-infection in high endemic communities even where there are

school deworming programmes (Njenga *et al.*, 2011). Compared to adults, children can easily change their behaviour as a result of increased knowledge and facilitated practices and also as role models for their peers (Guiney, 2010).

In their study, Freund *et al* (2005) reported that, none of the worms multiply in the human body, but their eggs are expelled either through faeces (intestinal worms) onto the soil or through urine and faeces (schistosomiasis) into bodies of water. This means that killing large portions of the worm infestation in children prevents the eggs from being disbursed, thus slowing the reproduction and spread of the worms in the entire community. When school children in Kenya were treated, untreated adults in the community showed reduced worm load and prevalence because of the reduced opportunities for the worms to go through their complete life cycle, exposing fewer community members to infection (Freund *et al.*, 2005). This spillover effect led to reduced pupil absenteeism in untreated neighbouring schools by 3.4 percent. Improved knowledge on practices that reduce worm re-infection can reduce incidences of malnutrition (Freund *et al.*, 2005).

Agronomic and Small Livestock Production Practices

Poorer households have less land, produced less food; have less food storage and little purchasing power (Bwibo & Newmann, 2003). Intervention measures that promote green leafy vegetable production and small livestock production should be embraced to enhance consumption of micronutrient rich foods. School-based gardening programmes can be an excellent means of introducing new ideas about gardening and a useful channel for reaching others in the community and hence promoting consumption of the vegetables and other iron rich foods (FAO, 2005b).

Gardening also promotes agriculture as a dignified and important vocation, increases the knowledge and use of best practices in farming and increases the quantity and quality of available food. Unfortunately, young people often have a poor opinion of agricultural work. Moreover, agriculture is not taught as a school subject in primary schools in Kenya and many students do not take it seriously since they consider it a financially and morally impoverishing vocation. Hence the importance of introducing it to the young primary school pupils when their habits are being formed. This study sought to use three nutrition education facilitators to address iron deficiency anaemia among school children in the coffee growing area of Gatanga Sub-County, Muranga County.

In Nepal, through Agriculture in Schools, students ages 10-14 and their teachers received training in best practices; including compost-making, proper sowing and cultivation e.t.c. Participants learned to appreciate the great importance and dignity of agricultural work. A school agricultural programme provided the resources to establish a model farm on each school's grounds; participants carried out the work, from tilling and digging of compost pits to final harvest. Students also passed knowledge along to their farming families (Lyons, 2013).

2.7 Iron Status, Nutrition Knowledge, Attitudes and Practices

The main strategies for the prevention and control of micronutrient deficiencies are; supplementation and food-based strategies of fortification and dietary diversification, combined with nutrition education. All of the approaches are necessary, but insufficient on their own.

Nutrition education by all stakeholders including deworming and malaria control in the interventions can greatly improve the nutritional status of populations (Sifri *et al.*, 2002). Food-based strategies are an essential component of a long-term global strategy for the control of micronutrient malnutrition.

Nutrition education engages in establishing existing levels of nutrition knowledge, attitudes and practices. In a study by Amani and Soflaei (2006), it was found out that nutrition education can improve knowledge of healthy nutrition and lifestyle choices. Focused nutritional education using available resources and correcting current dietary habits in a vulnerable group of adolescent girls resulted in dietary changes and practises that ultimately improved iron intake. In another study by Kapur *et al* (2003), they reported that nutrition education did have a positive effect on the iron status possibly by improving the dietary iron intake. The study also concluded that long-term community-based approaches involving dietary education emphasizing optimum feeding schedules and adequate diets for children may possibly reduce the risk of anaemia and raise iron status.

In most communities in Kenya, food beliefs, preferences and habits of the whole family are usually passed on from one generation to another and thus become customs or traditions. They thus dictate how the community or family select and prepare their foods. However, without knowing, some of these practices are what lead to poor nutrition and health problems in the first place. School-based approaches will accord the children the excellent chance to practically participate in the Nutrition Education programme, food selection, preparation and consumption as well as understanding why good nutrition is important (Hongo, 2004). Nutrition education

and promoting good nutrition practices in schools are known to have a significant effect in fostering healthy eating habits (MOA, 2007).

2.8 Nutrition Education, Iron Rich Food Consumption and Iron Status Outcomes

The pressures from population growth and poverty contribute to severe malnutrition and continue to affect nearly half of the world's population. Also alarming is that an 18 percent rise in the number of malnourished children is projected for Africa by 2020. Over 2 billion people suffer from malnutrition in their diets, including protein-calorie deficiencies and micronutrient malnutrition like iron deficiency anaemia. Such malnutrition prevents much of the world's population from reaching their full potential - mentally, physically or financially (GOK, 2012).

Dietary intervention may be a safer and more feasible solution to address iron deficiency anaemia in the long run compared to other strategies like supplementation. This intervention requires nutrition education to improve knowledge and practices that support healthy outcomes. Integrated rural nutrition projects and nutrition education have a significant impact on knowledge and attitudes leading to long-term beneficial health effects than activities that only aim at increasing food availability. Nutrition education is therefore a viable, sustainable solution in resource limited setting (Kakunted, 2008). In a study by Kapur *et al* (2003) in a population group in India, where, the iron and nutritional status was highly compromised, nutrition education intervention was effective, as it improved the dietary iron intake and prevented the children from suffering the sharp decline in iron status noted in the control group.

The physical growth of school children is mainly the result of environmental and genetic factors and their interaction. In population groups that have experienced constraints to economic and social development, most of the factors affecting school children are related to environmental factors experienced before puberty, including poor food consumption patterns, illness, lack of good sanitation, poor health and hygiene practices (WHO, 2001).

The influence of school goes beyond the classroom and includes normative messages from peers and adults regarding foods and eating patterns. Learners are more likely to receive a strong, consistent message when healthy eating is promoted through a comprehensive school health program (MMWR, 1996). In a study in Voi, Kenya Kakunted said that targeted behavior change should include identification and selection of locally available foods that provide a balanced diet rich in iron and vitamin C foods and less inhibitors on a daily basis in-order to improve anaemia status and decrease its adverse effect on general health. There is need for nutrition education to focus on both practical application and theoretical knowledge related to dietary intervention for iron deficiency anaemia (Kakunted, 2008).

2.9 Effect of Different Nutrition Education Strategies in Addressing IDA

Schools are the natural development zone for nutrition education. They are one of the main social contexts in which lifestyles are developed. Children of school-going age develop behaviour through interaction with other pupils, teachers, parents, siblings and peer groups. They are influenced by their homes, their communities, the mass media – and the school. Thus the school is part of a network of influences which shape eating patterns and attitudes. Piaget's stages of development related to

nutrition suggest that children at age 11 years and above are able to understand the effects of their choices on their health as well as that of their family, their community and the environment (FAO, 2005b).

The primary goal of nutrition education should be to help young people adopt eating behaviours that promote health and reduce risk for disease. Behaviourally based education encourages specific healthy eating behaviours for example eating more fruits and vegetables. Learners or target audience from different cultural groups have different health concerns, eating patterns, food preferences and food-related habits and attitudes. These differences need to be considered by teachers and facilitators when designing lesson plans or discussing food choices.

Learners are more likely to adopt healthy eating behaviours when they learn about these behaviours through fun, participatory activities rather than through lectures (MMWR, 1996). Food-based approaches to addressing malnutrition should include educational input. School-garden interventions are most effective when combined with promotional and educational interventions. Strategies combining information, education and communication are needed, and these should be combined with community mobilization and agricultural inputs.

School-based nutrition education can improve dietary practices that affect a young person's health, growth and intellectual development. Strategies to encourage adequate nutrition among young people include; promotion of school lunch program and advising parents and guardians about community-based food supplementation programs (MMWR, 1996).

Agricultural Extension workers teach nutrition in schools, however, there exists a high farmer-to-agriculture worker ratio- this is the number of farmers advised by one extension staff (Ali-Olubandwa *et al.*, 2011) for effective coverage of agricultural extension work in the farms and schools. The agriculture extension workers are on decline due to low recruitment levels, an aging and exiting staff from service (MOA, 2009a). Agriculture officers may be in constant contact with schools and young people in young farmers and 4-K clubs where various projects are promoted. The projects they promote include agriculture, health and nutrition that promote healthy eating, growth and income generation for schools and households. Therefore, embracing any strategy in nutrition education content delivery would go a long way in addressing malnutrition issues

The research was designed to include Peer and Agriculture staff in-order to compare their effectiveness in content delivery to the learners. Peer education is a flexible social strategy within a prevention and early intervention delivery system. It usually focuses on children and youth among others to reach high-risk populations. It is a process in which trained supervisors develop and support a group of suitable people to educate, strengthen and support their peers to contend with the health threats and decisions they face (trainer -of -trainer approach).

Peer educators create a safe place for candid and genuine examination of attitudes, choices and situations. Through their role as educators they become informal influences, helpers and advocates for systemic change (HPES, 2009). The power between two peers is at similar level, so a peer educator will not be seen as an authoritative figure like a teacher, a parent or simply a much older person. She or he

will be less seen as someone “preaching”, telling others how to be and behave from a judgemental point of view. Peer education may feel more like one is receiving guidance by a friend who knows about what one is going through, who has similar concerns and understands things from their perspective (www.epto.org, 2013).

A peer is a person who belongs to the same social group as another person or group. Peer education is the process whereby well trained and motivated young people undertake informal or organized educational activities with their peers (those similar to themselves in age, background or interests) over a period of time, aimed at developing their knowledge, attitudes, beliefs and skills and enabling them to be responsible for and protect their own health. The process of peer education is perceived more like receiving advice from a friend ‘in the know’, who has similar concerns and an understanding of what it’s like to be a young person (Turyamwijuka, 2007). Where resources are limited and large numbers have to be reached, peer education can have a multiplier effect (www.epto.org, 2013). Therefore the researcher designed the three strategies of researcher, peer and agriculture staff in-order to compare their effectiveness in nutrition education content delivery to the learners.

2.10 Summary of Literature Review

School age children suffer from iron deficiency and the causes are multi-factorial. Iron deficiency can negatively affect the mental development and learning ability of children and their resistance to infections. The benefits of interventions are substantial. Timely interventions can restore personal health and raise national productivity levels by as much as 20% (WHO, 2013). Despite its importance,

nutrition education has not been given its due emphasis in Kenya and the teaching of nutrition in formal setting has been on a downward trend over the last four decades, with each syllabus revision omitting essential nutrition topics or reducing the content (Mbithe *et al.*, 2008).

Evaluations suggest that school-based nutrition education can improve the eating behaviours of young persons (MMWR, 1996). Deficits in syllabi on nutrition education, among other factors, imply that nutrition knowledge and good dietary practices are lacking and need improvement among school children in Kenya. However, this requires concerted efforts of the researchers, teachers, parents and other relevant stakeholders in order to operationalize the School Health and Food Security and Nutrition Policies (MOE, 2009 a; MOE, 2009 b). School nutrition and health programmes offer multifaceted direct and indirect solutions to the management of hunger, malnutrition, disease and poverty both in the short term and long term. The school has several advantages which can be used to break this vicious cycle. Schools offer two excellent settings for nutrition and health education; the classroom and school feeding and health programmes. Yet these opportunities are often lost. The effects of the school meal program on wellbeing of rural Kenyan cannot be overstated (Langinger, 2011).

Pupils spend a lot of time over three quarters of the year in the school environment and therefore are in constant contact with the teachers, extension workers and peers who are their main models. School children are at an exploratory, learning stage an opportunity that can be taken advantage of to instill positive behavior, through classroom learning and hands on practical experiences. Habits and attitudes formed

in early life are translated into the future adults' lifestyles. It is therefore important that the school environments enable and reinforce healthful eating and health behaviours through behavioural-focused classroom instruction and by providing healthy school meals and health facilities and services.

Over 80% of the school children are either directly or indirectly related to members of the immediate community to the schools which provides an advantage of community involvement in the school programmes. Children influence and sometimes make decisions on food for themselves and others at home and are therefore a good entry point for nutrition and health education. Since children spend most of their time at school it becomes inevitable to ensure that they are not only well fed, but also that their general health is catered for. The school is a protected environment providing security which instils confidence and builds self-esteem in the children. The school also offers an ideal environment of contact for interventions, service provision and as a meeting center for any stakeholders that may want to carry out activities both at the school and for the community as a whole (MOPHS, 2012).

The main nutrition strategies employed in Kenya are the school feeding and gardening (MOA, 2007). Schools provide an ideal setting to promote good nutrition as they reach a high proportion of children and adolescents and provide opportunities to demonstrate and practice production of nutrient rich foods, keeping of small livestock, hygienic handling and preparation and healthy eating habits. Schools can contribute to reducing all types of nutrition problems by integrating nutrition interventions into routine school activities (MOA, 2007). Programmes should be tailored to local conditions and take into account anaemia's specific aetiology and the

population groups affected (WHO, 2013). The study was designed to address the gaps found at baseline study to increase haemoglobin levels of the pupils' using three facilitators the Peers, Agricultural officer and the Researcher to teach nutrition education.

CHAPTER THREE: METHODOLOGY

3.1 Research Design

This study adopted a pre- post test study design with both experimental schools and a control school. The study period was a calendar year or three school terms. The study was in two phases; a baseline and an intervention study.

3.2 Study Variables

The independent variables of this study at baseline included the socio-demographic and economic characteristics, food production, hygienic practices of pupils' households, dietary intake, worm status, malaria status and nutrition knowledge of the study pupils, while the dependent variable was the haemoglobin levels. In the interventions the dependent variables were functions of the independent variables on pretest and post test scores of nutrition knowledge, worm status, iron status, malaria status, multistorey gardening, conventional gardening, leaky tin use among others.

3.3 Study Area

The study was carried out in Gatanga Sub-County, Muranga County of Kenya (Appendix Z2). The area experiences a bimodal rainfall regime, the long rains falling between April and May, and the short rains which come between October and November and is between 1000- 2500 mm per annum. The district stands at an altitude of 2237m above sea level (ASL). Generally, agriculture is a major activity and is done at a small scale by the farmers (GOK/GTZ, 2006). This is a coffee growing zone and household food security is of concern due to pressure on agricultural land. Land is highly sub-divided into small land sizes averaging 0.75

acres per household and is under coffee and avocado crops. Food insecurity is also due to soil infertility as a result of over cultivation, effect of climate change, low uptake of new food production technologies, poor diversity of food crop production, insignificant use of farm inputs due to rural poverty, poor coffee crop payments to farmers and high prices of farm inputs. Rural poverty due to pressure on land and poor marketing of coffee has been experienced, forcing people to move out to urban areas to seek for employment (Mukui, 2000). Some farmers are forced to supplement the food they produce with purchased food to sustain their families' food supply. The diet of most households is composed of maize and beans, and ugali (stiff maize porridge) with vegetables (MOA, 2009a).

3.4 Study Population

Gatanga Sub-County was purposively selected because of its population pressure as compared to the lower ecological zone sub-counties like Kakuzi Sub-County. The land is also highly sub-divided in average plots of 0.75 acres, with coffee growing as a major cash crop. Gatanga Sub-County was divided into two educational zones namely Gatanga and Kihumbuini zones. The Gatanga zone was the study zone and had at the time of data collection 30 public primary schools. The baseline survey took place in 12 randomly selected public primary schools. These schools included: Rwegetha, Mabae, Kirwara, Gichumbu, Gakurari, Giatutu, Kigio, Ithangarari, Ngungungu, Gatunyu, Mabanda and Gatanga.

The study targeted pupils in upper primary class 6 and their parents who in our view were appropriate change agents in the community. The study population was chosen because at class six they would be able to grasp nutrition knowledge and practice it at

their homes. The pupils at this stage were not under any pressure of external examinations like those in class eight. It was important for them to understand the importance of iron as a micro-nutrient as they enter puberty. This study was designed to assess and address the gap in nutrition knowledge using three facilitators.

3.5 Sample and Sampling Procedure

3.5.1 Inclusion Criteria

All children enrolled in class 6 and their households and whose parents consented to the study. Schools with no clubs like 4K clubs or nutrition programmes.

3.5.2 Exclusion Criteria

Children who were chronically ill (as identified by the Head teacher in confidentiality (e.g. those with HIV and AIDs were excluded from the biochemical data collection), and those schools with school feeding programmes or nutrition programmes such as Youth for agriculture in Rural Development (YARD an NGO).

3.6 Sample Size Determination for Baseline Survey

3.6.1 Calculating Sample Size for Cluster Sampling

Multistage sampling methods require a larger sample size to achieve the same precision as a simple random sampling. Therefore, the calculated sample size was multiplied by the design effect as recommended by Israel (1992) and supported by Mugenda (2008) and Kasiulevicius *et al* (2006).

$$n = \frac{Z^2 P(1-P) \times d}{e^2}$$

Where :

n = Desired sample size for one population

P = estimate of the 25% prevalence in the population

$1-P$ (also referred to as Q) is the proportion of the non-prevalence in the population

e = estimated % points from the true value or the desired level of precision which is 0.05.

Z = critical value of the confidence interval for standard normal deviation set at 95% CI (Z^2 is the abscissa of the normal curve that cuts off an area at the tails (1– equals the desired confidence level, e.g., 95%), and is found in statistical tables which contain the area under the normal curve.

d = Design effect of 2 since the population was not homogenous and the design effect is generally assumed to be 2 for nutrition surveys using cluster-sampling methodology (IFAD, 2013).

In calculating the sample size, the anaemia prevalence among children found out in 18 schools (UNICEF, 1998) in Kenya and also global anaemia prevalence of school children of 25% (WHO, 2005) was used. The following formulae using 25% prevalence at 95% confidence level was calculated:

$$n = \frac{1.96^2 \times (0.25) \times (1-0.25) \times 2.0}{(0.05)^2} \approx 576$$

≈ 576 pupils for baseline survey.

After allowing for attrition and non-response rate of 10% (58 pupils) the desired sample size of the populations was 634. To gather and get the trends on the

individual pupil food intake and consumption patterns, 10% (63- actual sampled 67) of the households were sampled for baseline data collection (Stake, 2000).

For intervention, sample size calculation for epidemiological studies was used (Kasiulevicius *et al.*, 2006; Lachin, 1981).

$$n_2 = \frac{(Z_{\alpha/2} + Z_{\beta})^2 (P_1 Q_1 + P_2 Q_2)}{(P_1 - P_2)^2}$$

Where:

$Z_{\alpha/2}$ = The critical value, the positive z value that is at the vertical boundary for the area of $\frac{\alpha}{2}$ in the right tail of the standard normal distribution which is equal to 1.96.

Z_{β} = Referred from the tables of normal distribution at the power of $1 - \beta$ where values Z_{β} is < 0.0 in this case 5% 2 sided test with 80% power $Z_{\beta} = 0.842$

$Q_1 = 1 - p_1$ expected non-prevalence at the baseline at 75%

$Q_2 = 1 - p_2$ expected non-prevalence after the interventions at 85%

The proportions in the baseline findings were utilized to estimate the P_1 and P_2 , which was substituted in the equation n_2 above to get the number of pupils to participate in the intervention. The percentage prevalence of P_1 to be 25% and that of P_2 to be 15% was assumed.

Thus,

$$n_2 = \frac{(1.96 + 0.842)^2 (0.25 \times 0.75) + (0.15 \times 0.85)^2}{(0.25 - 0.15)^2} = 77 \text{ pupils}$$

After allowing an attrition rate of 10% (8 pupils) the desired sample was 85 study pupils (actual was 89 pupils') in the 4 intervention schools chosen proportionately according to the number of class six pupils in each school and the number used mainly for biochemical data. Proportionate sampling was used to get the 634 study

pupils required from the 12 baseline schools. That is, out of the total number of class 6 pupils (690) from these schools, the following formula was used to get the number of pupils required in each school to participate in the baseline study: $634/690 \times \text{no of pupils in class per school} = \text{the sample for baseline study}$. Table 3.1 shows the sample in each study school. Proportionate sampling is whereby the numbers in the groups selected for the sample reflect the relative numbers in the population as a whole.

Table 3.1 Sampling Procedures in Baseline Study Schools

School	Class Six population	Eligible class six sample	Percentage sample	Actual sample size
Gatunyu	115	111	$634/690 \times 115$	90
Mabanda	45	44	$634/690 \times 45$	42
Gatanga	64	58	$634/690 \times 60$	64
Kirwara	27	24	$634/690 \times 29$	27
Rwegetha	60	58	$634/690 \times 60$	60
Gichumbu	50	48	$634/690 \times 50$	44
Mabae	44	42	$634/690 \times 44$	46
Gakurari	41	39	$634/690 \times 41$	39
Giatutu	57	55	$634/690 \times 57$	51
Kigio	68	65	$634/690 \times 68$	57
Ithangarari	57	55	$634/690 \times 57$	46
Ngungugu	39	37	$634/690 \times 39$	35
Total Sample	690	634		601

During baseline data collection, a few anomalies were encountered which altered the number of children who participated in the study, these included absence from school

due to lack of school fees and the inclusion of new pupils in class six from a previous count during the identification of the study schools. The four (4) intervention schools (three experimental schools and one control school) which had 154 pupils were randomly selected. All the class six pupils (115) in the experimental schools participated in the nutrition education classes. Pre and post-tests questionnaires on nutrition knowledge were administered to the experimental schools and control school before and after the interventions. Biochemical data were collected from class 6 pupils who were proportionately selected to allow for comparability across the experimental schools and control school for these measurements. These are pupils' whose parents had consented to the study.

The intervention schools were to be at least 5km apart to reduce knowledge contamination. The schools were also supposed to be mixed day schools, and with the necessary resources to facilitate the interventions. These facilities included land for cultivation of vegetables, classrooms for teaching purposes, cooking facilities like water and room. The FAO (2005a) nutrition education classroom curriculum for primary schools in developing countries was used to guide the teaching process using class five and six guidelines (Appendix N- information extracted from FAO curriculum)).

3.7 Sampling Techniques

The researcher purposively identified all the rural mixed (boys and girls) day public primary schools in the zone with the assistance of the local Education officers in the coffee growing zone. From the names of the thirty (30) schools random sampling was used to select 12 schools that formed the required sample (Orodho, 2009).

Summary of the Sampling and Sampling Procedures

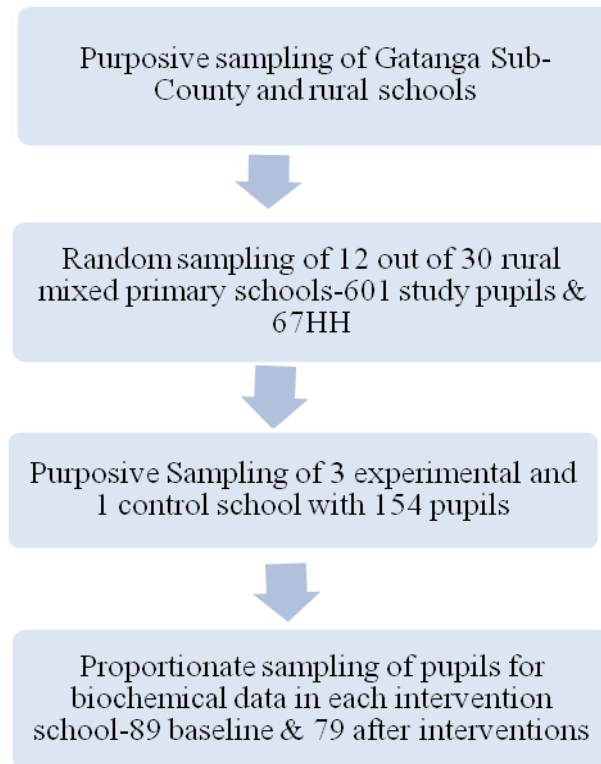


Figure 3.1: Summary of Sampling and Sampling Procedures

3.8 Description of the Intervention

The intervention study was meant to address the gaps in the baseline findings to improve on nutrition knowledge and also the iron status of the school pupils. The head teachers in the experimental schools identified five bright pupils in class six to be peer educators based on the pupils' performance reports. The five peer educators and the agriculture staff were trained by the researcher before embarking on teaching nutrition education in the experimental schools on each of the predetermined topic by the researcher (Appendix S) in March-May 2012, after the baseline study. Once trained, the 5 peers and agriculture staff planned and led classroom nutrition education activities with the guidance of the Deputy head-teachers. The researcher also taught in one of the experimental schools. The experimental schools included

the peer facilitated school (Kirwara), Agriculture staff facilitated school (Kigio) and researcher facilitated school (Mabanda) and the control school Gakurari. The interventions in nutrition education were undertaken in the evenings and during the holidays to avoid interrupting normal school lessons in the experimental schools. Nothing was taught to the control school during the study. Flip charts and other teaching materials for trainings in the experimental schools were developed by the researcher and validation done by the teachers and pretested before the study in Kathambara primary school which was not included in the study.

3.9 Data Collection Instruments and Procedures

3.9.1 Instruments and Procedures

Several instruments were employed by the researcher to elicit appropriate responses from the respondents. The questionnaires for pupils' on nutrition knowledge and an interview schedule for follow-up households were used to collect data. An interview schedule and a structured questionnaire were used in the 12 schools to collect baseline data about the study zone and pupils respectively. The interview schedule was used in the 3 experimental schools and 1 control school at follow up (Appendix C). Focus group discussion instrument with some teachers was (Appendix D) used at baseline and after the intervention study, content analysis through desk review of documents in the MOA/MOH/MOE office and observation checklist (Appendix E). Pictures (photographs) were also used to document the research activities in the study period.

The other subsequent instruments were used only for the intervention. They included pre and post-test questionnaire (Appendix F) administered before and after

intervention to test the effect of the intervention on nutrition knowledge, number of technologies adopted, iron, malaria and worm status. Appendix G provided a Marking Scheme for the pre and post-tests questions. An in-depth interview for head teachers (Appendix H) was used to collect data on the need, possibility and suitability for intervention. A structured questionnaire for teachers (Appendix I) was used to obtain information on possibility of nutrition education intervention. Appendix (J) was a Pupils' questionnaire on attitude on nutrition education, preference of food acceptability taste-tests of foods improved with iron rich foods. A teacher's process evaluation questionnaire (Appendix K) and outcome evaluation questionnaire (appendix L) was used to assess progress and outcome of the intervention respectively.

Appendix (M) was for home follow-up to assess effect of the nutrition and health knowledge on the adoption of various technologies. These technologies included for example leaky tins, multi-storey gardens, rabbits that were promoted during the study, by comparing what was available before and after the interventions. Appendix (N) was a sample scheme of work used to teach the pupils in the three nutrition education facilitations, while appendix (O) was a sample Lesson plan for classroom teaching. Appendix (R) was a detailed chronology of data collection and intervention activities and appendix (T) shows selected local dishes for improvement with iron rich foods. Teaching aids were developed and pre-tested after the baseline survey.

3.10 Pretesting the Instruments

To avoid flaws in measurement, research instruments together with the teaching and learning aids were pretested on a separate similar research population at Kathambara

primary school on 15 pupils' and their households. This was undertaken in Kathambara Primary school in the same educational zone but the school was not included in the study. Data collection instruments pre-tested were the pupils' questionnaire, the interview schedule which was administered to the caregiver, the focus group discussion guide with some teachers and the observation checklist guide. Pre-testing was to facilitate modifications to ensure clarity of the instruments. It also assisted the researcher understand the logistics and the administrative arrangements before the main study.

3.11 Validity and Reliability of Research Instruments

3.11.1 Validity of Research Instruments

Kabanza (2003) defines validity as the degree to which a test or tool measures what it is supposed to measure. During this study, close attention was paid to the validity of the instruments in various ways that included discussions with the supervisors at the time of designing and pre-testing. Subject teachers of the intervention schools also examined the pre and post tests questionnaire for suitability to the study pupils. Adjustments were then made accordingly.

3.11.2 Reliability of the Data Collection Instruments

According to Kabanza (2003), a research instrument should not only be valid but also be reliably consistent in producing the same results whenever it is used. The internal consistency of data is determined from scores obtained from a single test administered by the researcher to a sample of subjects. Therefore to ensure the reliability of the instrument in the measurements, Kuder-Richardson (KR₂₀)

Reliability coefficient was used on a similar population sample. The KR₂₀ formula is as follows:

$$KR_{20} = \frac{(K)(S^2 - \sum s^2)}{(S^2)(K-1)}$$

Where:

KR₂₀ = Reliability coefficient of internal consistency

K = Number of items used to measure the concept

S² = Variance of all scores

s² = Variance of individual items

Data for pre-testing were collected from subjects of Kathambara Primary school and their caregivers. The data were analyzed whereby the scores had reliability coefficient computed with a degree of reliability coefficient of internal consistency of 0.82. A high coefficient (> 0.80) implies that items correlate highly among themselves (homogeneity of data) (Mugenda and Mugenda, 2003), an indication that the research instrument is good enough to be used.

3.12 Data Collection Technique

3.12.1 Baseline Study

Baseline study was undertaken in-order to have a general overview of the study area and get the schools that met the required criteria for intervention. The intervention schools acted as a representative sample for the primary schools in the study area. Questionnaires were administered to class six pupils in 12 baseline schools. The structured interview schedule was administered to caregivers of the sampled households (those who prepared meals for the children). The researcher gathered

socio-demographic and health data, dietary practices based on a 24-hour dietary recall, seven day food frequency using a questionnaire (FFQ), and dietary diversity score for pupils from sixty seven (67) households in the 12 baseline survey schools from the caregivers. Focus group discussion at baseline was done in two schools with the teaching staff to assess the general need for a nutrition education study in the schools. The researcher convened parent meetings at each intervention school to inform them about the study, discuss child health issues and obtain a written informed consent for their children's participation in the study.

3.12.2 Pretests Done Before Interventions

Pre-tests questionnaires on nutrition knowledge were administered before embarking on the interventions to all the 154 study pupils in the experimental and control schools. This was done in March 2012 and interventions started immediately in the same month (Appendix R). These included determination of the level of nutrition knowledge about the nutritive value of food, food sources, nutrition deficiency diseases, health and sanitation (hygiene and food safety), cooking methods and selection of iron rich foods. For nutrition knowledge, each pupil in class six in the experimental and control schools did a pre- test (pre and post-test questionnaire- Appendix F) which was marked and marks recorded for each pupil to test the effect of the intervention on nutrition knowledge. Other nutrition education topics included food production mainly iron rich foods, selection of a balanced diet from locally available foods and recipe modifications and various projects at household level after the assessment. The assessment of iron, helminth and malaria status of the study pupils was done to 89 pupils (from the intervention sample size) had been sampled

randomly. The procedures were done by a laboratory technician from Kirwara Sub-District hospital (level 4) on the first week of April 2012.

The purpose of the study and the procedures for Hb, malaria and stool sample collection were explained to the head teacher, senior teacher, class teacher and the children in class six whose parents had signed the informed consent forms. Random sampling of boys and girls was done to come up with the sample required, from the 154 pupils' enrolled from both experimental schools and control school at baseline for the intervention. Information about name, sex, age and sample numbers were recorded. The sample size for both boys and girls were similar since none of the girls reported to have started menarche. The gender specific sample size was determined based on discussions with the laboratory technician who suggested a greater sample size for females than males if they had menarche since there is an established higher prevalence of anaemia in menstruating females. Pubertal status was assessed by the status quo method: Female pupils were asked whether they had experienced menarche before the blood samples were taken and the males' nocturnal emissions. None of them said they had menarche or emissions in both the pre-tests and post-tests.

Venous blood sample was drawn with a sterile disposable needle and syringe from the sampled pupils aseptically from antecubital veins of the arm and 2ml of blood was aliquotted into BD vacutainer tubes with K₂E anti-coagulant (EDTA-sequestrene) after disinfections with methylated spirit swap and drying of skin. The tubes were then packed in a cooler box at 20⁰C for maximum 6 hours before being transported to Kirwara Sub-district hospital (level 4). Full blood count was analyzed

using haematology analyser (Celltac)- Model MEK 6410K within 15 hours. A safety box and incineration container for used syringe and needles plus the used swaps was provided to carry the waste. The children were categorized as having iron deficiency anaemia when found with Hb <12g/dl for girls and <13g/dl for boys of the specified ages based on WHO standards.

For assessment of intestinal parasitic infection, plastic containers with identification numbers and names were supplied to the pupils and were used to collect stool sample from the study children. Stool samples were examined within 12 hours for cysts, trophozoites, red blood cells (RBCs) and ova of intestinal parasites by macroscopic with unaided eyes (for colour, odour, consistency and parasites) and also direct microscopic examination at the Kirwara Sub-District Hospital (Level 4).

The microscopic methods used to analyze the stool were the normal saline and iodine methods. The normal saline method was used to look for trophozoites, any active forms of trophozoites and larval stages. The iodine method was used to stain the cysts, ova and fecal debris for good contrast. A 10% sub-sample of smears were re-examined for quality control. The severity of intestinal worm infection was expressed by the number of cysts or egg/g faeces using WHO classification system. Clinical assessment for malaria was performed by the Ministry of Health clinician at pre- intervention. Malaria was classified as either present or absent. The results were keyed in into the computer to compare with those taken after the interventions.

3.12.3 Intervention Study

The intervention study (Appendix R) began by administering anti-helminthes and anti-protozoa's to 89 pupils at baseline study and 79 pupils at end-line study who were found to have helminth and protozoa infestation. The dosage was given according to the age and body weight of the pupils; those 11-13 years were given 200mg per day and those 14-18 years 400mg per day for three days according to WHO recommendations. The class six pupils' age ranged from 11-18 years. Those who were randomly sampled for biochemical data were in the range 11-14 years. Then the intervention on deworming took place. The intake of albendazole for worms and tinidazole for amoebiasis after taking the evening meals was supervised by the parents.

Before de-worming the pupils and their parents were trained on proper personal hygiene, hygiene while preparing meals, use of toilets and hand washing after visiting the toilet. Demonstrations on leaky tin construction, proper hand washing using soap and making dish-racks were taught by the field public health staff (Appendix V). The Aqua Guard ® for water treatment was issued to the trained parents. Clinical assessment for malaria was performed by the Ministry of Health clinician at post intervention. The control school pupils received their doses of drugs after the end-line biochemical data collection.

The researcher had identified what was to be taught (content) in nutrition knowledge (Appendices N, O, S & Z3), the structure (framework) (Appendices P, Q & R) with who was to teach in each experimental school and the teaching was able to take place from the notes offered by the researcher (same notes were used in all the

facilitations). From the notes, the researcher had identified, the topics covered were relevant fitting with psychological development of class six pupils by carefully considering existing dietary needs, local foods, nutritional practices and the children's perceptions. From age 11-13 children learn about food supply and that plants are the basis of food chain (food production). It was therefore important to use different parties or strategies in carrying healthy messages to children and also evaluate their effectiveness in the delivery of the contents.

Nutrition education was taught using the three facilitators of the researcher, agricultural officer and peer educators. Among other things the effectiveness of each facilitators was to be evaluated. At each visit, facilitators determined whether each child from the baseline roster was present, absent, had left school or had transferred to another school. Lesson plans showing the lesson organization and presentation were also made with guideline from the classroom curriculum chart and Class 5 and 6 Science books (FAO, 2005; Alex *et al*, 2010; Vasishta and Patel, 2002). The pupils' were taught using visual aids where necessary. Real objects like, foodstuffs, vegetable seeds and seedlings, rabbits and fireless cookers were used. Figure 3.1 shows the class notes after a lesson on nutrition education and Figure 3.2 writing some notes. The effectiveness of each facilitator in delivery of nutrition education messages was measured during the study.

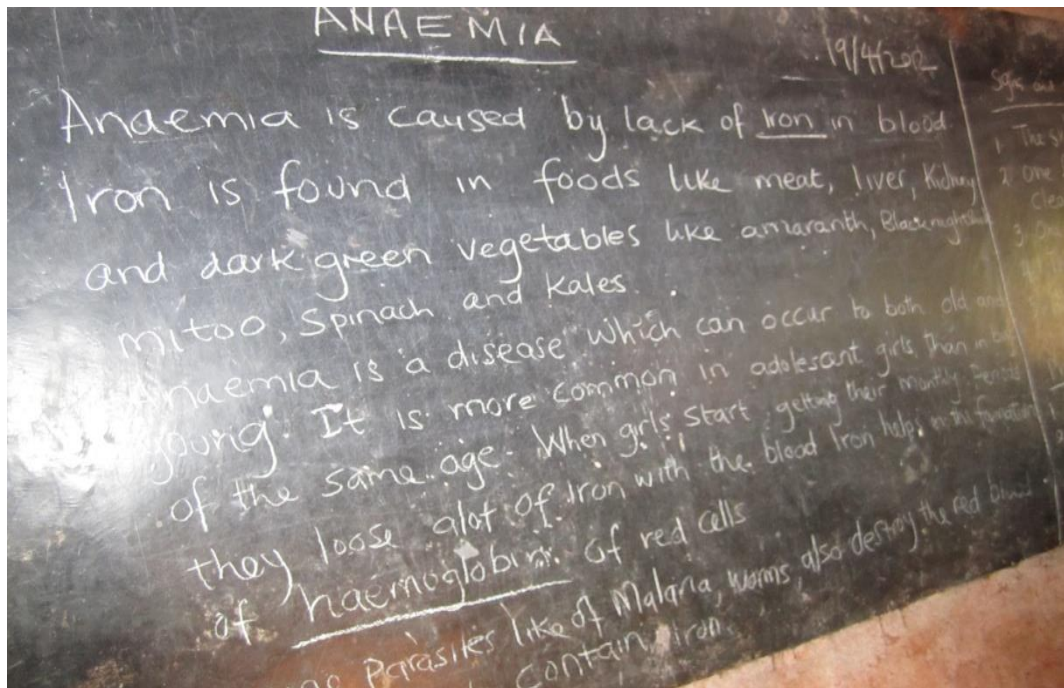


Plate 3.1: Class Notes After a Lesson on Nutrition Education.



Plate 3.2: Pupils Taking Some Nutrition Education Notes During a Class.

Source: Photographs Taken in April 2012 by the Researcher.

The lessons took 30-35 minutes each for 10 weeks in March to May 2012. This took place in the evenings, weekends and during the holidays to avoid interfering with the

school teaching programme. Charts and notes were validated by teachers and pre-tested as needed. Specific micro-nutrient rich foods by the facilitating team were used for demonstrations in the school gardens, including beetroots, Blacknightshade (*Solanum scabrum*) or *Managu*, *Amaranthus bitum (terere)* slenderleaf (*Crotalaria ochroleucia*) or *mitoo*, jute mallow (*Corchorus olitorius*) or *mrenda*, capsicum, kales, spinach, onion and cowpeas (-*Vigna unguiculata*) or *kunde* in local names.

The school gardening activities (establishment) included conventional and multistory gardens in the school at the plots allocated by the head-teacher. Cookery of the iron rich locally available foods was taught in all the experimental schools to class six pupils in about one hour of practical classroom setting. The sustainability projects meant to reduce micronutrient deficiencies, thus multistory gardens, conventional gardens, rabbit and poultry projects were promoted at pupils' households. Improved cookers (*jiko kisasa*) and fireless cookers were also promoted for nutrient and fuel conservation (Appendix T). The lessons that took 30-35 minutes also included the nutritive value of food, the balanced diet, the food guide pyramid, deficiency diseases, health and sanitation, hygiene and food safety, cooking methods and selection of balanced meals from locally available foods and recipe improvement. More emphasis was laid on the importance of iron rich foods and how to grow and eat them. The pupils' responses (Appendix J) and teachers' responses (Appendix K and L) on Likert items were analyzed at 3 point and 5 point scales respectively.

Two continuous assessment examinations validated by teachers and the post-test were done by the pupils during the study. An end-term survey was undertaken to assess the impact of the intervention to the pupils' households. The dietary intake on

24hr dietary recall (taken twice and averaged), food frequency, dietary diversity score and technologies adopted were assessed at the household level for the follow-up pupils. A focus group discussion was conducted at the end-term of the study in one school with some teaching staff to evaluate the effectiveness of the study. The post-tests and final home follow-up were done in July-August 2012.

3.12.4 Pre-test and Post-test Measurement Instruments

Pre and post-tests questionnaires on nutrition knowledge, number of multistory gardens, number of small livestock available, improved jikos, leaky tins and dish-racks were administered by the researcher. Biochemical data were taken at before and after the interventions by the hospital laboratory technician and the results recorded.

3.12.5 Process Evaluation

This was done to identify activities and actions that would work. It included weekly evaluation of the activities by the teachers and pupils. Weekly assessment of food consumption patterns and adherence to use of the recommended iron rich recipes was done. Follow-up of the study pupils at homes was done at the end of the intervention to assess the effect of the intervention at the household level. Assessment of Hb, stool and clinical signs of malaria at 3 months (end of intervention and data collection) was performed and a final focus group discussion done. These were done after the trainings.

3.13 Data Management

In Phase 1, biochemical results were keyed in the laboratory information system and copies of results kept in manual and an electronic laboratory notebook. These results were to be compared with post-tests of the experimental and control school class six pupils who consented to be included in the biochemical data collection. In phase two, the questionnaires were ordered numerically and edited before data entry. Averaged dietary data from the 24 hour dietary recall were entered into a modified version of Nutri-survey computer nutritional assessment package for quantitative calculations. The resulting data from socio-demographics and economic characteristics, health and sanitation, nutrition knowledge, attitude and practice among others were transferred to Statistical Package for Social Sciences (SPSS version 17) for comparison and contrasting between the independent variables.

3.14 Data Analysis

Data were cleaned and validated before the actual analysis using Statistical Package for Social Sciences (SPSS version 17) and SAS version 9.2 for clustering data in school categories. Data were checked for normality by running the exploratory data analysis procedure. Both quantitative and qualitative data analysis procedures were used to test the hypothesis. Quantitative data were discrete or continuous scores of measurements for example on haemoglobin tests and nutrition knowledge while the qualitative data included gender and socio economics among others. Nutrition knowledge in the pre-post test was marked out of 100%, 2 marks for every right answer. For attitude the likert scale was used.

Dietary analysis: The dietary intake was determined by assessing the intake of calories, protein, vitamins and minerals like iron, zinc, magnesium, folate, vitamin A, C and E among other nutrients. The dietary intake data were analyzed using the computer software Nutri-survey (For windows(c) ERHARDT, 2005). Kenyan (Jaswant, 1993) and American (Alex, 2011) food composition tables were also used to generate data.

Chi-square test (Table 3.2) was employed to determine the relationship between feeding practices, nutrition knowledge and the iron status of the children. Chi-square tests were also used to assess the differences between and within groups according to the proportion of anaemia and other indicators (Goldwater, 2007). Anova was used to compare means of Hb levels and worm status of the children at pre/ post tests and to determine significant differences in Hb concentration and worm status at 95% confidence level. T-test was used to test the hypothesis whether there is a significant difference between the means of the Hb levels of the children at pre and post-tests at a p -value of <0.05. The regression coefficient was employed for bivariate analysis on nutrient intake as related to levels of (Hb) and multiple regression analysis were done to identify predictors of Hb levels and iron intake. Pearson product moment correlation coefficient (r) was done to determine the degree of relationship between the Hb levels and the different variables among the children.

Likert scale was used - The “scale” refers to the total sum of all Likert items in the question. The traditional way to report on a Likert scale is to sum the values of each selected option and create a score for each respondent. This score is then used to represent a particular trait. This was useful for evaluating a respondent’s opinion of

the products or satisfaction features. It was used during teachers process evaluation at 5 point scale and menus prepared by the pupils on food consumption and nutrition knowledge at 3 point scale.

Descriptive statistics were used to summarize data on demographic factors that affect dietary iron intake and other variables. The frequencies, mean, standard deviation, and coefficient correlation pertaining to the information were described to determine changes that occurred after the interventions. To control the potential confounding factors and biases a careful evaluation design and selection of comparison groups and appropriate multivariate data analysis methodologies were employed.

Documents and reports from the government offices were used for secondary data which are summarized in the study. Altitude adjustment for Hb measurements was done using WHO adjustment factor of 0.25g/dl per every 1000m ASL rise in altitude due to increase in Hb concentration as an adaptive response to lower partial pressure of oxygen and reduced oxygen saturation of blood with rise in altitude (WHO, 2013). Summary of measurements and analysis of study variables are show in Table 3.2.

Table 3.2: Summary of Measurement and Analysis of Study Variables

Variable	Indicator	Assessment method	Statistical analysis
Demographic and Socio economic characteristics	Gender, age, religion	Interviews	Descriptive statistics
	Head of household, level of education, income, no of siblings, marital status, occupation	Questionnaires	T test, Anova Chi-square
Dietary Assessment	Nutrient intake	7 day food frequency, Nutri-survey, dietary diversity score(FAO)	T test, Anova and Descriptive statistics
Bio-chemical measurements	Haemoglobin levels	Hematology analyzer WHO classification	T test, Anova and pearson product moment Descriptive statistics
Helminthes or protozoa status	No of ova or cysts/g faeces	WHO classification	T test, Anova , Chi-square and pearson product moment, Descriptive statistics
Nutrition knowledge	Knowledge Index	Pre-post tests out of 100 (2 marks per right answer)	Descriptive statistics, Anova and T-test
Attitude	Likert scale	Practice	Chi-square
Skills	Knowledge gained	Practice	Chi-square
Qualitative data	Emerging themes	FGDs, Observations	Content analysis

3.15 Logistical and Ethical Considerations

A letter to get clearance to carry out research was obtained from the Kenyatta University Board of postgraduate (Appendix W) and the Deputy Vice Chancellor (Academics) in (Appendix X). Research permit was obtained from the National Council for Science and Technology (Appendices Y & Z). Administrative permission was also granted at Sub-County and Municipality level and by the schools management committees. Ethical clearance for biochemical data collection was

sought from Kenyatta University Ethics Review Committee (Appendix Z1) and also approved by Medical Officer of Health Thika, the Sub-county Public Health Officer and Kirwara Sub-county Hospital (Level 4). Head teachers, pupils and parents were informed about the aim of the study, its procedures and then written consents were obtained from the head teachers and parents.

CHAPTER FOUR: RESULTS

4.1 Overview

This chapter contains detailed presentation of the results of this research. A baseline survey was conducted among 601 pupils in class six (6) in 12 out of 30 schools in the coffee growing area of Gatanga Sub-county. Pupils were asked to answer a questionnaire on basic nutrition knowledge at school. This was done to really understand whether the pupils' had a knowledge gap. Follow-up school pupils were selected randomly for baseline data on demographics, socio-economic characteristics, identify whether they had projects that enhance nutrition and health at the households, food consumption patterns and intake from 10% sampled households. Three experimental and one control school for the study were selected based on the laid down criteria. Pretests on nutrition knowledge, hemoglobin levels, malaria and worm status (biochemical data) were carried out in all 4 intervention schools.

This study was designed to assess the effects of nutrition education facilitators thus; researcher, peer and agriculture staff on nutrition knowledge to combat anaemia in primary school children through a community based participatory approach. The results are reported as per the objectives of the study:

Phase 1-Findings from the Baseline Survey

4.2 School Pupils' Characteristics

The study took place in primary schools of Gatanga coffee growing area with the guidance of the zonal education office.

4.2.1 Sex of Schools Pupils' at Baseline Study

The results in the baseline survey indicated that 52% of the pupils were boys and 48% were girls (Table 4.1).

Table 4.1: Primary School Pupils by Sex

Name of school	n	Class six by sex		% no of pupils
		Boys	Girls	
Gatunyu	90	51	39	15.0
Mabanda	42	16	26	7.0
Gatanga	64	34	30	10.6
Kirwara	27	17	10	4.5
Gichumbu	44	22	22	7.3
Rwegetha	60	33	27	10.0
Mabae	46	22	24	7.7
Gakurari	39	13	26	6.5
Giatutu	51	33	18	8.5
Kigio	57	29	28	9.5
Ithangarari	46	22	24	7.7
Ngungugu	35	21	14	5.7
%	601	52.1	47.9	100

4.2.2 Age of the Pupils' at Baseline

Age will help determine the nutrition education materials that are appropriate for teaching the pupils to enable them actively participate and retain knowledge and transfer it to others. The age of the pupils in the 12 baseline schools in class six (6) (Figure 4.1) ranged from 11 years to 18 years. Of these, 86.2% were 11-13 years, 12.7% were 14-15 years and 1.1 % was 16-18 years. The results reveal that at younger age (11 years) there were more girls than boys but after that there is a decline in enrollment for girls. Majority of the participants were in the age category 11-13 years (Figure 4.1).

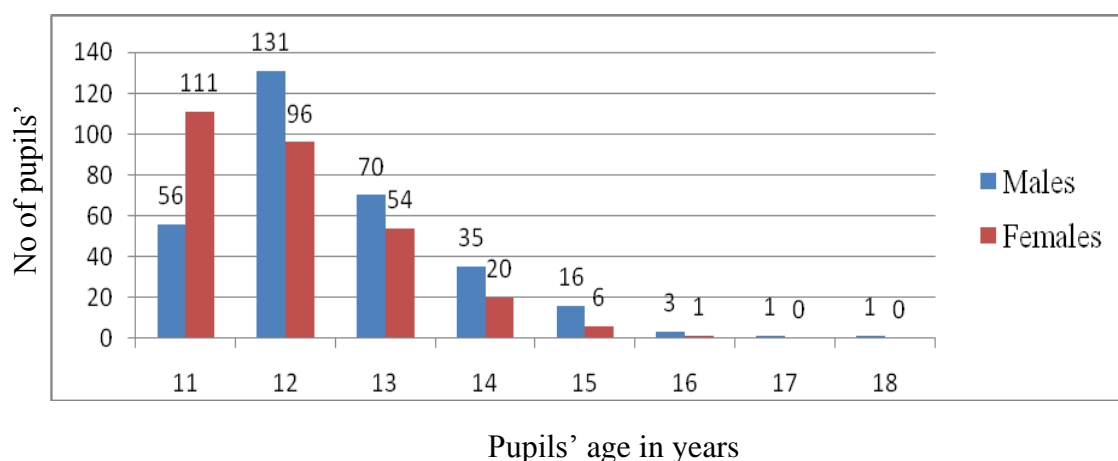


Figure 4.1: Distribution of Pupils' by Age in Years

4.2.3 Nutrition Knowledge at Baseline

Source of Nutrition Knowledge

The pupils interact with the entire environment they live in such as, the community around them, the school and media and hence may gain nutrition knowledge through such sources. Majority (64%) said (Figure 4.2) they had been taught some nutrition lessons by their science teachers during the science classes. The rest received knowledge from other sources while some did not respond or said they had not learnt any nutrition. The limited nutrition knowledge they had been taught in class five science lessons showed they did not know what iron deficiency was. Figure 4.2 shows pupils' source of nutrition knowledge at baseline study.

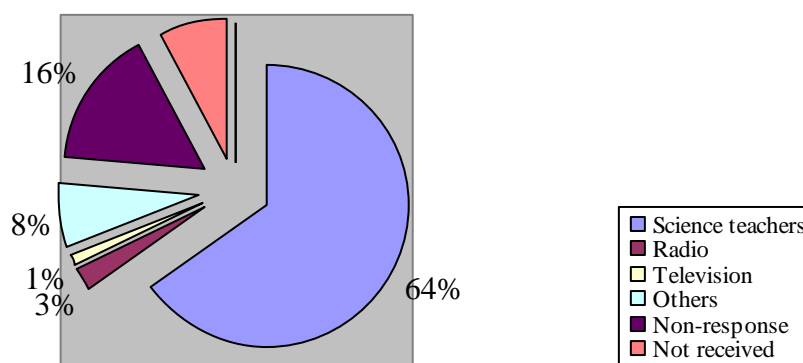


Figure 4.2: Source of Nutrition Knowledge

Knowledge on Food Groups

Nutrition knowledge of food groups can help the pupils and their households select the locally available foods wisely for their healthy living. More than half (64%) had some knowledge on a balanced diet while 73% had some knowledge on vitamins and only 23% had some knowledge on minerals. The results revealed that 77% children did not understand much about minerals (Table 4.2).

Table 4.2: Knowledge on Food Groups at Baseline

Food Group	n=601	%
Balanced Diet		
Had attained some knowledge	385	64
No idea	216	36
Protein		
Had attained some knowledge	231	38.5
No idea	370	61.5
Carbohydrates		
Had attained some knowledge	373	62
No idea	228	38
Minerals		
Had attained some knowledge	138	23
No idea	463	77
Vitamins		
Had attained some knowledge	459	73
No idea	162	27

4.2.4 Nutrition Knowledge for at Baseline for Intervention

The nutrition lessons they said they needed to be taught using the results at baseline showed 33.4% wanted information on food nutrients, traditional foods, food safety and hygiene and deficiency diseases. About, 21.5% needed topics on food nutrients only, 15.6% on deficiency diseases only, 15.5% on food safety and hygiene, 10.5% on traditional foods and 3.5% did not have any idea of what they wanted to learn.

4.2.5 Attitude and Practice of Pupils'

Hand washing needs a bit of improvement for most individuals because rarely do populations follow the WHO rules of handwashing. Many school teachers and management have the basic knowledge on handwashing rules but many factors are limiting to achieve this. This includes availability of clean safe water, gadgets like leaky tins within the ablution blocks and soap for handwashing. Based on the interviews, the study indicated that 68% of the children washed hands after visiting the toilet while 32 % did not. There could have been over-reporting on handwashing because the schools sources of water were far away and no leaky tins were in visibility. Many did not use soap in hand washing.

4.3 School Environment

Using the checklist all schools had tap water. About 80.4% of the pupils reported that their drinking water was from tap water when at school. The rest used untreated borehole, spring or river water for drinking. All the schools had stone, wooden or iron sheet pit latrines which were fairly maintained with cemented floors.

Garbage disposal was in small pits and there were no bushes around the school compound. Some schools had big compounds of 2 acres arable land with coffee growing in it. They were not practicing any form of productive agriculture except for Rwegetha and Ngungugu primary schools that had environmental clubs under a local NGO (Youth in Action for Rural Development (YARD)). They grew trees and also small plots of vegetables. The available land was adequate for subsistence agriculture especially for kitchen gardening (small livestock, multi-storey and home gardens).

4.4 Demographic and Socio-Economic Characteristics

Data on demographics and socio-economic characteristics was collected from households whose parents/ caregivers consented to the study. These were randomly selected and an interview schedule was administered. Most respondents or caregivers (70%) were between 20-40 years old and most of the heads of households (more than 80%) were 31-70 years. Some pupils were living *with* their grandparents. From the interviews 79.1 % of the caregivers were married (Table 4.3). Those who were in the ages less than 30 years were either relatives or older siblings to pupils who were orphaned.

The average household size in the study area (based on the pupils household) was 6 and majority of households had 5-7 dependents. About 95% of the respondents were Christians. Majority of the respondents had completed primary school education with about 30% having not completed or no primary education. Regarding occupation, most of the respondents (49.3%) and household members were casual labourers earning an average salary of Kshs.1000- Kshs. 5000 (\$11-57) per month. Since the heads of households also worked as casual labourers', the combined income was usually less than Kshs. 10, 000 (\$115) per month.

The households were congested in small parcels of land and most caregivers earned their living from small scale farming and smallholder businesses. Majority (over 50%) of households had land sizes of less than 0.75 acres (Table 4.3). Most of the land portions had a poor crop of maize and beans due to erratic short rains. Other crops that they grew were coffee bushes or avocado trees. Very little vegetable production was being practiced by conventional gardening mainly in the valley

bottoms along the river or stream beds. The vegetables grown were kales with little local vegetable production. Pumpkin plants were found planted in either the coffee farm or around the homestead. The leaves were used in small amounts in the maize and beans dish. Arrowroot/talo leaves were also used in the same dish when they made mashed maize and beans with irish potatoes or bananas.

Food storage was practised by 33% of households in their houses after harvest since the produce was little from the small pieces of land, while those who stored in granaries were 4.5%. There were very few granaries in Gatanga Sub-County which was an indicator of food insecurity. The little harvested food crops were neither preserved nor dusted with insecticides to preserve them against the weevils which are a major storage pest. The livestock kept within the homestead included poorly maintained dairy cows and goats in open sheds, and a few number of local poultry. This is because livestock feeds were limiting due to the small parcels of land. Napier grass was grown in small portions of land or as grass strips across the farming plots. There was stiff competition for the available land by the different enterprises that were found in the homesteads in the coffee growing area of Gatanga Sub- County.

Table 4.3: Demographic and Socio-Economic Characteristics of Households

Variable	Category	n=(67)	Per cent (%)
Age of caregivers (yrs)	20-30	8	11.9
	31-40	39	58.1
	41-50	9	13.5
	51-70	11	16.5
Age of household head	20-30	4	6
	31-40	21	31.5
	41-50	19	28.5
	51-70	23	34
Household size	3-5	29	43.2
	6-8	36	53.7
	8-11	2	3
Dependants	1-4	30	44.8
	5-7	35	52.2
	8-12	2	3
Marital status	Married	53	79.1
	Divorced/separated	1	1.5
	Single parents	8	11.9
	Widowed	5	7.5
Religion	Protestants	42	62.7
	Catholic	24	35.8
	None	1	1.5
Level of education	University	None	None
	Secondary complete	5	7.5
	Secondary incomplete	5	7.5
	Primary complete	38	56.7
	Primary incomplete	13	19.4
	None	6	8.9
Occupation	Farmer	16	23.9
	Casual labour	33	49.3
	Housewife	1	1.5
	Salaried	4	6
	Business	13	19.4
Income	None	23	34.3
	1000-5000	41	61.2
	5001-10000	2	3
	10001-20000	1	1.5
Land (Acres)	0-0.75	43	64.7
	0.76-2	22	32.3
	>5	2	3

4.5 Morbidity and Health Two Weeks Prior to Baseline Study

The effects of chronic and acute bacterial, parasitic and viral infections on erythropoiesis, haemolysis, catabolism and food appetite are well documented on the effects of personal health. A total of 32.8% of the sampled pupils' had complaints that they had a certain ailment two weeks prior to the study (Table 4.4). The main complaints were on eye ache (10.4%), chest ache (7.5%) headache and fungal infection (4.5%) each, URTI (3%), nose bleeding and stomach ache (1.5%) each. Table 4.4 shows the distribution by illness of the primary school pupils in Gatanga Sub-county.

Table 4.4: Morbidity and Health Two Weeks Prior to Baseline Study

Ailment last 2 weeks	n	%
None	45	67.2
Eyeache	7	10.4
Chestache	5	7.5
Headache	3	4.5
Upper respiratory tract infection (URTI)	2	3.0
Fungal Infection	3	4.5
Nose bleeding	1	1.5
Stomach ache	1	1.5
Total	67	100

4.6 Health and Sanitation of the Pupils' Households

The health and sanitation of the child's environment are very important to the growth and health of the pupils. The physical characteristics of the dwelling in which a family lives are important determinants of the health status of household members, especially children. Access to decent safe drinking water is important in health and nutrition status of the people. Unclean drinking water exposes individuals to different microbial infestations such as *Amoeba histolytica* and *Escherichia coli* which have detrimental effects on the population. The households that used tap water were 56.7%. The water supply was not regular, whereby households reverted to the use of

other sources mainly river and borehole water. Tap water was not under any form of treatment against the water borne parasites. The children who rarely washed hands were 12% and many did not use soap after visiting the toilets at home.

The households that were predominantly using the wood-fuel with the traditional three stones were 65.7% (Table 4.5). Others used charcoal in a ceramic jiko, paraffin stove or the fuel wood improved stove (*jiko kisasa*) and fireless cooker or in combination with the traditional three stone stoves. The other facilities also observed to be present were: pit latrines made of stone, wood or iron sheets and earth or cemented floors. Garbage was disposed in *shambas* (farm) or cattle sheds at the homestead. Table 4.5 shows the households' source of cooking fuel and water.

Table 4.5: Households' Source of Water and Cooking Fuel at Baseline

Pupils' household water sources	n=67	Per cent
Tap	38	56.7
River & borehole	22	32.8
Tap & borehole	4	6.0
River/well/spring	1	4.5
Total	67	100
Energy source for cooking		
Traditional three stones/firewood	44	65.7
Traditional stone (firewood) and Kenya ceramic jiko (charcoal)	14	20.9
Paraffin stove	4	6.0
Improved stove (firewood) and fireless cooker	3	4.5
Traditional three stone (firewood) and paraffin	1	1.5
Kenya ceramic jiko (charcoal)	1	1.5
Total	67	100

4.7 Household Technologies that Enhance Nutrition and Health

Most children (52%) practised some kitchen gardening with their parents. The other available technologies were also done by their parents. It is well documented that children at this age can be change agents and any knowledge gained can be translated

for household and community growth and development. The deficit in presence of the health and nutrition technologies called for further interventions. Table 4.6 shows the projects at pupils' home during the baseline study.

Table 4.6: Nutrition and Health Related Projects Homes at Baseline

Project	n= 67	%
Multi-storey gardens	8	12.0
Kitchen garden	35	52.0
Leaky tins	6	9.0
Improved stoves	2	3.0
Dish racks	1	1.5
Rabbits	7	10.5
Chicken	8	12.0

Technologies that promote the overall health, hygiene and nutrition of children such as gardening are very important in improving the nutritional status of populations. Healthy pupils will exhibit enhanced cognitive development, concentration, participation and retention in school hence improved academic performance. Children may also gain knowledge from their parents from the activities that they undertake at home.

4.8 Household Food Consumption Patterns, Attitude, Practice and Preference

Food Consumption Patterns

The study showed that in 57% (Figure 4.3) of the households men were served food first before other members of the family and then children came second at 39% followed by grandparents at 4%. Figure 4.3 shows priority in household food distribution in priority.



Figure 4.3: Priority in Household Food Distribution

The type and meal consumption pattern is crucial in determining the household and pupils iron intake. Culture in many African households affects intra-household food distribution.

Food Frequency and Consumption of Selected Iron Rich Foods

Iron is obtained from both animal and plant sources. (Table 4.7) shows pupils' food consumption pattern by sex of selected iron rich foods commonly found in Gatanga Sub-County. Non-heme iron obtained from plants is less bio-available than heme iron obtained from animal foods, such as meat, fish, liver and poultry. Heme iron is highly bioavailable (15-35% is absorbed) whereas non-heme iron is absorbed to much less extent (only 2-20% is absorbed). Non-heme iron from plants is affected by phytates which are present in cereals and legumes, the main staples of the studied population. The type of iron consumed dictates the levels of iron intake in the body.

The average weekly intake on the seven day food frequency was analysed and the T-test computed (Table 4.7). The iron rich foods selected provide more than 1mg/100g edible portion (calculated by the method of (Monsen *et al.*, 1978) except for milk (source USDA (1976-1994). Maize and maize products (average of 5 times) and Irish

potatoes (average of 3 times) had highest intake by both boys and girls. There was however no significant difference of food intakes in all the food groups between boys and girls. Table 4.7 shows the times various foods were eaten by each sex in the seven day food frequency.

Table 4.7: Mean Number of Times Various Foods were Eaten by Sex

Food item	N=67		t	p value
	Boys	Girls		
Kales	2.88+2.2	3.21+2.1	-0.622	0.536
Carrots	2.82+2.8	3.47+2.8	-0.961	0.340
Cabbage	1.21+1.6	1.85+2.1	-1.413	0.162
Amaranth	0.94+1.6	0.76+1.5	0.459	0.648
Black nightshade	0.30+1.1	0.0+0.0	1.691	0.096
Cowpea leaves	0.06+0.4	0.15+0.6	-0.710	0.480
Ripe banana	1.82+2.3	2.38+2.8	-0.903	0.370
Pawpaw	0.24+0.6	0.21+0.6	0.238	0.812
Mango	2.15+2.7	1.79+2.2	0.591	0.556
Avocado	0.18+0.6	0.15+0.6	0.229	0.820
Beans	2.67+1.9	2.85+2.1	-0.381	0.704
Dolicos lablab	0.67+0.9	0.62+1.0	0.206	0.837
Green grams	0.27+0.3	0.41+0.7	-0.855	0.396
Beef	0.85+1.4	0.59+0.9	0.934	0.354
Eggs	0.58+1.2	0.71+1.4	-0.415	0.680
Rabbit	0.06+0.2	0.0+0.0	1.459	0.149
Maize	4.73+2.2	5.24+1.7	-1.076	0.286
Sorghum	1.67+2.7	0.94+2.3	1.186	0.240
Millet	0.52+1.8	0.65+2.0	-0.286	0.776
Rice	1.21+1.0	1.47+1.0	-1.034	0.305
Wheat	0.64+0.7	0.79+1.3	-0.617	0.539
Irish potato	3.06+2.5	3.12+2.6	-0.091	0.928
Arrowroot	1.18+1.9	1.32+2.0	-0.299	0.766
Banana (Unripe)	1.24+0.9	1.62+1.5	-1.213	0.229

The primary schools visited in Gatanga Sub-County did not have any school feeding programme. It was mandatory as a school rule that pupils' should carry packed lunches, of which some pupils defied due to various reasons such as lack of food to carry to school. From the seven day food frequency meat was eaten less than once in a week by both sexes (Table 4.7). Rabbit meat was rarely eaten by boys while girls

did not eat the rabbit meat. Eggs were consumed moderately by most pupils. The most commonly consumed legumes were beans (*Vicia faba*) while blackbeans (*Dolichos lablab*) and green grams (*Vigna radiata*) were consumed moderately. The most frequently eaten vegetables were cabbage, kales (*Brassica oleracea*) and carrots (*Daucus carota*) which were eaten more than once in a week. The vegetables were usually stewed in some water and overcooking was cited by a number of respondents. Further probing revealed that there was little consumption of traditional vegetables like amaranth (*Amaranthus bitum*), black nightshade (*Solanum scabrum*) and cowpeas (*Vigna unguiculata*).

The commonly consumed fruits were the ripe banana (*Musa*) and mango (*Mangifera indica*) more than once in a week. The mango (*Mangifera indica*) was in season at the time of data collection and hence highly consumed. The pawpaw and avocado were consumed less than once in a week by both sexes. Other fruits like loquats (*Eriobotrya japonica*), tree tomato (*Solanum betaceum*) and passion fruit (*Passiflora edulis*) were out of season. None of the households mentioned having consumed the pineapple (*Ananas cosmosus*) although it is grown in the neighbouring Gatundu sub-county, this was probably due to limited purchasing power that existed at the time of data collection. Fruits and vegetables provide vitamin C that promotes iron absorption. Tea (*Camelia sinensis*) as a beverage was common and predominantly taken at breakfast, while coffee (*Coffee arabica*) was less consumed by both boys and girls. These beverages are known to contain tannins and caffeine respectively that inhibit iron uptake in the gut. However, these beverages were rarely consumed with the main meals.

There was a high consumption of maize (*Zea mays*) and its products, for example, maize and beans (Githeri) and stiff maize porridge (ugali) respectively. Rice (*Oryza sativa*), sorghum (*Sorghum bicolor*), millet (*Pennisetum typhoides*) and wheat (*Triticum aestivum*) were also moderately consumed based on the food frequency. These foods are known to have high amounts of phytates if unpolished which inhibit iron absorption. The maize and wheat flour were sifted and therefore contained less phytates, but less nutritious than whole grain cereals. Wheat flour consumption was in form of chapatti (flat fat cake) and *mandazi* (deep fried doughnuts).

The root tubers, irish potato (*Solanum tuberosum*), arrowroot/*talo* (*colocasia esculenta*) and the unripe banana (*Musa*) were commonly consumed based on the food frequency as part of the main dish at least once a week by both sexes (Table 4.7). These are energy giving foods known to provide some micro nutrients that are known to promote iron uptake such as vitamin A. From the information gathered, it was routine to fry food and the fat commonly used was hard yellow fat (KAPA brand in cartons) sold by merchants in as few as 5grams which are affordable to most households. Fat helps in the uptake of fat soluble vitamins A, D, E, K, which in turn interact with absorption of iron in the gut. The intakes were not statistically different for all the foods at $p > 0.05$ (Table 4.7). However, the girls consumed vegetables more times than boys.

Dietary Diversity Score

Based on FAO (2013) cut-off points, the study revealed that 91% of the pupils had medium consumption of the various food groups at baseline study. It should be noted that there was minimal consumption of traditional iron rich vegetables and fruits. The quantities given and overcooking may compromise the nutrient intake from the

foods. Few households consumed organ meat, eggs and red meat. The individual dietary diversity score (IDDS) was backed by the individual pupils who recalled whether they ate any other food outside the home. The study was undertaken when most mothers were harvesting their maize and beans whose yields were poor due to erratic rainfall pattern. Mangoes were also in season as a fruit and a few households were able to buy from the markets. The household dietary diversity score (HDDS) is meant to reflect in a snapshot form, the economic ability of a household to access a variety of foods. Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security. Individual dietary diversity score aim to reflect nutrient adequacy of the diet. In creating dietary diversity scores some related food groups are aggregated to form a group. Dietary diversity scores have been positively correlated with adequate macronutrient and micronutrient adequacy of the diet (FAO, 2013a). In this study a few 4.5% households had a high dietary diversity score, 91 % had medium dietary diversity score, and 4.5% a low dietary diversity score. Table 4.8 shows the distribution of pupils by dietary diversity score at baseline study.

Table 4.8: Dietary Diversity Score at Baseline

HH Dietary diversity Score (HDDS)	n	%
1-4 (Low diversity)	3.0	4.5
5-8 (medium diversity)	61	91
9-13 (high diversity)	3.0	4.5
Total	67	100

4.9. Pupils' Nutrient Intake

The study revealed pupils consumed 3 meals per day i.e. breakfast, lunch and supper. The energy (Kcal) mean intakes for the pupils (865kcal) were below the RDA for

age 10-14 years (1264 kcal) (Table 4.9). The mean intake for the macro-nutrients was above normal for carbohydrates (201g/day) compared to the RDA of 130g/day but lower for proteins and fat. The mean intakes for the micro- nutrients e.g. iron (5.6mg) compared to (8-13mg RDA) were below the RDAs for the studied age. Table 4.9 shows mean nutrient intakes of the pupils at baseline study.

Table 4.9: Mean Nutrient Intake at Baseline

Nutrient (n=67)	Mean	SD (+)	RDA(Age 10-14 years)
Energy (kcal)	864.5	48.3	1264
Protein (g)	23.7	8.0	34.0
Fat (g)	15.6	6.4	31.0
Carbohydrate (g)	201.5	23.0	130
Iron (mg)	5.6	3.2	10-15
Zinc (mg)	1.3	1.0	7.0
Carotene (mg)	20.4	7.2	-
Vitamin C (mg)	39.3	5.9	45.0
Vitamin A (ug)	367	48.0	600
Folic acid (mg)	76	20.0	250
Vitamin B1 (mg)	0.7	0.3	0.9
Magnesium (mg)	184	26.3	200
Calcium (mg)	104	30.3	1100

Source: USDA (2011): DRIs: RDA and adequate intakes, Elements. Food & nutrition Board, institute of medicine, National Academies.

From focus group discussion from teachers at Gatanga primary school it was revealed that *'some children come to school without having taken breakfast and others did not carry packed lunches and this led to food theft cases within the schools'*. After further probing some teachers reported that there was a problem in the area because most of the mothers were *'school dropouts and did not value the idea of packing lunches for their children'*. Asked what possible solution would be, the teachers suggested *that the mothers and caregivers needed nutrition education*. In Kigio primary school the teachers revealed that some of the children were *'orphaned due to HIV&AIDs and their guardians the grandparents were not able to provide a packed lunch'*. They also reported that most households are facing food

poverty due to *'the increased cost of living and large family sizes*. The teachers further said that *'there was a lot of local brews around the schools and many parents were either selling or taking the brew and hence did not care packing food for their children and the performance of the school was very low in the area compared to other schools'*. Asked what the possible solution was on this, the teacher said *'improved agricultural production in the farms was necessary for increased food production, incomes and employment creation'* (Focus group discussion held in February, 2012). The head teachers in these schools had made it mandatory for pupils to carry some food for lunch. But few pupils carried packed lunch.

Mean Intake of Selected Nutrients

Selected factors that may influence dietary iron intake were analysed. Table 4.10 and 4.11 show household and land size in relationship to the pupils' mean nutrient intake for selected nutrients.

Table 4.10: Mean Intake of Selected Nutrients from the 24 Hour Dietary Recall

Household size (n=67)	Mean nutrient intakes for the households						
	Energy (Kcal)	Protein (g)	Iron (mg)	Vit C (mg)	Vit A (IU)	Folic acid (mg)	Zinc (mg)
3	934.7 ^a	28.2 ^a	9.48 ^a	46.0 ^b	306.5 ^a	105.8 ^a	1.82 ^a
4	872.1 ^a	23.9 ^a	4.77 ^b	35.4 ^a	363.7 ^a	71.5 ^a	1.40 ^a
5	791.5 ^a	22.0 ^a	4.61 ^b	37.1 ^a	503.7 ^a	62.2 ^a	1.11 ^a
6	907.0 ^a	26.4 ^a	5.50 ^b	40.7 ^a	564.3 ^a	82.4 ^a	1.49 ^a
7	885.8 ^a	23.0 ^a	5.60 ^b	52.0 ^b	334.6 ^a	82.6 ^a	1.28 ^a
8	844.8 ^a	21.2 ^a	5.30 ^b	32.3 ^a	75.6 ^a	66.7 ^a	1.01 ^a
>10	784.1 ^a	20.2 ^a	5.80 ^b	10.2 ^a	70.2 ^a	65.7 ^a	0.67 ^a

Means in the same column with the same letter are not significantly different.

There was a positive correlation between household size and consumption of the macronutrients, micro-nutrients and vitamins. The general trend was that the larger the household size, the less the intake of the various nutrients except for a few

households who consumed more vitamins and minerals but were not significantly different at $p > 0.05$. Correlation between Pupils' nutrient intakes and size of land (Table 4.11) was computed.

Table 4.11: Correlation Between Pupils' Nutrient Intake and Size of Land

n=67	Kcal	Iron	Vitamin C	Zinc	Size of land
Kcal	1.000				
Iron	0.688**	1.000			
Vitamin C	0.299*	0.341*	1.000		
Zinc	0.271*	0.245*	0.669**	1.000	
Size of land	0.068	0.175	0.143	0.199	1.000

*Correlation is significant at the 0.05 Level (2-tailed)

** Correlation is significant at the 0.01 level (2-tailed)

Iron intake was significantly related to kilocalories with a positive correlation at ($r=0.688$, $p<0.01$), vitamin C ($r=0.341$, $p<0.05$) and zinc ($r=0.245$, $p<0.05$). There was also a positive correlation between kilo-calories and vitamin C at ($r=0.299$, $p<0.05$) and zinc ($r=0.271$, $p<0.05$). The higher the consumption of energy foods, the higher the likelihood of consuming more iron or other minerals and vitamins which are found in the food group, hence the positive correlation.

4.10 Iron Intake, Nutrition Knowledge, Hb Levels, Worm & Malaria Statuses

24 Hour Dietary Mean Intakes of Nutrients

Nutrients do not act singly but they interact during metabolism in the body. In nutritional anaemia interactions between iron and other food components affect the absorption of non-heme iron. Iron deficiency anaemia results from the inability of absorptive mechanisms to extract sufficient iron from many foods. Dietary factors may enhance or inhibit iron absorption. Table 4.12 shows the mean intake of various nutrients by the pupils' 24 hour dietary recall.

Table 4.12: Mean Intakes of Various Nutrients Before Interventions

Nutrient	n=67		t	p value
	Male	Females		
Kcal	862.7+68	830+71	-0.490	0.626
Protein	25.1+7.4	21.6+9.1	-1.768	0.082
CHO	182.2+56	210.2+40	-1.004	0.319
Vitamin A	421.4+66	308.1+51	-0.793	0.430
Carotene	25.2+8.0	15.1+6.3	-0.858	0.558
Vitamin E	1.2+2.1	0.7+1.3	-1.294	0.200
Vitamin C	41.2+30	36.4+21	-0.776	0.440
Folic acid	80+60	70+44	-0.837	0.406
Calcium	110+46	98+39	-1.155	0.252
Magnesium	182+93	179+61	0.152	0.880
Zinc	1.5+1.1	1.1+0.9	-1.421	0.160
Iron	5.6+4.0	5.3+2.4	-0.466	0.642

****significance 2 tailed**

Mean nutrient intake for all the nutrients was not significantly different between the boys and girls at baseline at $p > 0.05$. However, boys displayed better consumption of all nutrients than girls except for carbohydrates.

Nutrition Knowledge in Intervention Schools at Baseline

The girls performance in nutrition knowledge ranged from 12-62 per cent, while the boys had 0-53 per cent (Table 4.13). On average, boys had a lower mean mark of (27.71) than the girls (32.11) with a mean difference of 4.4 per cent in the pre- tests. Table 4.13 shows performance in nutrition knowledge in the intervention schools.

Table 4.13: Nutrition Knowledge in Intervention Schools at Baseline

Gender	n=154	Minimum	Maximum	Mean	SD
Males	71	0	53	27.71	+10.26
Females	83	12	62	32.11	+11.28
n	154	0	62	30.05	+10.99

Nutrition Knowledge Across the Intervention Schools at Baseline Study

Nutrition knowledge was almost similar for all intervention schools at baseline study. Kirwara had a mean score of 31.31%, Mabanda 32.21%, Kigio 28.21% and Gakurari

29.81%. Figure 4.4 shows the mean marks for pre-tests on nutrition knowledge in the intervention schools.

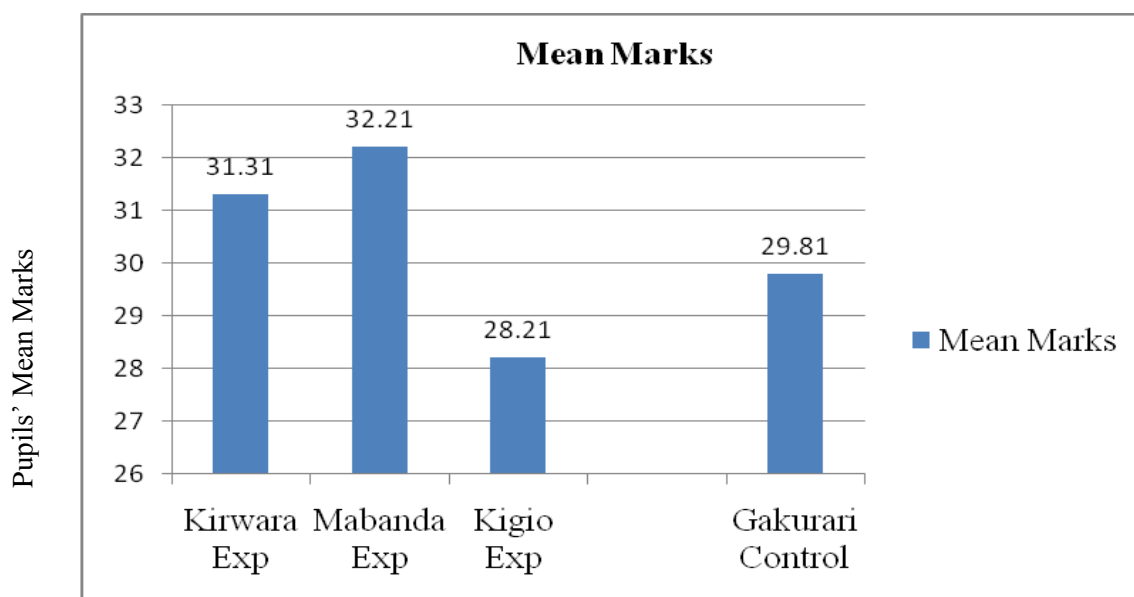


Figure 4.4: Nutrition Knowledge Across the Intervention Schools at Baseline

Pupils' Performance in Nutrition Knowledge by Sex

To determine if the differences in the mean score were significant, one way anova was computed and the results are presented in Table 4.14.

Table 4.14: Performance in Nutrition Knowledge by Sex Before Interventions

	% Mean Total marks	%Mean marks for boys	% Mean marks for girls
Exp. schools			
Peer facilitated ¹ n=26	31.31 ^a	31.69 ^{ab}	34.79 ^a
Researcher facilitated ² n=38	32.21 ^a	28.64 ^a	35.78 ^a
Agriculture staff facilitated ³ n=58	28.64 ^a	26.90 ^a	29.46 ^a
Control school			
Control ⁰ n=39	29.81 ^a	22.91 ^a	33.12 ^a
p value	0.212	0.243	0.107

Means in the same column with the same letter are not significantly different.

⁰=Control school: Gakurari, Experimental Schools: ¹=Kirwara, ²=Mabanda, ³= Kigio

After averaging the marks, the mean average score was 30.05% in the pre-test for all intervention schools. All schools scored very poorly in the pre-tests on nutrition knowledge indicating that the pupils needed deeper understanding of nutrition knowledge. Girls did better across all schools. The mean marks were not significantly different across all schools at $p > 0.05$, at 95% confidence level.

Iron Deficiency Anaemia in the Intervention Schools

Baseline pre-tests on haemoglobin levels and parasitological survey identified through laboratory tests anaemia, *Amoeba histolytica*, *Ascaris lumbricoides* infections as important health problems in this population. In this study girls had haemoglobin levels ranging from 10.5-15.2g/dl, while the boys had 12-16g/dl (Table 4.15). On average, boys had a lower mean (13.5g/dl) than the girls (13.7g/dl) with a mean difference of 0.2g/dl. Table 4.15 shows the distribution of Hb levels for primary school pupils in Gatanga Sub-County.

Table 4.15: Haemoglobin Levels of Pupils at Baseline

Gender	n=89	Minimum Hb in g/dl	Maximum Hb g/dl	Mean Hb in g/dl	SD (+)
Pre-test					
Males	42	12.0	16.0	13.5	+1.10
Females	47	10.5	15.2	13.7	+0.96
Total	89	10.5	16.0	13.6	+1.03

The study assessed the prevalence of anaemia among apparently healthy primary school pupils of Gatanga Sub-County in ages 11-18 years (those who participated in the biochemical data collection were in this age range). In general, most of the girls (50.6%) had normal haemoglobin levels (>11.5 - >12 g/dl) as compared to 2.3% who were anaemic (< 11.5 - <12 g/dl (Table 4.15). In comparison, 28% of boys had normal

haemoglobin, 19.1% were anaemic with haemoglobin levels $<11.5\text{g/dl}$ and $< 13\text{g/dl}$.

A total of 21.4% pupils were anaemic.

Boys were found to be significantly more likely to be anaemic than girls at $p<0.05$. Nevertheless, since iron deficiency anaemia is the final stage of haemoglobin levels deterioration, many pupils are suffering from iron deficiency with its adverse effects on health and physical stamina, than are frankly anaemic. Table 4.16 shows the pre-test distribution of the non-anaemic and anaemic pupils of Gatanga by sex.

4.16: Non-anaemics and Anaemic Pupils by Sex at Baseline

Hb level n=89	Boys	Girls	Total (%)	p value
Non anaemic (Without anaemia)	28	50.6	78.6	0.236
Anaemic (With anaemia)	19.1	2.3	21.4	0.000

Altitude Adjusted Haemoglobin Levels at Baseline Study

A total of 31.4 % pupils were found to be anaemic after altitude adjustments at a calculated factor 0.5 for Gatanga altitude 2237m ASL (GOK/GTZ, 2006). Altitude adjustments were based on an increase of 0.25g/dl per 1000m rise ASL (WHO, 2008; Sangeetha *et al.*,2010). On average the girls had a higher haemoglobin level than the boys. The haemoglobin levels were not significantly different at $p>0.05$ across the four schools in the pre-tests. Table 4.17 shows pupils' mean haemoglobin levels in all intervention schools.

Table 4.17: Baseline Mean Haemoglobin Levels Across all Intervention Schools

School	Mean total Hb g/dl	Mean Hb for Boys in g/dl	Mean Hb for Girls in g/dl
Experimental schools			
Peer facilitated ¹ n=26	12.80 ^{a*}	12.83 ^{a*}	12.87 ^{a*}
Researcher facilitated ² n=38	14.26 ^{c*}	14.04 ^{b*}	14.43 ^{c*}
Agriculture staff facilitated ³ n=58	13.50 ^{b*}	13.31 ^{ab**}	13.65 ^{b*}
Control school			
Control ⁰	13.70 ^{bc**}	13.76 ^{ab**}	13.63 ^{b*}
P value	0.101	0.349	0.166

*Belongs to one subset **Belong to two subsets. Means in the same column with the same letter are not significantly different.

⁰=Control school: Gakurari, Experimental Schools: ¹=Kirwara, ²=Mabanda, ³=Kigio

Parasitic Infestations of Pupils of Intervention Schools

All school pupils are at a risk for geo-helminth infestations because they are exposed to factors that favour the continued existence of worms and the most affected are children in rural areas. These children are from low socio-economic status where there is total absence of or inadequate basic social amenities such as poor drainage network, lack of piped water supply and waste disposal facilities. These infestations lead to nutritional deficiencies with impaired physical development and poor learning. Frequent infections put a very heavy toll on nutritional status of the individuals through increased basal metabolic rate, anorexia and diarrhoea among others (Table 4.18).

The study in the pre-test revealed that the prevalence of intestinal parasites was 63.1%: *Entamoeba histolytica* accounted for 61.3% while *Ascaris lumbricoides* accounted for 1.8%. No other intestinal parasites were present in the stools. Trophozoites, the infective stage of *Amoeba histolytica* were present in 56.7% and

Red blood cells (RBCs) in 46.9% of the study population. Prevalence of trophozoites was statistically significant at $p < 0.05$ between boys and girls being higher in girls than in boys. No pupil had malaria at the time of pre-test. Table 4.18 shows the prevalence of parasitic infestations among primary school pupils.

Table 4.18: Prevalence of Parasitic Infestations at Baseline

Gender n =89	Parasitic infestation						
	Giardia lamblia (%)	Entamoeba histolytica (%)	Ova (%)	Trophozoites (%)	RBCs (%)	Ascaries lumbricoides (%)	Malaria
Males	0	21.1	0	17.4	19.1	1.8	0
Females	0	40.2	0	40.2	27.8	0	0
Without	100	38.7	100	42.4	53.1	98.2	100
p value	NS	0.087	NS	0.021	0.174	0.214	NS

χ^2 -Pearson Chi-square

Phase 2 - Findings from the Intervention Study

4.11 Nutrition Education Through the Different Facilitations

Nutrition knowledge was offered to all the experimental schools using the three facilitators; 5 peers, an agriculture extension worker and the researcher. It included classroom lessons on nutrition, cookery and kitchen gardening activities in the school. School gardens help to improve the nutrition and education of the children and their families in both rural and urban areas. The gardens included a variety of vegetables and small livestock like rabbits (FAO, 2005b).

Nutrition Knowledge Before and After Interventions

Learners were taught by the different facilitators on various predetermined nutrition education topics. Table 4.19 shows the performance in nutrition knowledge before and after the interventions.

Table 4.19: Nutrition Knowledge by Sex Before and After the Interventions

	Total		Mean marks:			
	Pretest	Posttest	boys		girls	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Exp. Schools						
Peer facilitated ¹ n=26	31.31 ^a	51.52 ^c	31.69 ^{ab}	48.93 ^c	34.79 ^a	55.40 ^c
Researcher facilitated ² n=38	32.21 ^a	49.67 ^c	28.64 ^a	41.67 ^b	28.64 ^a	54.67 ^c
Agriculture staff facilitated ³ n=58	28.64 ^a	39.29 ^b	26.90 ^a	38.90 ^b	29.46 ^a	39.69 ^b
Control school						
Control ⁰ n=39	29.81 ^a	31.21 ^a	22.91 ^a	27.45 ^a	33.12 ^a	33.88 ^a
p value	0.212	<0.05	>0.05	<0.05	>0.05	<0.05

Means in the same column with the same letter are not significantly different.

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio

In the post-tests, girls still did better than the boys in nutrition knowledge. Post-tests showed a significant difference with the experimental schools performing significantly better than the control school at $p < 0.05$. There was no intervention in the control school during the intervention study. The performance of the control school improved but not significantly. The improvement may have been caused by the sensitization at pre-test, such that pupils may have tended to remember their responses during the post-test as reported by Mugenda and Mugenda (2003). The pre-test post-test improvement in the control school was however not significant ($p > 0.05$) as compared to the performance of the experimental schools.

Nutrition Knowledge Across the Experimental Schools After Interventions

The primary outcome was nutrition knowledge while iron status and less parasitic infestation and hygienic practice were considered as secondary outcomes resulting from the intervention. Post-tests showed a significant difference with experimental schools under three facilitators performing significantly better than the control school (Figure 4.5). The peer facilitated school performed best with (51.52+24.79) marks, followed by the researcher facilitated school (48.39+22.23) and the agriculture staff (39.29+9.87). The pre-test post- test improvement in the control school (31.21+12.74) was however not significant ($p>0.05$) as compared to the performance of the experimental school.

The hypothesis that there is no significant difference between nutritional knowledge in the experimental schools across the three nutrition education facilitations compared to the control schools in the coffee growing area of Gatanga Sub-County is therefore rejected at $p< 0.05$ (Figure 4.5). The hypothesis is rejected because T-test revealed differences in nutrition knowledge before and after the interventions at $p<0.05$.

The results shown in Figure 4.5 show the performance in nutrition knowledge before and after interventions across all the intervention schools.

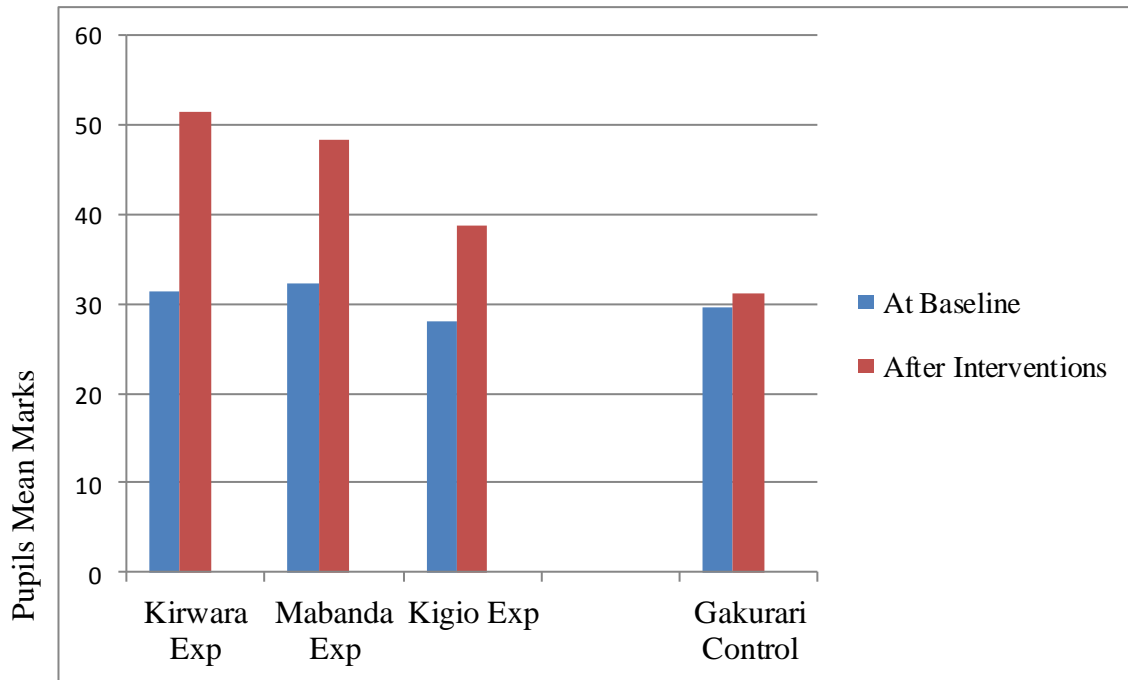


Figure 4.5: Nutrition Knowledge Before and After Interventions

The results show the improvement attained in experimental schools compared to the control school after the interventions. The improvements in the experimental schools were significantly different compared to the control school.

The 24hr Dietary Intake After interventions

Dietary intakes increased significantly after the interventions in the experimental schools as compared to the control school (Table 4.20). T –test was computed on food consumption and iron status and food consumption patterns and iron status were not significantly different ($p > 0.05$) between the experimental and control schools at baseline. Notable differences occurred in the experimental schools after the interventions in the intake of some nutrients.

Consumption of all nutrients increased and was statistically significant at $p < 0.05$ except for Vitamin E, Calcium (Ca), iron (Fe) and Magnesium (Mg). Based on the results the hypothesis that there is no significant relationship between nutrition knowledge and the consumption of iron rich foods in the experimental schools (Kirwara, Kigio, Mabanda) across the three nutrition education strategies and the control school (Gakurari) of Gatanga Sub-county at $p < 0.05$ is rejected. Table 4.20 shows the 24hr dietary intakes at post intervention.

Table 4.20: The 24 hr Dietary Recall Nutrient Intake After Interventions

Nutrient	Control School ⁰	Experimental schools (n=43)			p value
		Peer facilitated ¹	Researcher facilitated ²	Agriculture Staff facilitated ³	
Energy (Kcal)	1125+34 ^a	1554 +30 ^b	1662+28 ^b	1627+24 ^b	$p < 0.001$
Protein (g)	32.8 +3.0 ^a	42.3+9.2 ^b	45.9+12.0 ^b	46.4+9.8 ^b	$P < 0.05$
CHO (g)	315+21 ^a	305+23 ^a	402+27 ^a	465+17 ^a	$P = 0.146$
Vit. A (ug)	259+48 ^a	488+41 ^b	502+45 ^b	576+30 ^b	$P < 0.05$
Carot. (mg)	554+46 ^{ab}	249+35 ^a	244+39 ^a	1230+33 ^b	$P < 0.05$
Vit. E (mg)	0.72+0.62 ^a	1.28+1.07 ^a	0.75+0.33 ^a	0.71+0.62 ^a	$P = 0.181$
Vit. B ₁ (mg)	0.93+0.19 ^a	2.26+3.35 ^a	3.5+7.4 ^a	1.28+0.28 ^a	$P = 0.416$
Fol.acid (ug)	71+19 ^a	179+10 ^b	141+42 ^b	128+44 ^b	$P < 0.05$
Vit. C (mg)	44.4+19.4 ^a	65.2+17.1 ^a	76.0+19.6 ^b	81.2+18.4 ^b	$P < 0.05$
Ca (mg)	248+22 ^{ab}	228+26 ^a	268+21 ^{ab}	306+25 ^b	$P = 0.129$
Mg (mg)	398+19 ^a	425+11 ^a	373+10 ^a	358+13 ^a	$p = 0.670$
Zinc (mg)	1.3+0.5 ^a	3.4+2.4 ^b	2.8+1.4 ^b	2.6+1.2 ^b	$P < 0.05$
Iron (mg)	10.2+1.7 ^a	11.0+2.3 ^a	11.7+3.6 ^a	11.5+2.6 ^a	$P = 0.368$

NB: Means in the same row with the same letter are not significantly different.

⁰=Control school: Gakurari, Experimental Schools: ¹=Kirwara, ²=Mabanda, ³=Kigio

Mean Nutrient Intake from 24hr Dietary Recall by Sex

Intakes differ by sex due to various reasons. For example, girls usually assist with cookery in the households and hence may have higher intakes than the boys. Boys keep rabbits or fish in the rivers and mainly consume these without involving other members of the household since these foods are not culturally accepted by the adults.

Consumption of various nutrients was not statistically significant between both genders at $p > 0.05$ but consumption of various nutrients improved after the interventions for both sexes as compared to the control school (Table 4.21). The study period was favoured by a cool weather which influenced vegetable production with little watering. Table 4.21 shows the pupils mean nutrient intake by sex at post intervention.

Table 4.21: Pupils' Mean Nutrient Intake by Sex After Intervention

Nutrient	RDA	(n=43)		t	p value**
		Boys	Girls		
Kcal	1264	1509+29	1513 +39	-0.027	0.978
Protein(g)	34	40 +10	41+11	0.725	0.472
CHO (g)	130	355+40	404+35	-0.818	0.417
Vit. A (ug)	600	490+29	456+23	0.437	0.664
Carot. (mg)	-	762+1.0	536+0.9	0.775	0.443
Vit. E (mg)	-	0.86+0.9	0.83+0.6	0.140	0.889
Vit. B ₁ (mg)	0.9	1.2+0.25	2.5+5.2	-1.160	0.252
Fol.acid (ug)	250	118+23	138+26	-0.999	0.323
Vit. C (mg)	45	63+17	73+16	-0.982	0.331
Ca (mg)	1100	255+10	277+8.4	-0.839	0.406
Mg (mg)	200	389+13	381+14	0.201	0.841
Zinc (mg)	7	2.9+1.8	2.2+1.4	1.460	0.151
Iron (mg)	10-15	11.+2.0	11.0+3.0	-0.703	0.486

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Seven Day Food Frequency & Intake of Selected Iron Rich Foods After Interventions

Seven day food frequency from various selected food groups were analyzed to compare their consumption pre and post intervention (Table 4.22). There was improved consumption of some iron rich foods that included green leafy vegetables like amaranth and cowpea leaves by pupils and their households by the number of times the food was taken in a week, though it was not statistically significant. The seven day food frequency was compared at pretest (67 households) and post –test (43

households). Table 4.22 shows pupils seven day food frequency before and after the intervention.

Table 4.22: Seven Day Food Frequency on Selected Iron Rich Foods Before and After Interventions

Foods Pre= Pretest Post= Posttest	Daily	4-5 times/wk	3 times/wk	2 times/ week	Once/wk	Rarely/n ever	P value
Beef							
Pre (n=67)	1.5	0.0	6.0	4.5	34.3	53.7	0.660
Post(n=43)	0.0	8.5	6.4	23.4	48.9	12.8	
Eggs							
Pre(n=67)	0.0	4.5	6.0	6.0	11.9	71.6	0.589
Post(n=43)	2.1	0.0	12.8	27.7	10.6	46.8	
Beans							
Pre(n=67)	9.0	14.0	28.4	0.0	14.9	9.0	0.766
Post(n=43)	10.6	12.8	31.9	0.0	17	4.3	
Green grams							
Pre(n=67)	0.0	0.0	1.5	6.0	17.9	62.7	0.514
Post(n=43)	0.0	0.0	4.3	4.3	21.3	70.2	
Amaranths							
Pre(n=67)	0.0	9.0	4.5	9.0	9.0	68.7	0.819
Post(n=43)	8.5	4.3	31.9	17	17	21.3	
Cowpea leaves							
Pre(n=67)	0.0	0.0	1.5	3.0	0.0	95.5	0.278
Post(n=43)	6.4	6.4	14.9	19.1	4.3	48.9	

Dietary Diversity Score for Pupils After Interventions

The dietary diversity score were compared before and after the interventions (Table 4.23). Before the interventions, 4.5% of the households were in low diversity score in food consumption but after interventions the number of households that had high diversity score increased to 20.8%. The improvement was not statistically significant at $p < 0.05$. There was increased consumption of green leafy vegetables like the amaranth, pumpkin leaves, black nightshade and cowpeas (Table 4.23). Fruit consumption was also noted as there was high consumption of avocados, loquats,

oranges which were in season and were also plenty in the market. In the post-test, all the caregivers packed lunches for the children which included fruits like the avocado. The season was good with plenty of food and avocado as the major fruit. Table 4.23 shows the dietary diversity scores for pre and post test interventions.

Table 4.23: The Pupils' Dietary Diversity Score Before and After Interventions

Score out of 16	Before %(n=67)	After% (n=43)	p value (χ^2)
1-4 (Low diversity)	4.5	0	0.561
5-8 (medium diversity)	91.0	79.2	
9-13 (high diversity)	4.5	20.8	
Total	100	100	

χ^2 - Pearson Chi-square

Morbidity & Health Data After the Interventions

Diseases have negative impact on nutritional status of the populations. Home follow up after interventions was undertaken and the study showed that more children complained of having had a bout of the ailments as reported in the table below (Table 4.24). The most common ailment was Upper Respiratory Tract Infection (URTI). The weather was quite cold and this may have contributed to the said illnesses. Table 4.24 shows the ailments pupils suffered from before and after interventions.

Table 4.24: Morbidity and Health Two Weeks Before and After Interventions

Ailment last 2 weeks	Pre	% at pre-test	Post-test	% increase (+) or decrease (-) at post-test
None	45	67.2	24	55.8(-)
Eyeache	7	10.4	4	9.3(-)
Chestache	5	7.5	2	4.7(-)
Headache	3	4.5	1	2.3(-)
URTI	2	3.0	8	18.6(+)
Fungal Infection	3	4.5	2	4.7(+)
Nose bleeding	1	1.5	1	2.3(+)
Stomach ache	1	1.5	1	2.3 (+)
Total	67	100	43	100

A total of 32.8% of pupils' complained that they had certain ailments two weeks prior to the study (Table 4.24). The main complaints were on eye ache, chest ache, headache, fungal infection as ringworms were visible, nose bleeding and stomach ache. About 43% of them sought medical help and the rest got over the counter drugs. A chi-square analysis revealed that there was no statistical significance ($p = 0.265$) between the type of ailment and the source of water for the pupils' households. Table 4.25 shows the households' source of water and pupils' ailments.

Table 4.25: Morbidity & Households' Source of Water After Intervention

Water source n=43								
	None	URTI	headache	Eye ache	Fungal infection	Chest ache	Nose bleeding	Stomach ache
Tap	19	2	1	2	1	0	0	1
River	2	1	0	0	0	1	0	0
Borehole	2	0	0	1	1	0	0	0
River/borehole	2	0	0	1	0	0	0	0
Tap/borehole	2	1	0	0	0	0	0	0
River/Well/Spring	2	0	0	0	0	0	1	0
Total	29	4	1	4	2	1	1	1
P value(χ^2)	0.265							
χ^2-Pearson chi-square								

Haemoglobin Levels After the Interventions

An attrition of ten learners for biochemical assessment on iron status occurred in the post-test procedures. After the interventions, marked changes were noted and Hb levels in the control school decreased drastically by (55%) while improvements were noted in the experimental schools (Table 4.26). Improvements were noted in peer facilitated school (58.8%) that reported high adherence to Antihelminthic and amoebiasis drugs prescribed by the pharmacists. The control school pupils received their doses of drugs after the end-line biochemical data collection for ethical reasons. Table 4.26 shows the percentage in haemoglobin levels after the interventions.

Table 4.26: Percentage Change in Haemoglobin Levels After the Intervention

n=79	Non-response (%)	Increased (%)	Decreased (%)	Unchanged (%)
Control ⁰ n=20	5	30	55	10
Peer facilitated ¹ n=17	17.6	58.8	17.6	6.0
Researcher facilitated ² n=23	9	50	41	0.0
Agriculture staff facilitated ³ n=29	17.9	42.9	32.1	7.1

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio

Changes in Mean Haemoglobin Levels After Intervention

After the intervention, the haemoglobin levels were compared at pre and post intervention to establish if there was any change (Table 4.27). Pupils' haemoglobin status were not significantly different ($p > 0.05$) between the experimental and control schools at baseline (Table 4.17), but, notable differences occurred in the experimental schools after the interventions. In the peer facilitated school (Kirwara) the mean Hb levels were 12.8g/dl before interventions and after the interventions the mean levels improved to 13.41g/dl. For researcher facilitated school (Mabanda) the

mean levels improved from 14.26 g/dl to 14.50g/dl, and the agricultural officer facilitated school (Kigio) the levels improved from 13.50g/dl to 13.83g/dl. For the control school the Hb levels decreased from 13.70g/dl to 13.33g/dl. There was a statistically significant difference between the pre-test and post-test mean Hb values ($p= 0.038$). Table 4.27 shows changes in mean haemoglobin levels of pupils at post intervention.

Table 4.27: Changes in Mean Haemoglobin Levels After Intervention

Schools	Mean Hb levels g/dl (+) SD		
	Pretest	Posttest	p- value (t-test)
Control ⁰	13.8+0.9	13.3+0.7	0.038
Peer facilitated ¹	12.8+0.9	13.4+1.0	0.002
Researcher facilitated ²	14.2+1.2	14.5+0.7	0.268
Agriculture staff facilitated ³	13.6+0.8	13.8+0.8	0.075

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³= Kigio

There was a statistically significant difference in the Hb levels before and after the interventions in the peer facilitated school at $p= 0.002$. Notable improvement occurred in the other two schools but was not significantly different at $p=0.268$ in the researcher facilitated school and $p=0.075$ in the agriculture staff facilitated school. The results rejected the hypothesis that there is no significant difference between iron status in the experimental schools across the three nutrition education facilitations compared to the control schools in the coffee growing area of Gatanga Sub-County at $p<0.05$. The hypothesis is rejected because t-test revealed significant differences in iron status before and after the interventions at $p<0.05$.

Prevalence of Intestinal Parasites After the Interventions

In order to avert the harmful effects and complications of intestinal parasites, prompt preventive measures should be taken for the eradication of the high infestation rate which should include public health education, clean drinking water, sanitation facilities, promoting personal hygiene and periodic deworming of the children. If the prevalence of soil-transmitted worms is 50% or more, deworming leads to significant extra gains in nutritional status. Deworming was included since worm infections can contribute to anaemia. Deworming contributes to prevention of anaemia, good health and nutrition. Health and sanitation knowledge was offered to the experimental schools with the assistance of public health office. After the interventions, the pupils in the experimental schools improved in hand-washing, use of leaky tins, dish-racks, cookery and kitchen gardening. The intervention period was favoured by a conducive environment for kitchen garden establishment.

Children are vulnerable to serious complications of the infestations such as anaemia and bowel obstruction, which should be managed after the diagnosis. The infected children were treated with tinidazole and albendazole for *amoebiasis* and *Ascaris lumbricoides* respectively. They took the drugs for three days under the supervision of their parents after the evening meals. The pupils were trained on hygiene practices. Table 4.30 shows the comparison before and after intervention prevalence of intestinal parasites.

The parasites reduced in the experimental schools while they increased in the control school. The ova/egg positive rate was low while the trophozoite (infective stage) reduced in the experimental schools and increased in the control school. There was a

significant difference after the interventions at $p < 0.05$. Red blood cells (RBCs) isolated were less in experimental schools after the intervention and statistically significant at $p < 0.05$. No malaria symptoms were noted. After the study, the control school pupils were given the necessary drugs by a pharmacist from Kirwara Sub-District Hospital (level 4). The results indicate that intestinal parasitic infestation among the school children in the study area was water-borne.

Table 4.28: Prevalence of Intestinal Parasites for Pupils' Before and After Interventions

Pre-test (pre) n=89 Post-test (Po) n = 79	Prevalence (%)											
	Entamoeba histolytica		Ova		Trophozoite		RBCs		Ascaries lumbricoides		Giardia lamblia	
	pr	po	pr	po	pr	po	pr	po	pr	po	pr	po
Control ⁰	47.0	66.7	0	0	40.0	61.1	40	38.9	0	0	0	17.7
Peer facilitated ¹	41.2	0	0	0	41.2	7.7	41.2	0	0	0	0	0
Researcher facilitated ²	71.4	29.4	0	5.9	71.4	41.2	71.4	29.4	0	0	0	0
Agriculture staff facilitated ³	93.3	28.0	0	0	86.7	8	83.3	4.0	6.7	0	0	0
χ^2	-7.996		3.675		22.132		11.975		NS		NS	
P	0.046		0.299		0.000		0.007					

χ^2 -Pearson Chi-square

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³= Kigio

The laboratory stool tests at baseline showed that the schools that were upstream had less infestations of *Amoeba histolytica* compared to those schools which were downstream (Table 4.28). The peer facilitated school was located upstream followed by the control school then researcher facilitated and finally the agriculture staff

facilitated. After the analysis of the stools, the results revealed that there was an increment of parasites in schools pupils as one went downstream.

In the post test, the stool samples were examined for evidence of parasitic infections for the intervention schools and it was found out that the prevalence was higher in the control school compared to the experimental schools. Prevalence of parasites, infective stages and the RBCs decreased in all the experimental schools as compared to the control school. In fact in the control school cysts of a new species of parasite *Giardia lamblia* were isolated and whose cyst positive rate was at 17.7%. Other parasites like the *Ascaris lumbricoides* cysts were absent in all the schools. *Entamoeba histolytica* cyst positive rate reduced in the experimental schools.

Some cases of none adherence to drugs were noted in some schools. Some children did not take full dose of drugs complaining that the drugs were bitter. However, on intake of the drugs the results were statistically significant at $p < 0.05$ between the experimental and control schools (Table 4.28).

4.12 Effect of Nutrition Education facilitation on Nutrition Knowledge and Practices

The study partly aimed to translate the knowledge transferred through the three facilitators into practices that promote good nutrition and health for pupils and their households. Experimental schools grew vegetables at school in the school gardens. During the study period, the researcher facilitated school did best in vegetable production (12kgs) followed by peer facilitated (10.5kgs) and agriculture staff (8.0kgs).

Presence of Multi-storey Gardens in Pupils' Households

Training and use of demonstrations to children on food production showed increase in the crop yields and the variety of foods grown at their households (Table 4.29). This improves nutrition and combats chronic hunger. Follow up on the pupils to their households revealed that two households in the peer facilitated and researcher facilitated schools had adopted growing of vegetables using the gunny bags (Plates 4.1 and 4.2) Table 4.29 shows the Performance in adoption of multi-storey gardens in households.

Table 4.29: Adoption of Multi-storey Gardens in Pupils' Households

Schools	Households that had Before Interventions	Households that had After interventions	p value (t-test)
Control ⁰	1.92+0.27	1.95+0.23	P=0.324
Peer facilitated ¹	1.83+0.38	1.96+0.20	P=0.001
Researcher facilitated ²	1.87+0.34	1.97+0.16	P=0.044
Agriculture staff facilitated ³	1.71+0.68	1.73+0.67	P=0.323

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio



Plate 4.1: A Sack (Multi-storey) Garden at School



Plate 4.2: A Pupil with a Sack Garden at Home

The researcher and peer facilitated school did significantly better than the agricultural staff facilitated school at $p < 0.05$ (Table 4.29). The control school improved but not statistically significant at $p > 0.05$.

Conventional Kitchen Gardening in Pupils' Households

Children learn by doing. Many children acquired skills that improved kitchen gardening at their home, peer and researcher facilitated schools each had more than two households growing vegetables. Plates 4.3 and 4.4 show pupils with conventional gardens at their homes while Table 4.30 shows performance in conventional kitchen gardening. Children were instructed to start at their homes kitchen gardening after the trainings in schools with the assistance of their parents. They established gardens at their homes and cared for them.



Plate 4.3: A Girl with a Conventional Cowpea Garden at Home



Plate 4.4: A Boy with a Conventional Kales Garden at Home

Table 4.30: Conventional Kitchen Gardening in Pupils' Households

Schools	Households that had Before Interventions	Households that had After interventions	p value(t-test)
Control ⁰	1.96+0.20	1.98+0.33	0.162
Peer facilitated ¹	1.17+0.38	1.54+0.51	0.001
Researcher facilitated ²	1.29+0.46	1.55+0.50	0.001
Agriculture staff facilitated ³	1.50+2.00	1.53+2.00	0.320

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio

Peer and Researcher facilitated schools showed improved adoption in food production with peer and researcher facilitated schools showing a statistically significant different improvement at $p < 0.05$. Knowledge gained from school gardens was transferred to the community by the experimental pupils. There was an evident improvement in the introduction of new varieties of foods such as cowpea leaves, kales, jute mallow (*mlenda*), beetroot, capsicum, amaranth and black nightshade in the experimental schools. The establishment of gardens with a variety of vegetables was significantly different in the experimental schools households than in the control school. Children from two experimental groups in the peer facilitated and researcher facilitated schools were more likely to have consumed several of the individual micronutrient-rich foods.

Rabbit Rearing in Pupils' Households

Kitchen gardening includes production of small livestock for home consumption. The animals do not require a lot of space to rear but they provide the household with cheap protein source. Table 4.31 shows the performance in rabbit rearing in the households'.

Table 4.31: Rabbit Rearing in Pupils' Households

Schools	Households that had rabbits Before Interventions	Households that had rabbits After interventions	p-value (t-test)
Control ⁰	1.84+0.4	1.89+ 0.3	0.534
Peer facilitated ¹	1.71+1.0	1.79+1.1	0.627
Researcher facilitated ²	1.68+1.1	1.79+1.1	0.103
Agriculture staff facilitated ³	1.50+2.0	1.53+2.0	0.323

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda , ³=Kigio

Improvement in rabbit production was not statistically significant different across all schools at $p > 0.05$. Some pupils implemented these projects at their households and even influenced other households who said that they would keep some rabbits for home consumption.

Leaky Tins Use in Households

Children's potential effectiveness as agents of change in the home was revealed by a study in Nyanza, whereby parents/guardians reported changing their hand washing behaviour because of what their children had told them about hand washing from lessons at school (O'reilly *et al.*, 2006). Leaky tins are containers that are improvised for hand washing purpose in areas where running water is not available using locally available materials like empty cans of any size. These tins are pierced at the bottom with a nail to release water and then covered with a fitting stick after use. Leaky tin use improved in peer facilitated schools with two households visited having adopted use of the leaky tins while in the control school there was no change. Plate 4.5 and Table 4.32 show a pupil with a leaky tin at home during the home follow-up by the researcher and performance in leaky tins use in pupils' households respectively.



Plate 4.5: A pupil with a leaky tin at home

Table 4.32: Leaky Tins Use in Pupils' Households

Schools	Households that had leaky tins Before Interventions	Households that had leaky tins After interventions	p-value (t-test)
Control ⁰	1.92+0.27	1.92+0.27	Not significant
Peer facilitated ¹	1.71+0.06	1.96+0.50	0.031
Researcher facilitated ²	1.89+0.23	1.95+0.31	0.324
Agriculture staff facilitated ³	1.93+0.27	1.95+0.22	0.660

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio

Personal hygiene and leaky tin installation improved after the intervention in the experimental schools. During home follow-ups, pupils in experimental schools were observed to have improved on various practices as compared to pupils from the control school (Table 4.32). The peer facilitated showed statistically significant changes at $p < 0.05$. Parents in experimental schools could explain the changes that had occurred such as hand-washing, construction of leaky tins and home clean-ups.

Dish Racks Use in Pupils' Households

Households embraced the use of dish-racks after the pupils learned and constructed some at home in the experimental schools. In the Agriculture facilitated school three households had adopted and used them for drying utensils in the sun, but no change was observed in the control school. Table 4.33 shows performance in dish racks use in pupils' household.

Table 4.33: Dish Racks Use in Pupils' Household

Schools	Households that had dishracks before Interventions	Households that had dishracks after interventions	p value (t-test)
Control ⁰	1.61+0.50	1.61+0.50	Not significant
Peer facilitated ¹	1.80+0.34	1.96+0.20	0.162
Researcher facilitated ²	1.84+0.37	1.89+0.31	0.534
Agriculture staff facilitated ³	1.68+0.27	2.57+0.45	0.000

⁰-Control school: Gakurari, **Experimental Schools:** ¹-Kirwara, ²-Mabanda, ³-Kigio

A few households adopted the use of the dish-rack after the lessons. Improvements were noted in the Agriculture staff facilitated school.

Relationship Between Nutrition Knowledge and Selected Practices

Knowledge on some health promoting practises like hand washing, washing fruits before consumption and use of wholesome fresh food stuff help reduce ingestion of harmful parasites like worms. Table 4.34 shows relationship between nutrition knowledge and the selected practices.

Table 4.34: Relationship Between Nutrition Knowledge and Selected Practices

Variable	Pretest		Posttest	
	χ^2 -Pearson Chi-square	p value	χ^2 -Pearson Chi-square	p value
Washing hands	0.508	0.283	2.956	0.075
Washing fruits	0.638	0.508	2.761	0.099
Identification of fresh farm produce(food stuff)	0.513	0.638	0.199	0.495

The results shows that the practices selected were not significantly associated at $p > 0.05$, but the associations were stronger at post test for washing of hands at ($\chi^2 = 2.956$, $p = 0.075$) and washing of fruits at ($\chi^2 = 2.761$, $p = 0.099$).

Presence of Fireless Cookers in Households

The WHO estimates that exposure to smoke from cooking constitutes the fifth worst risk factor for disease in poor developing countries and causes almost two million premature deaths per year. Exposure to these toxic fumes is greatest among women and children who spend most time near open fires or traditional cook stoves tending to the family meal or school children who may study by the weak light of an open flame (Rascona, 2011). The study promoted the use of energy saving device the fireless cooker. Table 4.35 and Plate 4.6 show improvement in use of fireless cookers.

Table 4.35: Fireless Cookers Use in Pupils' Households

Schools	HH that used fireless cookers before interventions	HH that used fireless cookers after interventions	p- value (t-test)
Control ⁰	2.00+0.00	1.98+0.49	0.232
Peer facilitated ¹	2.00+0.00	2.60+0.06	0.022
Researcher facilitated ²	1.89+0.31	1.97+0.16	0.183
Agriculture staff facilitated ³	1.68+0.47	2.00+0.00	0.000

⁰=Control school: Gakurari, **Experimental Schools:** ¹=Kirwara, ²=Mabanda, ³=Kigio

Learners did cookery practicals with iron rich foods using energy conserving cookers thus the *ceramic jiko* and the *fireless cooker* as shown in Plate 4.6 Pupils' were explained about the healthy plate which included demonstration on portion size. The vegetables should take half of the plate then the carbohydrates and proteins the other half, a quarter plate of each food group. Explanation was made for the need of taking fruits with the meals and also taking plenty of clean safe drinking water.



Plate 4.6: Fireless Cooking of Balanced Meals with the Pupils at School

Adoption in use of the fireless cooker occurred in the agriculture staff facilitated experimental school.

In a focus group discussion, a teacher at Agriculture staff facilitated school revealed that 'the children had acquired some knowledge which had enabled the *'pupils to value carrying a fruit to school to accompany their packed lunches'*. Another

commented that ‘*the parents are now appreciating agriculture and nutrition lessons which had been implemented at school and adopted in the households*’. Asked what can be done to continue with the programme, some teachers said it was necessary to have an agricultural club in the schools (Focus group discussion held in July, 2012).

Relationship Between Nutrition Knowledge of Some Topics and Hb Levels

The acquisition of nutrition knowledge may lead to improved nutritional status and thus increased Hb levels. Chi-square test was computed and showed relationship among categorical variables. Table 4.36 shows the relationship of nutrition knowledge and some selected topics and Hb.

Table 4.36: Relationship of Nutrition Knowledge on some Topics and Hb Levels

Topic	Pre-test		Post-test	
	χ^2 -Pearson Chi-square	P value	χ^2 -Pearson Chi-square	p value
Balanced diet	0.457	0.344	0.918	0.245
Iron rich foods	2.321	0.107	1.678	0.150
Consumption of fruits	0.714	0.318	1.057	0.266
Consumption of spinach	0.976	0.254	0.052	0.533
Consumption of liver and kidney	0.346	0.432	0.847	0.259
Importance of water in the body	0.417	0.363	2.002	0.126

The results show the selected nutrition knowledge topics were not significantly associated at $p > 0.05$, but the associations were stronger at post-tests for all topics except the consumption of spinach.

4.13 Effectiveness of the Different Nutrition Education facilitations Amongst the Study Pupils at Pre and Post-test

The different nutrition education strategies had different impact on the study pupils.

Table 4.37 shows effect of different nutrition education facilitations on the study pupils at pre and post-test.

Table 4.37: Performance of Nutrition Education Facilitations Before and After Interventions

Variable	Strategy used in schools	P value(t-test)
Nutrition knowledge	Control	0.337
	Peer facilitated	0.000
	Researcher facilitated	0.000
	Agriculture staff facilitated	0.000
Haemoglobin levels	Control	0.038
	Peer facilitated	0.002
	Researcher facilitated	0.268
	Agriculture staff facilitated	0.075
Amoeba histolytica	Control	0.331
	Peer facilitated	0.009
	Researcher facilitated	0.096
	Agriculture staff facilitated	0.000
Multi-storey gardens	Control	0.324
	Peer facilitated	0.001
	Researcher facilitated	0.044
	Agriculture facilitated	0.323
Fireless cookers	Control	0.232
	Peer facilitated	0.022
	Researcher facilitated	0.183
	Agriculture staff facilitated	0.000

Performance in all the nutrition education strategies showed improvement in all the selected variables. Most of the selected variables showed a significant difference at $p < 0.05$.

4.14 Relationship of Nutrition Knowledge, Consumption of Iron Rich Foods and the Iron Status

Relationship of Nutrition Knowledge and Selected Nutrient Intakes After

Interventions

Nutrition interventions are known to help in management of all kinds of malnutrition amongst the populations. Table 4.38 shows correlation and p values post interventions.

Table 4.38: Correlation and p values post Interventions

Nutrition knowledge and:	r	p value
Protein intake	0.218	0.080
CHO intake	0.667	0.000
Kcal intake	0.661	0.001
Vitamin A intake	0.217	0.036
Vitamin C intake	0.272	0.068
Zinc intake	0.037	0.261
Folic acid intake	0.230	0.057
Iron intake	0.349	0.007
Hb levels	0.253	0.025 (p<0.05)

Bivariate correlations (r) explain the relationship between nutrition knowledge and selected nutrients at post-test. The Kcal, Carbohydrate, Vitamin A, folic acid and iron intake relationships were statistically significant except for protein, zinc, folic acid and vitamin C (Table 4.38).

There were significant positive correlations between nutrition knowledge and hemoglobin levels (Table 4.38). The pupils in the experimental schools improved their nutrition knowledge, iron rich food intake which could have positively influenced their hemoglobin levels (Table 4.38). The hypothesis that there is no

significant relationship between nutrition knowledge and the iron status in the experimental schools compared to the control school (Gakurari) in the coffee growing area of Gatanga Sub-County at ($r= 0.253$, $P=0.025$) $p<0.05$ is rejected.

4.15. Multivariate Analysis on Variables that Predicted the Haemoglobin levels

Regression analysis on independent variables was done to see which variables were contributing to the increase in the haemoglobin levels.

At pre-test : Hb levels= $14.847-0.53(1)+0.61(2)-0.93$ (presence of amoeba histolytica(coefficient was negative (-ve) and lowered the Hb $+0.547$ (presence of trophozoites)- 0.159 (presence of RBCs)+ 0.05 (presence of lumbricoides ($p=0.115$)- Not significant at $p>0.05$.

At post- test : Hb levels = $13.614-0.029$ (1)+ $0.024(2)+0.259$ (presence of cysts)- 0.043 (presence of lumbricoides+ 0.616 (presence of trophozoites)- 0.024 (presence of RBCs) $p=0.028$ - Significant at $p<0.05$.

From the analysis, anything that was a minus explained itself as reducing the haemoglobin levels and the plus was increasing the haemoglobin levels. Linear regression for post-test nutrition knowledge had a positive trend and the haemoglobin levels were increasing. It was clear that the presence of RBCs lowered the haemoglobin levels while the nutrition knowledge scores increased the haemoglobin levels. The results show that the interventions in nutrition knowledge and treatment had an effect on the levels of haemoglobin levels.

4K clubs were initiated in the intervention schools with the assistance of an NGO by the name Youth in Agriculture and Rural development (YARD) whereby the clubs

were to benefit from trainings conducted on agricultural production, food and nutrition security. The staff would meet them once a week. The school gardens would be used as a simple and cost effective means to improve nutrition education. Children learn by doing therefore an effort was made to continue training them and involving them in food production, record keeping, sales and utilization by involving the NGO.

CHAPTER FIVE: DISCUSSION

The broad objective of the study was to evaluate the effects of three Nutrition Education facilitators on iron status of primary school pupils in Gatanga Sub-County. In the baseline study, pupils were generally found to lack nutrition knowledge, while some pupils were found to be anaemic and with heavy infestation of amoebiasis. An intervention followed thereafter in the three experimental schools while there was one control school.

Gender Representation of the Study Pupils'

In a study undertaken in Pakistan, it was found out that iron deficiency anemia affects both sexes equally at primary school age (Ramzan *et al.*, 2009). The baseline survey revealed that both sexes were well represented in the study of class six primary school pupils in Gatanga Sub-County. The results were in agreement with UNESCO (2010) that class six (6) enrollments in primary schools in Kenya were 51% boys and 49% girls.

Nutrition Knowledge of Pupils at Baseline

The study revealed that pupils had learnt some nutrition lessons at school and out of school but very little content as was demonstrated by the pupils' nutrition knowledge performance at baseline. According to FAO (2013b), there is need to enhance nutrition education content by development of new educational materials in this area. The Kenyan National School Health policy and Guidelines and the National Food Security and Nutrition policy emphasize the importance of prevention and control of micro-nutrient malnutrition through enhancing nutrition education in schools.

Food Consumption Pattern of Pupils at Baseline

The pupils food consumption was average in that three meals were eaten in a day and 90% carried packed lunches from their homes. The food may not have been adequate qualitatively and quantitatively because they carried left over foods from the last evening meals. According to Gunde (2004) in a study done in Egypt, the aim of packed lunches is to ensure that children are not hungry and unable to concentrate on school work. Teachers perceived that the unhealthy feeding habits of the school children especially lack of breakfast affected the interaction between the school children and the teachers. The school teachers observed that the active child in class was usually the child who received breakfast at home and at the same time the more intelligent child with good scholastic performance.

Hygienic Practices and Worm Status of Pupils'

Results from the study also revealed that 80.4% of the pupils washed hands after visiting the toilets and before eating food. This could have been an over reporting because the study found out that most schools had tap water which was far from the toilets, the water was untreated and had no facilities like the leaky tin while soap was also not used. Studies have shown that access to decent sanitary and fecal waste disposal and personal hygiene are important in determination of health and nutritional status of individuals. Worm infestation impairs the nutritional status of the individuals they infect in multiple ways; feeding on host tissues including blood, which leads to a loss of iron and protein and increasing mal-absorption of nutrients.

Worms also cause loss of appetite and therefore a reduction of nutrient intake and physical fitness. Iron deficiency anaemia is caused by increased losses from

hookworm infestation and other parasites (WHO, 2013; MOPHS, 2012c). This is closely correlated to poverty, poor environmental hygiene and impoverished health services. Infections causing chronic blood loss such as infestation with malaria parasites, hookworm, *Amoeba histolytica*, viral and bacterial infections interfere with food intake, absorption, storage and use of nutrients hence contribute to iron deficiency anaemia (Munasinghe and Broeke, 2005).

School Environment in the Study Area

Most schools did not have any school garden except for Rwegetha and Ngungugu Primary schools who practised some gardening with the assistance of the local NGO (YARD). The few schools that had more than two acres grew some coffee and nappier grass which was not well maintained. Many believe that learning at school happens only inside the classroom, not realizing that the whole school environment is involved in children's development. The school grounds are a source of food for improving children's diet and health, health influences, an area for learning about nature, agriculture and nutrition and a place for continuing lesson in respecting the environment. The school gardens are important components which help to transfer knowledge and practices to children's homes. The school gardens are intended for ages 9 to 14 years (FAO, 2005).

Demographic and Socio-Economics Characteristics of Households

Age and Marital Status of Respondents and Spouses

During the study, follow up pupils were chosen and their households studied which showed that majority of the parents/caregivers were 20-40 years (70%) old while 94% of the household heads were 31-70 years. Majority (79%) of the

caregivers/respondents were married women. The results were in agreement with ICFMACRO (2010) report that 54.2% women were married, single women were 31.2%, widowed 4.4% and divorced and separated 6.1% in Kenya. The findings were also in agreement with KIHBS (2005/06) report, 63.5% of households (68.4% for Central Province) are in monogamous unions and 14.7% widows or widowers. The same report revealed that 70% of Kenyan households were male-headed and that male household heads in Central Province were 69.2% and 30.8% female headed. The Kenya Demographic and Health Survey ICFMACRO (2010) reported 64.2% of the rural households were male-headed and 35.8% were female headed.

Studies have shown that male headed households are more food secure than female-headed households. Previous studies have shown a better nutritional status of married women (households headed by males) than single mothers. This may be due to the fact that married women get financial assistance from their spouses and hence can afford better meals (Gitau, Kimiywe and Waudu, 2014).

Source of Income

Most of the respondents were able to get some earnings from casual labour, small businesses or subsistence agriculture mainly growing maize, beans and bananas. The age of the care givers is also very important because it determines how well the household is food secure. If the caregiver is a grandparent or the household is headed by an orphan, the household is food insecure. This category of persons may not be able to acquire jobs as casual labourers to access food for the household, and this becomes a challenge due to their vulnerability to food and nutrition security.

Household Size

In this study the average household size was 6 persons with majority (97%) of dependents ranging between 1-7 persons per household. Family size has an implication to nutrition and health because it determines levels of household food consumption patterns and expenditure on food and health items. The household size determines the amount of food required for that household. The total household size shows sharp differences between women with no education (6.7 children) and women with some secondary education (3.1 children). Relatively small households are successful in asset accumulation and family resources. This is translated into better food and nutrition security for the household (Munyanga *et al.*, 2010). This is also in consistence with KIHBS (2005/06) which indicated that in rural areas the average household size was 5.5 (4.1 for Thika) persons. The ICFMACRO (2010) reported an average household of 5.2 children per woman in rural Kenya with a mean national household size of 4.6 persons. Mainly, dependents in Kenya are the population under 15 years of age (45%) and those aged 65 and older (4%), a total of 49% Kenyan household population (ICFMACRO, 2010). According to the Kenya 1999 Micronutrient survey, family size is associated with iron deficiency; the larger the family size the higher the chances of high prevalence of childhood anaemia.

Religion

Majority of the respondents (90%) were Christians who did not mention any restriction to the consumption of any food. Nutrition studies have shown that some religions and cultures have an influence on what the followers should eat. For example, Muslims do not eat pork or any pig product, Seventh Day Adventists are mainly vegetarians with little white meat and some Kenya highland communities do

not eat fish in their diet which can influence the nutritional status of the population (www. wikipedia, 2012).

Education

Most of the respondents (56.7%) had attained primary education with very few (7.5%) with secondary education. They worked as casual laborers in coffee, flower plantations, and Thika town where they earned little income. With their level of education, it was clear that this alone was not enough to enable them compete effectively in the job market and hence engaged in casual labour. The level of education is crucial as it determines job opportunity and income levels as well as aiding in decision-making on food purchase and consumption. This determines the overall well-being of the household.

Food Consumption

At baseline survey, most households consumed plant based foods with very little animal foods which are rich in iron, and with less inhibitors compared with vegetable based foods. During the study, there was total crop failure due to erratic rainfall pattern and many households depended on food purchase. These findings were in agreement with other studies, which have shown low consumption of animal products and increased consumption of plant foods in developing countries (UNICEF, 2001). Iron deficiency usually is prevalent in resource poor households, the vulnerable and least educated (WHO, 2013).

Land Ownership

Land parcels ranged from 0 acres to 5 acres. Land ownership means diversified economic activities that increase household financial base and food access. Most of the land holdings were inherited in the patrilineal inheritance systems whereby the

amount of land a person receives potentially passes it on to his sons and hence the fragmentation of parcels of land. The land parcels in Gatanga Sub-County were fragmented to the various households and very little land was left for viable agricultural production. Further, apart from the small parcels of land, the few granaries and low paying jobs were likely indicators of food insecurity in the study area. Communities growing cash crops have little land for food crops, as coffee and avocado were the major cash crops. Coupled with small land sizes, the households had limited capacity to grow and purchase food; therefore might have had more nutrient deficiencies (Bwibo and Newmann, 2003). This further indicated the need for nutrition education among the school children and their caregivers in order to alleviate the food insecurity problems. The socio- economics of the households in Gatanga Sub-County were not stable because most of them were casual labourers hence their incomes were not regular.

Focus group discussion revealed that some households also acquire some income from coffee, avocado and wood-fuel sale which was not adequate to meet their daily needs. Some teachers, who were locals with farms, lamented that *'the economy was very bad and it was like most families were living from hand to mouth. The households did not have enough money to do developmental projects to keep people busy and many youths were idling in market places and along the paths'*. Low levels of income influence the rates of adoption of new innovations. In a study in Nyanza among parents/guardians who had never used water-guard, the main barrier was product cost, which is a common finding among populations with little disposable income (O'reilly *et al.*, 2006).

Source of Cooking Fuel

Cooking from open fires is unhealthy and unsafe to both women and children and causes millions of deaths each year. Smoke from the traditional three stones fireplace is a health hazard to the persons who cook in the household. Open fires and rudimentary cook stoves are inefficient, unhealthy, unsafe and inhaling the acrid smoke and fine particles they emit leads to nearly two million deaths a year worldwide, primarily among women and children (Rascona, 2011). Studies have shown that up to 50% of energy fuel is saved when improved stove (*jiko kisasa*) is used. There is also less smoke produced since the fire-wood used must be very dry. High levels of indoor smoke, a complex mix of health damaging pollutants increases the risk of acute respiratory diseases. A smoke free environment is very conducive to work in and mothers will enjoy preparing quality meals for the household. Lack of energy saving devices means a mother will spend quality time looking for firewood and little time is left for other household chores. Research has shown that when mothers use a combination of energy saving fuel devices (fireless cooker), food nutrients are retained, incomes saved and hence improving the nutritional status of people (MOA, 2008a).

Most households in Gatanga Sub-County used wood fuel for cooking with the traditional three stones cookstoves. The energy saving devices were rarely used in the study area. The results are in agreement with KIHBS (2005/06) that firewood remains the predominant energy fuel for cooking by over 80% (69% Central Province) of households in the rural areas. Charcoal is the second popular and paraffin follows as source of fuel. The ICFMACRO (2008/09) found out the same trends that 83% of rural households used fuel wood for cooking.

Use of energy efficient stoves can mitigate against the said health hazards and also retain food nutrients, save wood fuel, improve the environment and incomes. Studies have also shown that women re-invest 90% of their income in their families and communities, which means fuel saving benefits, can ripple through the entire community (Roscona, 2011).

Source of Water

The water source for most households in the study area was from tap untreated water, river and boreholes. It is well known that water borne diseases are frequent where unsafe water is used. These waterborne diseases include dysentery, cholera, and amoebiasis which compromise the nutritional status of the populations. The results do not agree with the KIHBS (2005/06) that, overall 57% of households in Kenya use safe drinking water because the water was not under treatment for parasites.

Toilets

All the households visited had pit latrines made of earth or concrete floors. Proper human waste disposal is necessary to reduce incidences of contamination of the water and soil, hence reduce disease prevalence. The results were in agreement with KIHBS (2005/06) 84% of Kenyan households use adequate human waste disposal facilities. The results are also in agreement with the 1999 population and housing census in Kenya that showed that Central province of Kenya has highest access to decent sanitary facility (99.1%) (Mukui, 2000). In the present study, most families had acceptable modes of sanitation.

Projects that Promote Health and Nutrition

Small projects that promote good health like vegetable and small livestock gardening, use of leaky tins, dish-racks and washing of hands at specified times were rarely practiced in the study area.

Pupils' Nutrition Knowledge at Pre-test

The pre-intervention tests showed that pupils lacked adequate nutrition knowledge (an average of 30.05%) and identified the need to increase effort on nutrition education in Gatanga Sub-County. Interventions on nutrition education to improve knowledge and practice that support healthy eating to address iron deficiency are required in any given population (Kakunted, 2008). School gardens and other resources like the leaky tins that could have been used as teaching aids for nutrition education were not actively used in the study area. Consistent with the findings, nutrition practices in the area before the intervention were poor since the learners could not practice what they did not know. This is comparable to a study undertaken in Machakos County whereby most pupils scored an average of 35% at pre-test in nutrition knowledge (Mbithe, 2008).

Pupils' Haemoglobin Levels at Pre-test

In the current study almost 1/3 of the total pupils were found to be anaemic after altitude adjustments at a calculated factor 0.5 for Gatanga altitude (2237m ASL). The findings compared well with Basu *et al* (2004) report that in rural public schools in Delhi anaemia was 23% among boys and, 15.3% among girls. This also compares with a study done in Turkey, by Kaya *et al* (2006) whereby 12.6% of pupils' in two primary schools were anaemic. In the current study, it was revealed that iron

deficiency in a population may be masked by altitude induced polycythaemia as increased prevalence of anaemia after altitude adjustment amongst the population stood at 31.4%. The results are in agreement with Basu *et al* (2004) in a study undertaken in Chandigarh India where 25.4% rural pupils (age 12-18years) sampled from two rural schools were anaemic. A similar study in Ouagadougou, Burkina Faso revealed that 45.6% of primary school pupils of ages 13-14 years were anaemic. In a report on six African and two Asian countries, 40.2% of children aged 7-11 years and 54.4% of those aged 12-14 years were anaemic (Dabone *et al.*, 2011). In their study Tatala *et al* (2004) found iron deficiency anaemia prevalence of 31% among Tanzanian school going children.

Pupils' Worm Status at Before Interventions

In the current study, parasitic infestation was a health problem to the pupils with 63.1% infection. Baseline hemoglobin and parasitological study identified anaemia, amoebiasis and helminth infections as important health problems in this population. The burden of parasitic infestations among school children should be regarded as an issue of public health priority. This strongly supports the need for school health programmes that will involve periodic deworming, health education and improvement of school and households sanitation (Chandrashekar *et al.*, 2005). Deworming improves children's health and nutritional status which in turn increases school enrollment, attendance and school achievement and decreases grade repetition. Treatment against worms has the effect of decreasing anaemia rates and increasing the child's micronutrient levels (Freund *et al.*, 2005). In the current study area, the Ministry of Public Health and Sanitation had embarked on a periodic

helminth deworming, but incidences of re-infection were noted in the agriculture staff facilitated school.

Pupils' Dietary Intakes at Pre-test

This study showed a low intake of most nutrients except carbohydrates which were above RDA. The low mean intakes could have been influenced by the poor harvests, large family sizes and the level of inflation that affected food access during the study. In poor countries, diets tend to be deficient in multiple micro-nutrients and not only iron and folate, but deficiency in vitamin B₁₂, vitamin A as well as zinc contribute to iron deficiency anaemia (Bwibo and Newmann, 2003).

Many factors influence dietary intake at individual and household levels. It has been documented in some studies that the bigger the land the more diversified crops and livestock breeds are grown and kept respectively meaning diversified diets and more nutrient intake. Research has shown that the higher the income, the better the dietary intakes and the bigger the household the higher the competition for various resources (Munyanga *et al.*, 2010). Low dietary iron intake is an attributed cause of iron deficiency and anaemia in many parts of the developing world. Food-based intervention should be one of the important strategies for reducing the magnitude of the problem of anaemia in school children and their communities (Tatala *et al.*, 2004).

Pupils' Nutrition Knowledge at After Interventions

Post-tests showed a significant difference in nutrition knowledge with the experimental schools performing significantly better than the control school. The

performance of the control school also improved in some nutrition knowledge aspects such as the knowledge of enhancers of iron uptake, food guide pyramid and iron rich green vegetables. This could have been contributed by the first sensitization during the pre-test assessment, which may have provoked the pupils thinking and understanding of the nutrition knowledge. The pre-test post-test improvement in the control schools was however not significant ($p>0.05$) as compared to the performance of the experimental schools. Findings in an integrated rural nutrition project in Kawambwa, Zambia indicated that nutrition education programs have a significant impact on knowledge and attitudes than activities that only aimed at increasing food availability (Kukunted, 2008). The pre-intervention test had shown that without adequate training no sex would have an advantage over the other in nutrition knowledge. Significant improvement in nutrition knowledge and practice were observed in all the experimental schools under the different facilitators, while the control school improved but not significantly. In the study, the control school could have improved because the children were exposed to similar questions and discussions may have occurred after the first exposure meaning an improvement in the repetition (post-test).

Peer education can produce leaders in nutrition education who act as positive role models for other pupils. Peer education makes a conscious use of peer influence in a positive way (meaning in a way that contributes to everyone's well-being) (www.epto.org, 2013). It is well documented that peers have confidence with one another and this could have resulted into the good performance under the peer facilitation strategy. The other reason could probably be because the class was fairly small with twenty seven pupils. The primary outcome was improved nutrition

knowledge while the iron, worm status and practice were considered as secondary outcomes resulting from the positive effect of the intervention. Changes in practice after intervention demonstrate the effectiveness of the intervention programmes in improving nutrition both among school pupils and household members. Class participation and iron rich food consumption improved greatly. These findings are in agreement with a study done in India whereby there was improved nutrition knowledge after interventions (Sangeetha *et al.*, 2010). Pupils in the experimental schools adopted new projects as compared to the control school. Nutrition education leads to general improvement in dietary patterns and other practices like use of leaky tin, hand washing and better farming practices.

Pupils' Nutrition and Health Practices After Intervention

After the interventions, nutrition and health practices improved greatly at schools and the pupils' households. For example, in this study, consumption of traditional vegetables before the nutrition intervention was poor although almost every family had a small plot to grow the crops. After the intervention, growing of vegetables, consumption of cowpeas, amaranth and black nightshade increased. Increase in the hemoglobin levels and decrease in worm infestation was noted in the experimental schools compared to the control school. The results were in agreement with a study in Machakos primary schools whereby the pupils transferred nutrition knowledge to their community/households and improved various practices like hygienic practices and consumption of various foods which in turn improved their nutritional status (Mbithe, 2008).

The findings of the intervention study leads to the conclusion that the food based approach using the three facilitators (Peer facilitated, Researcher facilitated and agricultural extension worker facilitated) could have some influence and hence effective to combat deficiencies and promote good health and well-being of the pupils. Gains made may be attributed to the interventions made, when comparison were made between the experimental schools and the control school. Similar findings are reported in a study done in Chennai district, India where by haemoglobin levels of school children who used micronutrient rich foods improved significantly. Sound nutrition knowledge imparted to the children and their households may also have helped to promote their home food intake (Sangeetha *et al.*, 2010). The impact was the improved nutrition and haemoglobin levels. The School Health and Nutrition Policy emphasize the promotion of school gardens to enhance integration of nutrition interventions into routine school activities (MOPHS, 2011).

Relationship of Variables

The improvement in nutrition knowledge, practices and deworming may have contributed to the improvement in the haemoglobin levels in the experimental schools. The findings were in agreement with a study undertaken in Nepal whereby the protozoa infection was higher than that of helminth infection in school children (Chandrashekar *et al.*, 2005). Amoebiasis is usually waterborne as a result of untreated or unboiled water for domestic use. The results are also in agreement with a study undertaken in 30 primary schools in Western Kenya which found out that under- nutrition and helminth infections have a large impact on the survival and quality of lives of school aged children living in Africa (Koukounari *et al.*, 2008). The same study further highlighted the importance of parasites as contributors to reduced haemoglobin levels among school children and helps guide the

implementation of integrated school health intervention programmes that include deworming and micronutrient control in areas of differing parasitic transmission. In the current study, haemoglobin levels were low before the interventions but significantly improved in the experimental schools. The peer facilitated school had the best improvement in haemoglobin levels, followed by the agriculture facilitated and then the researcher facilitated school. In the peer facilitated school, the school management and the parents were very supportive and adherence to drugs use was almost 100%. It is well documented that nutrition knowledge, good dietary practices and hygiene can reduce disease prevalence. The results in the current study are in agreement with a study undertaken in Tanzania on school children whereby there was a significant correlation between iron intake and serum ferritin at $p < 0.05$. Food-based intervention was an important strategy for reducing the magnitude of the problem of anaemia in the school children (Tatala *et al.*, 2004). Establishment of 4K clubs in the intervention schools was done to ensure sustainability of the intervention and demonstrate kitchen gardening to the pupils and their households.

Iron deficiency anemia is a serious health problem that affects school going children reducing pupils' school performance and productivity. Iron deficient children tend to exhibit irritability and a low level of engagement with an interest in their immediate environment. These traits inhibit the development of a child's active learning capacity and impinge upon school achievement. Poor performance in a variety of achievement tests by iron deficient children enrolled in school has been reported by several authors. Iron deficiency anaemia is the end stage of a relatively long process of deterioration in Hb levels. Hb levels are indicators of the final stage of IDA. In the current study it was observed that the Gatanga primary school going children

were moderately anaemic at baseline but improvements were noted in the experimental schools after the interventions. Children also appreciated hand washing as a hygienic practice and adoption of leaky tins and dish racks was observed at household level in the experimental schools.

The facilitations used to address iron deficiency anaemia through nutrition education and associated measures to increase dietary intake and control of parasitic infection were effective measures which can be up-scaled to other locations with a similar population. Signs and symptoms of anaemia are non-specific and difficult to detect though simple laboratory tests can be used to diagnose and determine its severity. According to a study undertaken in primary schools on health and sanitation in Nairobi informal settlements, schools that worked as control groups observed little or no change in health promoting activities like hand washing which helps prevent communicable diseases particularly in school settings. On the other hand, in the experimental schools, children for instance, valued hand washing as an important health practice (Keidar and Mwangi, 2011).

Nutrition knowledge offered to the pupils impacted positively as the results revealed. The experimental schools improved in all aspects of the intervention as compared to the control school. The experimental school pupils households adopted various practices and increased food production in vegetable growing and small livestock keeping. Dish racks and leaky tins were used in some households hence increasing hygienic practices. Improved stoves were used which add to food nutrient retention in the experimental schools. The relevant stakeholders should come up and address

this public health problem with strategies to improve iron status and help the growing child attain their educational dreams successfully for the growth and development of our nation.

CHAPTER SIX: SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of Findings

Introduction

Iron deficiency anaemia is among the world's widespread health problem especially for school age children but it's rarely studied in developing countries. It affects more than 50% of school going children. Low dietary iron intake has been attributed cause IDA in many parts of the developing world.

6.2 Key Findings

6.2.1 Baseline Results

Nutrition Knowledge

Pupils had little nutrition knowledge at baseline. They scored an average of 30.05% indicating that the pupils had little nutrition knowledge and therefore, required more in order to be able to address the nutrition and health problems that affect them. The mean marks were not significantly different across all schools at $p=0.05$.

Demographics and Socio-economics Characteristics of Households

Most caregivers were casual labourers with low incomes. The average household size was 6 persons per household, with 6-8 persons per household taking 53.7%. Most households had small parcels of land and food insecurity was reported in most homes.

Food Consumption Patterns

At baseline, the mean nutrient intakes were all below the RDAs except for carbohydrates. The average mean intake of iron by the study pupils was 5.6 mg per day compared to 8-13 gm for ages 10-15 years.

Technologies Available that Enhance Nutrition and Health

There were very few technologies that promote nutrition and health in the pupils' households and also in the schools. These technologies include hygienic and gardening devices that promote health and nutritional status. About 52% practiced some conventional kitchen gardening of kales at their homes with the assistance of parents.

Health and Sanitation of the Households

The hygienic practices of the pupils' households were average with 57% households with tap water and 100% with toilets. A small number of children (12%) said that they rarely washed hands after visiting the toilet.

Pupils' Dietary Iron Intake

From the seven day food frequency, the food consumption patterns were similar across all households. For dietary diversity score most of the households had medium consumption of various food groups. At baseline 4.5 % had low dietary diversity scores, 91% had medium and 4.5% had high diversity scores. The quantities consumed in some instances were little especially for onions, tomato and vegetables. The scores improved after the interventions with those at high diversity score at 20.8%.

Iron and Parasitic Status at Baseline

Almost a third of pupils were found to be anaemic after altitude adjustments at a calculated factor 0.5 for Gatanga altitude (2237m ASL) at the baseline study. Most pupils (63.1%) were found to be infested with *Amoeba histolytica* and *Ascaris lumbricoides*.

6.2.2 Intervention Results

The Impact of the Study After the Intervention

The average mean mark in nutrition knowledge in experimental schools improved from 30.05% to 46.8% while the control school did not improve at 31.21%. Post-tests showed a significant difference with the experimental schools performing significantly better than the control school at $p=0.001$. Practices like vegetable growing, livestock production, personal hygiene, leaky tin and dish-racks installation improved after the intervention in the experimental schools. There was increased consumption of fruits and green leafy vegetables after the interventions. After the interventions, those children who were anaemic decreased in the experimental but increased in the control schools. This implies that the intervention was effective and the pupils' haemoglobin levels were improving. In the pre-test, all the schools were found to be infested with worms while in the post-test the stool samples were examined for evidence of parasitic infections and it was found that the prevalence was higher in the control school compared to the experimental schools.

Relationship of Variables

Relationship between nutrition knowledge and nutrient intake was positive and there was a statistically significant relationship between nutrition knowledge and

hemoglobin levels at ($r=0.253$, $P=0.025$). Launching of 4K clubs was done during the study starting with Agriculture staff facilitated (Kigio) primary school. A rabbit project for multiplication to the other study schools was started. From the results, it can be concluded that the intervention was successful and led to improved intake of iron and haemoglobin levels of the study pupils.

6.3 Conclusion

6.3.1 At Baseline

1. The study results showed that both sexes at primary schools were almost equally represented and had acquired some nutrition knowledge from science teachers, health facility, radio, television, and parents or neighbours. From the pre-test assessment most pupils were not knowledgeable in most practices and confidence in nutrition knowledge was inadequate hence more knowledge was needed as indicated by the pupils performance at baseline. All schools scored very poorly in the pre-tests on nutrition knowledge at baseline study. Many pupils had an interest in learning more in nutrition as a subject.
2. The baseline study revealed that the households had low consumption of animal products and high consumption of plant foods. There was minimum consumption of traditional vegetables which were generally overcooked. Few households consumed organ meat, eggs and red meat. The mean nutrient intakes were all below the RDAs for iron.
3. There was a high prevalence of intestinal parasites (*Entamoeba histolytica* & *Ascaris lumbricoides*). The prevalence of protozoal infection was higher than that of helminths. The schools that were up-stream were less infested than those downstream. The results indicate that intestinal parasitic infestation among school children in the study area was mainly water borne.

6.3.2 Effects of the Intervention

1. Nutrition knowledge given to the experimental schools improved their dietary intake, hygienic practices and agronomic practices.
2. The helminth and amoeba status decreased after the interventions in the experimental schools where the pupils took the anti-amoebiasis and anti-helminth drugs while it increased in the control school.
3. The hemoglobin levels increased after the intervention in the experimental schools while it decreased in the control schools.
4. All nutrition education facilitators showed some impact such that there was improved performance in all aspects with the peer facilitated school doing the best.
5. Relationship between nutrition knowledge and iron rich food intake showed increased nutrient intake and iron status. There was an increased iron rich food intake and hence increased hemoglobin levels. These interventions provided an opportunity to link food security interventions and nutrition outcomes.

6.4 Recommendations

The following recommendations are based on the findings of the study:

6.4.1 To Policy Makers

1. Objective 1 and 4 Interventions

The government should consider allocating funds for school meals in all primary schools to improve on food consumption and address the issue of iron deficiency and should preferably have iron rich snacks and school meals. The school feeding

programs in place in Kenya targets schools in ASAL areas (Home Grown school feeding program).

2. Objectives 6 Baseline and 2& 3 Interventions

The Ministry of Education to have a policy on harnessing the power of peers in primary schools to promote interest and improve agricultural production, food and nutrition security to the young learners.

6.4.2. For Practice

1. Objective 1 Baseline

Emphasis should be laid on the importance of nutrition education among the school pupils to address malnutrition. Learners should be given comprehensive knowledge for them to understand the importance of a balanced diet and the causes of deficiency diseases especially the importance of micronutrients like iron in the body. Ministry of Education should include topics in the syllabus that focus on promoting the use of iron rich foods to both the pupils and the caregivers.

2. Objective 2 and 4 Baseline

The caregivers should be trained on the importance of energy saving devices like the improved stoves and the fireless cookers to promote food nutrient retention and fuel wood conservation.

3. Objective 3 Baseline

Emphasis should be laid on the importance of personal hygiene, food safety and diseases associated with lack of observance in good personal hygiene both at school and home. Introduction of “leaky tins” next to the toilets and hand washing is of importance. Nutritionists and health workers should continuously educate households

and schools to ensure all hygienic practices are observed, which includes hand washing, treated or boiled drinking water at school and households and the use of dish-racks at household level. The parasitic infestations decreased in the experimental schools compared to the control school, consequently the haemoglobin levels increased in the experimental schools compared to the control school. This calls for action amongst the stakeholders to address this health and nutrition problems amongst this age category.

4. Objective 4 Baseline

Projects and technologies should be promoted by the Ministries of: Education, Agriculture and Public health that embrace food production in small pieces of land; these include multi-storey kitchen gardening, and small livestock production. Schools should start projects on small livestock and kitchen gardening for the purpose of teaching the school children food production and utilization skills.

5. Objective 4 and 5 Baseline

Practical knowledge on food production should be promoted in all primary schools by establishing clubs that are agriculture and environmental related. School management should encourage the young children to embrace agricultural production in school gardens to enhance food security.

6.5 Suggestions for Further Research

1. The project promoted multi-storey kitchen gardening as farming technologies and hygienic practices. The suggestion is that a longitudinal study should be done to determine the adoption rates of the technologies at household level so that the constraints can be addressed.

2. Another study should be done to determine the level of waterborne parasitic infestation on the other household members to address the issue of re-infection to the pupils.

REFERENCES

- Alex, B; Njenga, J and Embeywa, H. (2010). *Science in Action, Pupils Book 5*. Oxford New Syllabus, University Press, East Africa Ltd, Nairobi Kenya. Pg 56-63.
- Alex, J. (2011). *Nutrient Guide: Food Composition Tables for More Than 400 Natural and Conventional Foods*. Update on America's Vanishing Nutrients, 2011 planetary Health/Amberwaves . P.O. Box 487, Becket MAO 1223, 413-623-0012 Shenwa@ bon.net Pg 8-33
- Ali-Olubandwa, A.M; Kathuri, N.J; Odero-Wanga, D; Shivoga, W.A. (2011). *Challenges Facing Small Scale Maize Farmers in Western Province of Kenya in the Agricultural Reform Era*. American Journal of Experimental Agriculture 1(4): 466-476, 2011. Science Domain International. www. Scincedomain.org. Pg 471.
- Amani, R and Soflaei, M. (2006). *Nutrition education alone improves dietary practices but not hematologic indices of adolescent girls in Iran*. Department of Nutrition, Faculty of Paramedicine, Ahvaz Jundi-Shapour University of Medical Sciences, Ahvaz, Iran. PubMed. US National Library of Medicine National Institutes of Health. Food Nutr Bull. 2006 Sep;27(3):260-4.
- 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 school children in Kenya: a randomized controlled trial, scientific journal*. The Lancet of Sub-department of Human Nutrition Wageningen University.
- Basu, S; Srikanta, B; Hazarika, R and Parmar, V. (2004). *Prevalence of Anaemia Among School going Adolescents of Chandigarh*. Department of Immunohematology & Blood Transfusion, and Paediatrics, Government Medical College & Hospital, sector 32, Chandigarh, India. Vol. 42-June 17, 2005. Pg 592- 597.
- Bhutta, Z.A. and Dewraj, H. L.(2007). *Iron and zinc deficiency in children in developing countries*. National Center for Biotechnology Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA. BMJ. 2007 January 20; 334(7585): 104–105.
- Bobonis, G. J; Miguel, E. and Sharma, C. P. (2004). *Iron Deficiency Anaemia and school participation*. Poverty Action lab, Translating Research Into Action Paper 7, Department of Economics, University Of California, Berkeley gbobonis@econ.berkeley.edu,Pg-1-10.
- Bwibo, N.O. and Newmann, C.G. (2003). *Research on food intake and nutrition in Kenya Communities*. Department of Pediatrics, Faculty of Medicine, University of Nairobi, Nairobi, Kenya and Department of Community Health

Sciences and Pediatrics, Schools of Public Health and Medicine, University of California Los Angeles, Los Angeles, CA. Journal of Nutrition. The American Society for Nutritional Sciences.

Chandrashekhar, T.S; Joshi, H.S; Gurung, M; Subba, S.H; Rana, M.S. and Shivananda, P.G. (2005). *Prevalence and Distribution of Intestinal parasitic infestations among school children in Kaski district, Western Nepal*. Journal of medicine and biomedical Research, college of medical Sciences, University of Benin, ISSN: 1596-6941, Vol.4, Num.1, June 2005, Pg.78-82.

Dabone, C; Delisle, H. F. and Receveur, O. (2011). *Poor nutritional status of school children in urban and peri-urban areas of Ouagadougou (Burkina Faso)*. Department of Nutrition, Faculty of Medicine, University of Montreal, 2405 Chemin de la Côte Ste Catherine, Montreal Qc, H3T 1A8, Canada. Nutrition Journal 2011, 10:34 doi:10.1186/1475-2891-10-34.<http://www.nutritionj.com>

Duncan, B.S. and Mcdade, T. (2006). *The cultural Ecology of iron Deficiency among Northern Kenya School Children*. Journal of Human ecology, International, Inter-disciplinary Journal of Man-Environment. Human Ecology Special Issue No 14:107-116, Chapter 15. KRE Journals ON-LINE publishers since 1933.

Food and Agriculture Organization. (2013a). *Guidelines for Measuring Household and individual Dietary Diversity*. Prepared by FAO Nutrition and Consumer Protection Division Rome, Italy.www.foodsec.org. ISBN 978-92-5-106749-9, Reprint 2013, Pg1-49.

Food and Agriculture Organization. (2013b). *Nutrition Education in Primary Schools in Argentina*. UN: Ministry of Education, Science and Technology (MECyT); Secretary of Agriculture, Livestock, Fisheries and Foods, (SAGPyA) of the Ministry of Economy and Production. FAO web site retrieved 25thMarch 2013.

Food and Agriculture Organization. (2005a). *Classroom Curriculum Chart. Learning Objectives For Nutrition Education in Primary Schools in Developing Countries*. Promoting Lifelong Health.

Food and Agriculture Organization. (2005b). *Nutrition Education in Primary Schools.* " A planning guide for curriculum Development Vol 1 and 11. FAO viale delle terme di caracalla, 00100 Rome Italy. Pg 1-8

Food and Agriculture Organization. (2005c). *Setting up and Running a school garden. A manual for teachers, parents and communities*. Promoting Lifelong healthy eating habits.FAO viale delle terme di caracalla,00100 Rome Italy. Pg 1-199.

Freund, P; Graybill, E. and Keith, N. (2005). *Health and Education Working Together*. A case study of a successful school health and nutrition model. Pg1-10

- Gitau, G. N; Kimiywe, J and Waudo, J. (2014). *Investigating Iron Status of Women in Kenya*. A published Msc Thesis. Lambert Academic Publishing Press© OmniScriptum GmbH & Co. KG Pg 23-25.
- Gitonga, C. W; Karanja, P. N; Kihara, J; Mwanje, M; Juma, E; Snow, R.W; Noor, A.M, and Brooker, S. (2010). *Implementing school malaria surveys in Kenya: towards a national surveillance system*. Malar J. 2010; 9: 306. Published online 2010 October 30. doi: [10.1186/1475-2875-9-306](https://doi.org/10.1186/1475-2875-9-306) PMID: PMC2984573
- GOK/GTZ. (2006). *The farm Management Handbook of Kenya Vol.11*. Natural conditions and Farm Management Information 2nd Edition Part B- Central Kenya. Publisher Ministry Of Agriculture, Kenya in Cooperation with the German Agency for Technical Cooperation (GTZ). Pg 38.
- Government of Kenya. (2012). *National Food and Nutrition Security Policy*. Ministry of Agriculture. Agricultural Sector Coordination Unit (ASCU). Pg 1-20.
- Government of Kenya. (2010). *Public Sector workplace Policy on HIV/AIDs*. Ministry of State for Public service, Office of the Prime Minister. Pg 1.
- Government of Kenya. (2007). *School Feeding Programme Handbook*. Ministry of Education and World Food Programme. Kenya institute of Education.
- Guiney, A. M.(2010). *Call to Action for WASH in Schools*. Drinking water, sanitation and Hygiene- WASH in schools. <http://www.unicef.org/>.
- Guiney, A. M. (2010). *Call to Action for WASH in schools*. <http://www.unicef.org/> . Pg 3-10.
- Gunde, R. (2004). *School children in Developing world: Health, Nutrition and school performance*. UCLA International institute,11248 Bunche hall,Box 951487, Los Angeles, CA90095-1487, email:info-intl@internationalucla.edu.
- Hongo, T. (2004). *School Nutrition Programs in Kenya: Successes and Problem areas*. A Paper presented in Global Child Nutrition Forum and AFSA Annual National Conference, Indianapolis, Indiana USA. Retrieved 15th August, 2013.
- HPES. (2009). *Peer Education Systems – Overview*. Harvard School of Public Health- Harvard Peer Education Systems, education, prevention, support. hpes.info@harvard.edu: t - 617.432.3936 /f - 617.432.3123.
- IFAD. (2013). *Calculating sample size*. Retrieved on 4th July 2013.
- ICF/MACRO. (2010). *Kenya demographic and health survey 2008/09*. Kenya Bureau of statistics, Nairobi, Kenya. Calverton, Maryland: KNBS and ICF Macro. Pg1-106.

- Ismail, I. (2004). *Awareness of Teachers of the Relationship between Students' Performance and Nutrition Status: Egypt's Experience*. National Institute of Nutrition, Egypt.
- Israel, G.D. (1992). "Determining Sample Size." Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD-6.
- Jaswant, K. S. (1993). *National Composition and Planning of Satisfaction diets in Kenya*. Government printers, Nairobi, Kenya.
- Jukes, M. C. H; Drake, L. J. and Bandy, D. A. P. (2007). *School Health, Nutrition and Education for all: Levelling the playing field*. CABI Publishing, Wallingford, 2007. ISBN-13: 978-1-845-93311-1. Bulletin of the World Health Organization 2009;87:75-75. doi: 10.2471/BLT.08.059519
- Kabanza, P. N. (2003). *Factors influencing acceptance of institutional Meals by students at Public Universities in Uganda*. A dissertation on Food Nutrition and Dietetics of Kenyatta University.pg 20-60
- Kakunted, P. (2008). *Nutrition Education Material to Address iron deficiency Anaemia in Kenya*. A Master's of science Thesis, Faculty of the Department of Nutrition, Food Science, and Packaging, San Jose State University. UMI Number: 1459707. ProQuest LLC,789E. Eisenhower Parkway, P.O Box 1346 Ann Arbor, MI 48106-1346.
- Kapil, U . and Kaur, S.L. R.(2007). *Prevalence of anaemia and iron, folic acid and vitamin B-12 deficiencies in children of 11-18 years of age in India*. All India nstitute of Medical Sciences, New Delhi, India. M 76.
- Kapur, D; Sharma, S. and Agarwal, K.N.(2003). *Effectiveness of Nutrition Education, Iron Supplementation or both on Iron status in children*. Indian Pediatrics 2003; 40:1131-1144
- Kasiulevicius, V; Sapoka, V. and Filipaviciute, R. (2006). *Sample Size Calculation in Epidemiological Studies*. Theory and practice. Gerontologija 7(4) 225-231. Institute of Experimental and Clinical Medicine, Vilnius University.
- Kaya, M; Pehlivan, E; Aydogdu, I; Genc, M; Gunes, G; Kaya, E. and Kuku, I. (2006). *Iron Deficiency Anaemia Among students of Two primary Schools at different socio-economic conditions In Malatya, Turkey*. Public Health specialist, Local office of the Ministry of Health, Mother and Child health center, Malatya, Inonu Universitesi Tip Fakultesi Lojmanlari, 22 Blok, No;7 Malatya-Turkey. Pg 236-242 .
- Keidar, O. and Mwangi, A. (2011). *Creating healthy schools: implementing a Health Promoting Schools initiative in Nairobi's informal settlements*. APHRC policy brief no. 23. [Powered by WordPress.com](http://www.aphrc.or.ke/wordpress/wp-content/uploads/2011/07/APHRC-Policy-Brief-23-Creating-Healthy-Schools-Implementing-a-Health-Promoting-Schools-Initiative-in-Nairobi-s-Informal-Settlements.pdf)
- Kigotho, W. (2009). *Report paints sad picture of malnutrition on learners*. Kenya standard Newspaper of 17th October 2009.

KIHBS. (2005/06). *Basic Report*. ISBN: 9966-767-07-X Pg 1-103.

Kimiywe, J. (1999). *The effect of peer-facilitated participatory Nutrition Education on Acceptability of Reduced –fat Foods by 5TH Graders*: A doctoral Dissertation. The Florida State University College of Human Sciences. Pg 20-25.

Koukounari, A; Estambale, B. B. A; Njagi, J. K; Cundill, B; Anyanga, A; Crudder, C; Otido, J; Jukes, M. C. H; Clarke, S. E. and Brooker, S. (2008). *Relationship between anaemia and parasitic Infections in Kenyan school children: A Bayesian hierarchial modelling approach*. Int. J. Parasitol 2008 December, 38(14). 1663-1671. Published online 2008 June 12 doi 10.1016/j-ijpara.2008.05.013. UK PUBmed Central.

Lachin ,J. M. (1981). *Introduction to sample size determination and power analysis for clinical trials*. Controlled Clinical Trials 2, 93-113. Biostatistics centre, George Washington University Bethesda, Maryland. USA.

Langinger, N. (2011). *School Feeding Programs in Kenya: Transitioning to a Homegrown Approach*. Standard Journal of International Relations. Vol.X111 No.1: 30-37.

Lyons, L. (2013). *Nepal Children- Agriculture in Schools*. 2000-2013 Global Giving Foundation, a 501(c) 3 organization (EIN: 30-0108263). 1023 15th Street, NW, 12th Floor, Washington, DC 20005.<http://www.etc-nepal.org>.

Mayo, C. (2011). *Iron Deficiency in Children: Prevention tips for Parents*. 1998-2012 Mayo Foundation for Medical Education and Research (MFMER). Mayoclinic.com. MYO1654 Pg. 1-2

Mbithe, D. D; Kimiywe J. O; Waudu J. N. and Orodho J. A. (2008). *Promotion of Nutrition Education Interventions in Rural and Urban Primary Schools in Machakos District, Kenya*. A Journal of Applied Biosciences (2008), Vol6:130-139 ISSN 1997-590. www.biosciences.elewa.org.

Ministry of Agriculture. (2009a). *Thika District Annual Report* .Pg 3-4.

Ministry of Agriculture. (2009b). *Nutrition Information and recipe book for People Living with HIV/Aids*. Pg 1.

Ministry Of Agriculture. (2008). *Nutrition Training Manual. Njaa Marufuku Programme; in collaboration with Ministries of Health and Education*. Pg126.

Ministry of Agriculture. (2008a). *A handbook on Appropriate Technology for Household time and Energy saving*. Pg17.

Ministry of Education, (2009a). *National School Health Policy*. Ministry of Public Health and Sanitation and Ministry of Education. Website: www.health.go.ke/www.education.go.ke.

- Ministry of Education. (2009b). *National School Health guidelines*. Ministry of Public Health and Sanitation and Ministry of Education. Website: www.health.go.ke/www.education.go.ke
- Ministry of Public Health and sanitation. (2012 a). *Scaling Up Nutrition Symposium 5th -6th November 2012 Reports*.
- Ministry of Public Health and sanitation. (2012b). *National guidelines for healthy diets and physical activity*. First draft, September 2012 Pg 1-11.
- Ministry of Public Health and sanitation. (2012c). *High Impact Nutrition Interventions(HiNi) Bulletin*. Scaling Up Nutrition, Nutrition is Key, “Take up you role, Act now”. Division of Nutrition. Pg 2- 4.
- Ministry of Public Health and sanitation. (2011). *Kenya National Nutrition Plan of Action (2011-2017) Draft* . Pg 4-58
- Ministry of Public Health and sanitation. (2009). *Thika District Health Activities Annual Report*. Pg 32, 33 , 42.
- Ministry of Public Health and sanitation / United Nations Childrens Education Fund. (1999). *Anaemia and the Status of Iron, Vitamin A and Zinc in Kenya*. The 1999 National Micronutrient Survey Report Pg 3-157.
- Morbidity and Mortality Weekly Report. (MMWR). (1996). *Recommendations and Reports, Guidelines for School Health Programs to Promote Lifelong Healthy Eating* .June 14, 1996 / Vol. 45 / No. RR-9 U.S. Department of health and human services ,Public Health Service Centers for Disease Control and Prevention (CDC) Atlanta, Georgia 30333 Pg 2-18.
- Mugenda, A.G. (2008). *Social research and methodology*. Art Pg 186.
- Mugenda, O. and Mugenda, A. (2003). *Research Methods. Quantitative and Qualitative Approaches* .Nairobi. Acts press, 5 41-68
- Mukui, J. T. (2000). *Draft Nutrition Policy Report*. Ministry of Planning and National Developmental/UNICEF, Pg 45-46.
- Munasinghe and Broek. (2005). *Anemia in Pregnancy in Malawi-A Review*. Liverpool School of Tropical Medicine, UK. Pg 6-20.
- Munyanga, M; Jayne, T. S. and Burke, W. J. (2010). *Pathways into and out of Poverty: a Study of Rural Household wealth Dynamics in Kenya*. Egerton University WPS 39/2010. Tegemeo Institute of Agricultural Policy and Development. P.O. Box 20498. 00200, Nairobi, Kenya. Website URL: <http://www.tegemeo.org>. Pg 1-15.
- Nair, M. K. (2001). *Alternate Stages For Improving Iron Nutrition: Lessons from Recent Research*, Department of Biophysics, National Institute of Nutrition,

India Council Of Medical Research, British Journal Of Nutrition, .85 Supp. 2, S187-191.

- Nederveen,,L. (2010). *Global Mapping of Initiatives in School Health and Nutrition, with Emphasis on Health Education*. Together for Child vitality- School Feeding Programme. United Nations World Food Programme. *website: wfp.org/school-meals*. Pg 27,30,31,37,41-44.
- Ngonjo T.W; Kihara J.H; Gicheru M ;Wanzala P; Njenga S.M. and Mwandawiro C. S.(2012). *Prevalence and Intensity of Intestinal Parasites in School age Children in Thika District, Kenya*. African Journal of Health Sciences, Volume 21, Number 3-4 April-June 2012. Pg, 157,158.
- Njenga, S. M; Mwandawiro, C. S; Muniu, E: Mwanje, M. T; Haji, F. M. and Bockarie M. J. (2011). *Adult population as potential reservoir of NTD infections in rural villages of Kwale district, Coastal Kenya: implications for preventive chemotherapy interventions policy*. Parasites & Vectors 2011, 4:175 doi:10.1186/1756-3305-4-175 <http://www.parasitesandvectors.com>.
- Nutrition Reviews.(2009). DOI: 10.1111/j.1753-4887.1997.tb01609.x. Vol 55 Issue 6 pages. Online publishing 2009. Wiley Online Library Retrieved 15th August 2013.
- Olney, D. K; Iannotti, L. L; Talukder, A; Ruel, M. T. and Quinn, V. (2009). *Assessing impact and impact pathways of a homestead food production program on household and child nutrition in Cambodia*. Food and Nutrition Bulletin, vol. 30, no. 4 © 2009, The United Nations University. Deanna K. Olney, 2033 K St., Washington, DC 20006, USA;e-mail: D.Olney@cgiar.org. Pg 355-367.
- O'reilly, C. E; Freeman, M. C; Ravani, M; Migele, J; Mwaki, A; Ayalo, M; Ombeki, S; Hoekstra, R.M. and Quick, R. (2006). *The Impact of School-based safe water and hygiene programme on knowledge and practice of students and their parents: Nyanza Province, Western Kenya, 2006*. National Center for Biotechnology Information, U.S. National Library of Medicine 8600 Rockville Pike, Bethesda MD, 20894 USA.
- Orodho, J. (2009). Sampling lecture on 13th May 2010, Kenyatta University.
- Ramakrishnan, U. and Huffman, S.L. (2008). *Multiple Micronutrient Malnutrition. Nutrition and Health in Developing Countries*. Department of International Health, Rolling School of Public Health, Emory University, Atlanta, GA and Global Alliance for Improved Nutrition, Geneva Switzerland. Pg 531.
- Ramzan, M; Ali, I. and Salam, A. (2009). *Iron Deficiency Anemia in School Children of Dera Ismail Khan, Pakistan*. Pakistan Journal of Nutrition 8 (3): 259-263, 2009 .ISSN 1680-5194.
- Rascona, R. (2011). *Global Alliances for clean cook stoves. Igniting Change: A strategy for universal adoption of clean cook stoves and fuels*. 1800

Massachusetts Avenue NW/ suite 400/ Washington, DC 20036/+1-202-887-9040. www.cleancookstoves.org. Pg 4-49.

- Reddy, M.B; Hurrell, R.F. and Cook, J.D. (2006). *Meat Consumption in a Varied Diet Marginally Influences Nonheme Iron Absorption in Normal Individuals*. Department of Food Science and Human Nutrition, Iowa State University, Ames, IA 50011; Institute of Food Science and Nutrition, Swiss Federal Institute of Technology, Zurich, Switzerland; and Department of Medicine, Kansas University Medical Center, Kansas City, KS 66160. American Society for Nutrition- Journal of Nutrition. Pg 1, 6.
- Reicks, M. (2006). *Iron Absorption and Coffee/Tea Intake*. University of Minnesota-Extension. Department of Food Science and Nutrition, 225 FScN, 1364 Eckles Avenue, St. Paul, MN 55108, 612-624-1290, <http://fscn.cfans.umn.edu>.
- Sandoval, C. (2013). *Approaches to the Child with Anaemia*. UpToDate® Walters Kluwer Health Clinical Solutions. Retrieved on 15th August 2013.
- Sangeetha, N. and Premakumari, S. (2010). *Effect of Micronutrient Supplementation on the Nutritional and immune Status of School going children with Iron deficiency Anaemia*. Department of Food science and technology, Pondicherry University. International Journal of nutrition and metabolism, Vol.2(3) pg. 045-055 March 2010. www.academicjournals.org.
- Stake, R. (2000). "Case Studies", In N Denzin & Y Lincoln (eds), *Handbook of Qualitative Research*. 2nd edition, sage Publications Inc., Thousand Oaks Pg 435-54.
- Stoltzfus, R. J; Michele L; Dreyfuss, M.P.H; Hababuu, M; Chwaya, M.D and Albonico, M.D. (2009). *Hookworm Control as a Strategy to Prevent Iron Deficiency*.
- Tatala, S. R; Ash, D; Svanberg, U. & Ndosu, G. (2004). *Impact of dietary iron Intake on anaemia in Tanzanian school children*. SAJCN 94, Nov/Dec, 2004 Vol.17 Article No.3 Pg 94-100.
- Taylor, A. K. (2011). *School Feeding Program in Kenya*. NGO focused on community based conservation projects. Global Child Nutrition Foundation. 120 Waterfront Street, Suite 300 National Harbor, MD 20745.
- Turyamwijuka, S. (2007). *The Role of Peer-to-Peer education in overcoming Cultural Barriers to HIV Prevention Communication Approaches: Experiences from Primary Schools in Uganda*. Uganda Program for Human and Holistic Development (UPHOLD).
- Ullah, I; Sarwar, G; Aziz, S. and Khan, M. H. (2009). *Intestinal Worm infestation in Primary School Children in Rural Peshawar*. Department of Community Medicine, Khyber Girls Medical College, Peshawar, Pakistan. Gomal Journal of Medical Sciences July-December 2009, vol.7, No.2 Pg132-136.

- UNESCO . (2010). *National Education Support Strategy (UNESS) for the Republic of Kenya 2010-2011*. Publishing Services Section, UNON, Nairobi –Kenya, ISO 14001:2004 certified .Pg 1-12.
- United Nations Childrens Education Fund. (2009). *Nutrition situation update and Rationale for Financing Nutrition within the Health sector in Kenya*.www.UNICEF.
- United Nations Childrens Education Fund. (2008). *The Kenya National Technical Guidelines for Micronutrient Deficiency Control*. Micro-nutrient Initiative. Ministry of Public Health and Sanitation, Kenya Pg 49-64.
- United Nations Childrens Education Fund. (2005). *Food Based Approaches to Reducing Micro-nutrient Malnutrition*. International Food Policy Research Institute. 2033K Street, NW, Washington DC 2006 USA Pg 45.
- United Nations Childrens Education Fund/Government of Kenya. (1998). *Situation Analysis of Children and Women in Kenya*. Nairobi Pg 101-110.
- USDA. (2011). Dietary reference intakes (DRIs). *Recommended Dietary Allowances and Adequate Intakes, Elements*. Food and Nutrition Board, Institute of Medicine, National Academies.Website.www.nap.edu.
- USAID.(2013). *Applied Basic Agri-Nutrition Resource Manual for Trainers*. USAID/KHCP, MOA & MOPHS pg 13.
- Vasishta S. K. and Patel N. M. (2002). *Learning Science for standard 5*, Latest Revised Syllabus. Malimu Publications. Printed by: English Press Limited P.O. Box 30127,00100, Nairobi.Pg 59-119.
- Vivas, A; Gelaye, B; Aboset, N; Kumie, A; Berhane, Y. and Williams, M. A. (2011). *Knowledge, Attitudes, and Practices (KAP) of Hygiene among School Children in Angolela, Ethiopia* .National Institutes of Health, National Center on Minority Health and Health Disparities (T37-MD001449). J Prev Med Hyg. 2010 June; 51(2): 73–79.
- World Food Programme/ United Nations Childrens Education Fund. (2006). *Global Framework for action. Ending child hunger and undernutrition initiative (Draft)*. WFP via C.G. Viola 68, Parco de' medici 00148, Rome Italy. UNICEF House, 3 United Nations, Plaza New York 10017, USA.
- World Health Organisation. (2013). *Micronutrient Deficiencies*. World Health Organization Website 2013. Retrieved on 25th March 2013.
- World Health Organisation. (2008). *Global Database on anaemia*. The database on anaemia by country on prevalence and mean haemoglobin concentration for Kenya.. Vitamin and mineral nutrition information System (VMNIS). World Health Organization Website 2012. Retrieved on 21st May 2012.

- World Health Organisation. (2007). *Micronutrient Deficiencies*. World Health Organization Website 2007.
- World Health Organisation. (2005). *Worldwide Prevalence of Anemia 1993-2005. WHO Global Database on Anemia. Centers for Disease Control and Prevention*. Atlanta, Georgia. WHO press, 20 Avenue Appia, 1211 Geneva 27 Switzerland. Pg 1.
- World Health Organisation. (2002). *Iron Deficiency Assessment, Prevention and Control Guide for Program Managers*. Geneva. WHO, 3-21.
- World Health Organization. (2001). *Effectiveness of large scale nutrition interventions*. Pg 6
- World Health Organisation /United Nations Childrens Education Fund. (1998). *Nutrition Support Programmes*. Published by WHO/UNICEF. Pg126.
- www.epto.org. (2013). *Together, We learn, We Change*. European Peer Training Organisation. Retrieved on 5th November 2013.
- www.innvista.com. (2012). *Amoebas. VITA-MIX*. Retrieved 12th March 2012.
- www.schoolfoodtrust.org.uk. (2012). *School Food Trust, Eat Better Do better, Iron rich recipes and tips-Recipes for success*. Registered charity number 1118995. Pg 1-20. Retrieved on 21st May 2012.
- www.schoolsandhealth.org. (2013). *School- Age Children Their Health and Nutrition*. The partnership for Child Development. Department of Infectious Disease Epidemiology,Imperial College, London W2 1PG, UK Retrieved on 4th November 2013.
- www.wikipedia.com. (2012). *Taboo food and drink*. Wikipedia the free encyclopedia. Rretrieved on 17th August 2012.
- www.4collegewomen.com. (2007). *College women's health*. Pg 2 Retrieved on 5th April 2008.

APPENDICES: RESEARCH INSTRUMENTS

Appendix 1.1 Head Teachers' Consent Form

Appendix 1.1 Head Teachers' Consent forms:

"EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA"

I support Gladys Njura Gitau who is a student at Kenyatta University in the Department of Foods, Nutrition and Dietetics to participate and carry out the study "EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA" in my school. The study entails collection of information on dietary intake, assessment of hemoglobin levels, worm and malaria status of the subjects. Nutrition education will be provided to the pupils for better eating habits to reduce micro-nutrient malnutrition.

Once the study is complete the researcher will share the findings with the participating schools, parents and local community.

Name of school NABANDA PRT Sublocation MUGUMBINI

Headmaster's Name FRANCIS KATHOO Signature [Signature] Date 25/10/11

NABANDA PRIMARY SCHOOL
P. O. BOX 917 THIN
DATE 25/10/11

Appendix B: Parental/Pupil Informed Consent Forms

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

I freely and voluntarily and without any element of force or coercion agree to have my child _____ class _____ to participate in the research entitled

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Whereby, Gladys Njura Gitau, is involved in the study as a PHD student at Kenyatta University in the Department of Foods, Nutrition and Dietetics. I understand the purpose of the study is to teach Nutrition Education which also entails collection of information on dietary intake, assessment of hemoglobin levels, worm infestation and malaria status of the subjects to ascertain whether the child is anaemic or not.

The pupils will be supplying specimens for analysis to a laboratory technician from Kirwara health centre. Anaemia affects the child’s concentration in his/her studies and reduces their potential in school performance. Once the pupil’s biochemical data is evaluated, and they are found to be anemic or with worms, measures will be put in place to correct the condition. Once the study is complete the researcher will share the findings with the participating schools and local community.

For any further clarification I should talk to the head-teacher or Gladys Njura Gitau. I have read and understood the contents of the form.

Please feel free to use the pupil as a subject of your study.

Child’s name _____ **Date** _____

Parent’s Name _____

Signature _____ **Date** _____

Appendix C: Questionnaire for Parents and Pupils in Class 6 at Baseline Survey

The researcher is conducting a baseline survey on the topic “EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”. The information will help the researcher develop appropriate interventions for the children and the community. Whatever information you provide will be treated with confidentiality and will not be used for any other purpose other than the objectives of this study.

Part A: Identification

Interviewer No..... Date.....

Child No..... School.....Class.....

Part B: Demographic Characteristics

1. Please give me information about members of the household starting with the head of the household

S/no	Name	Sex 1=M 2=female	Age in years	Education*	Occupation	Religion	Income 1=yes 2=no	Marital status	R/Ship to child
1									
2									
3									
4									
5									
6									
7									

*For children in primary record education by classes they are currently in.

Codes

Educational Level

1=None 2=Primary uncomplete 3= Primary complete 4=Vocational (primary)
5=Vocational (secondary) 6= Secondary uncomplete 7= Secondary complete 8=
College (certificate) 9=College (diploma) 10= University(degree) 11= Primary
(class) 12= Do not know

Occupation

1=Farmer 2= Casual labour 3= Housewife 4= Salaried (formal employment)
5=Student 6=Businessman/woman 7=School leaver 8= other specify

Marital Status

1=Married 2= Divorced/separated 3=widowed 4 =Single 5=single parent 6= child

Religion

1=Anglican 2=Catholic 3=PCEA 4=Methodist 5=Others specify

Relationship to Child

1= Father 2=Mother 3=Brother 4= Sister 5= Grandparents 6=Aunt/uncle 7=cousin
8=others

2. Who usually makes the meals for the family.....

1=Father 2=Mother 3=Brother 4= sister 5=Grandmother 6=Aunt 7= Others
specify.....

3. Who is served first in the household ?.....

1=child 2=father 3=grandparent 4=mother 5= other specify

4. Who eats last in the household?.....

1=child 2=father 3=grandparent 4=mother 5= other specify

5. Are their foods that are restricted to certain individuals in the household culturally? If yes, which ones and to whom?

a)1= eggs 2=liver 3=njahi 4 other specify.....

b)1=to mother 2=to father 3= to children 4= other specify

6.What are the main sources of income

1=sale of farm produce 2=Coffee sales 3= Casual labour 4 =Formal employment

5= funds from relatives 6=Business 7= other specify.....

Part C: Household Food and Livestock Production

1.What is the approximate size of Land used by the household?

Land	Acreage
Owned	
Rented	
Others	
Total land	

2. Do you grow any crops.....

1=yes 2=No(skip to Q8)

3. If yes, what portion of total land acreage do you grow crops.....acres

4. What crops did you grow in the last one year.....

Crops grown	Annual yield in kgs	Estimated amount of food consumed in the household(kgs)	Estimated amount sold per year (kgs)	Does the produce last to the next harvest 1=yes 2=no	Remarks
Maize					
Beans					
Irish potatoes					
Bananas					
Kales					
Terere					
pawpaws					
Mangoes					
Others specify					

5. Did you store any food after harvest.....

1=yes 2=no (skip to Q7)

6. If yes, please give the following information

Food stored	Quantity in Kg	Where stored	Method of preservation
Maize			
Beans			
Irish potatoes			
Kales			
Terere			
Pawpaw			
Tomatoes			
Passion fruit			
Tree tomato			
Other specify			

Codes

Where Stored

1=granary 2=In the house on a rack, 3=Other specify.....

Method of Preservation

1=chemical 2=ash 3= smoking 4= drying 5=none 6=other specify

7. Why is food not stored?(can have multiple responses)

Food not stored	Reason for not storing
Maize	
Beans	
Irish potatoes	
Kales	
Terere	
Passion fruit	
Tree tomato	
Tomatoes	

Codes

1= sale for cash 2=Insufficient harvest 3=lack of storage facilities 4=lack of storage technologies 5= other specify.....

8. Do you keep livestock.....

1=yes 2=no(skip to Q10)

9. If yes, provide me with the following information for the last one year

Type	No of Livestock	Product	Production per month	Amount sold per year	Amount of product purchased per year(kgs)	Amount consumed by the household per month(kgs)
)

Dairy Cattle		Milk				
Goats		Milk				
Chicken		Eggs				
		Meat				
Rabbit		Meat				
Sheep		Meat				
Doves		Eggs				
		Meat				
Other						

10. Apart from farming and purchases, how (else) do you obtain food for household consumption? (Can have multiple responses).....

1= Food gifts, 2=Food for work 4=borrow 5=none 6=other specify

Part D: Food Consumption Patterns

1. Seven day Food frequency

I would like to know the type of food your child/household consumes in a week and the number of times per week they are consumed

Food	Frequency per week	Food	Frequency per week
Fruits and vegetables		Legumes and nuts	
Kales		Beans	
Carrots		Njahi(Dolicos lablab)	
Cabbage		Green gram(ndengu)	
Amaranth		Pigeon peas	
Black nightshade		Beef	
Cowpea leaves		Chicken	
Ripe banana		Eggs	
Pawpaw		Peas	
Mangoes		Rabbit	
Guavas		Pork	
Loquats		Fish	
Avocad		Groundnuts	
		Macadamia nuts	
		cashewnuts	
Cereals, roots & tubers		Fats,oils and sugar	
maize		Cooking fat	
sorghum		Cooking oil	
Millet		Sugar	
Rice		Honey	
Wheat			
Sweet potato			
Yams			
Arrowroots			
Sweet potatoes			
Raw banana			

Codes 1=Daily 2=4-5 times 3= Thrice 4= Twice 5=Once 6= none 7=Other specify

2. I would like to know the type of food your Child (name) consumed in the last 24 hrs.

Time of meal	Name of dish	Name of Ingredient	Amount of ingredients taken in household measures	HH Measure (gms)	Amt taken by child in metric measures	Fe	Zn	Vit C	Vit A	Vit B12	Folic Acid	Cu
B/fast												
Snack												
Lunch												
Snack												
Super												
Snack												

3. What foods does your child like and which ones does he/she not like?.....

Part I: Dietary Diversity Questionnaire

Yesterday or in the night did your child consume the following foods? Start with the first food or drink of the morning. Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned.

Food /Grp	Specified food	Yes =1	No= 0
Cereals	Maize, rice, wheat, millet, sorghum, biscuit, mandazi, chapatti, ugali, Porridge from cereals		
White roots and tubers	Irish potato, sweet potato, arrowroot, Cassava, green bananas, yams		
Vitamin rich vegetables	Pumpkin, carrot, squash sweet potato that are orange inside+ other locally available vitamin A rich vegetables (e.g. red sweet pepper)		

and tubers			
Dark green leafy vegetables	Spinach, kales, cabbage, amaranth, cassava, arrowroot		
Other vegetables	French beans, green peas ,tomato, onion, eggplant including wild vegetables		
Vitamin A rich fruits	Ripe mango,ripe pawpaw, and 100% fruit juice made from these+ other locally available vitamin A rich fruits		
Other fruits	Guava, pineapple, orange, loquats, custard apple, passion fruit and 100% fruit juice made from these		
Organ meat	Liver, kidney, heart or other organ meats or blood based foods		
Flesh meats	Beef, rabbit, goat, pork, chicken		
Dry legumes	Beans, pigeon peas, green grams, dry peas		
Eggs	Chicken,duck,guinea fowl or any other egg		
Fish and sea food	Fresh or dried fish or shell fish		
Legumes, nuts and seeds	Bean, pea, lentil, nuts, seed or foods made from these		
Milk and milk products	Yoghurt,milk,cheese or other milk products		
Oils and fats	Oil, fat or butter added to food or used for cooking		
Red palm products	Red palm oil, palm nut or palm nut pulp sauce		
Sweets	Sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolate, candies cookies and cakes		
Spices, condiments, beverages	Spices(black pepper, salt), condiments(soy sauce, hot sauce), coffee, tea, alcoholic beverages		
Household level only	This is for household members- did you or anyone in your household eat anything (meal or snack) outside the home yesterday?		
Individual child	Did you eat anything (meal or snack apart from packed lunch) outside the home yesterday?		
1) 1-3 low diversity, 2) 4-6 medium diversity, 3) 7-9 high diversity			

Part E: Assessment Age and Health Status of the Child

1. Date of birth Month----- Day----- Year-----

2. Birth order

1	2	3	4	5	6	7	8	9	10
---	---	---	---	---	---	---	---	---	----

3. What diseases has the child suffered for the last 2 weeks?

1) Malaria

2) URTI

3) Worms

4) Diarrhea

5) Stomachache

6) Others specify

4. Has your child been immunized against all relevant diseases? 1) Yes 2) No

1. If no, Why?.....

Part F: Health and Sanitation

1. What is the source of water that you use in the household?

1. River

2. Tap

3. Dam

4. Well/Spring

5. Roof catchments

6. Other specify

2. Does your child wash hands after visiting the toilet at home? 1) Yes 2) No

3. If yes what facilities do you have for hand washing at home?

1) Leaky tin 2) Tap 3) Tank , 4) Tilting tin 5) Basin 6) Others specify

4. In addition to water, what else do you use to wash hands at home? 1) Soap 2) Lemon 3) Nothing

5. What energy saving devices do you use while cooking in your kitchen?

1) Improved jiko (Jiko kisasa)

2) Fireless cooker

3) Improved jiko (Jiko kisasa) and fireless cooker

4) Rocket mud stove

5) KCJ

6) Three traditional stones

7) Other specify

Part G: Child Nutrition Knowledge (Sex: 1 Male 2 Female)

Age_____

19. Have you received any information on nutrition? 1) Yes 2) No

20. If yes, what information and from what source?

Type of information	Source*	By Who**	Duration hours/days	When was the last time?

*Source: 1) Radio 2) Church 3) Health facility 4) Field training 6) Neighbor 7) Television 8) Others specify

**Who: 1 Health worker 2) Extension worker 3) Friend 4) Others

21. Which food is eaten at home that provide

- Protein/Body building food_____
- Carbohydrates/Energy giving foods_____
- Vitamins_____
- Minerals_____

22. What nutrition knowledge do you feel you require at the moment?

1. About food nutrients
2. About traditional foods
3. About deficiency diseases
4. About food safety and hygiene
5. About all above
6. Other specify

23. What is the source of water at school

1. River
2. Tap
3. Dam
4. Well/Spring
5. Roof catchments
6. Other specify

24. Do you wash hands after visiting the toilet at School? 1) Yes 2) No

25. If yes what facilities do you have for hand washing at school?

- 1) Leaky tin 2) Tap 3) Tank , 4) Tilting tin 5) Basin 6) Others specify

26. What else do you use for hand washing apart from water

- 1) Lemon 2) soap 3) leaves that produce lather , 4) Others specify

26. Position in class last year (class 5) Term 1_____Term 2_____Term 3_____

Appendix D: Focus Group Discussion with Some Teachers

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Please tell us the types of crops and livestock kept in most households.

2. What nutrition programme have you had in this area which included the schools? 1=School feeding, 2=Kitchen gardening 3=None that I know
3. What kind of nutrition education does the community receive? 1= Cookery of underutilized foods like rabbits, 2=Balanced diet, 3=Growing of local vegetables, 4=Other specify.
4. Kindly explain to me about the farming activities you undertake at your households and school for best nutrition adequacy? 1=Growing of vegetables, 2= Keeping of livestock, 3=Keeping of small livestock like rabbits and chicken 4=other
5. In order of priority what are the major sources of income in the households of this area? 1=Coffee, 2=Avocado, 3=Casual labour, 4=Business,
6. You are endowed with many cash crops and livestock in this area .Will you please tell me how has the community benefited from coffee sales in this area for the last two years?
7. What would you say are the nutrition and health problems affecting the children in the schools? 1= kwashiorkor, 2= marasmus, 3=dental caries 4, =None that we know.
8. Has any teaching strategy/strategies been used before to teach on issues pertaining to Iron deficiency anaemia?
9. If so to Q7, which ones?

10. If none to Q7, What do you think about nutrition education and the farming practices in this area?
11. What technologies have been used before for fuel energy conservation and food preservation? Have you heard about the Maendeleo jiko and the fire less cooker?

Appendix E: Observation Checklist for Schools, Pupils and Households.

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

1. Environment around the schools.(1=Toilet, 2= clean water supply,3=leaky tins
4=other specify)
2. General health of the community 1=Clothing, 2 =Shoes, 4 = state of houses
3. General sanitation of the compounds in the households.1=Cut bushes around the
homesteads, 2=short grass, 3=well swept surroundings 4=Garbage disposal
4. Types of crops grown and livestock kept.1=presence of kitchen gardens,
2=drought tolerant crops, 3=cereals, 4=small livestock kept, 5=dairy animals
5. What are the common nutrition related problems in the area? 1= Kwashiorkor,
2=marasmus, 3=blindness, 4=diabetes 5= Women and children eat soil
- 6.What measures are taken to address the nutrition problems?
1=Nutrition lessons 2=Visit the health centre, 3= Take herbal medicines 4,= other
specify

Appendix F: Pupils Pre & Post-test Questionnaire on Acquisition of Nutrition Knowledge

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Interviewer No..... Date.....

Child No..... School.....Class.....Age in years.....

Please answer the following questions

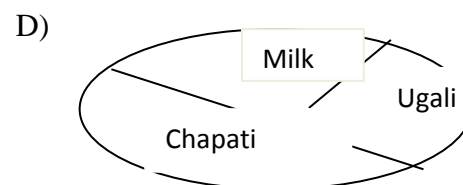
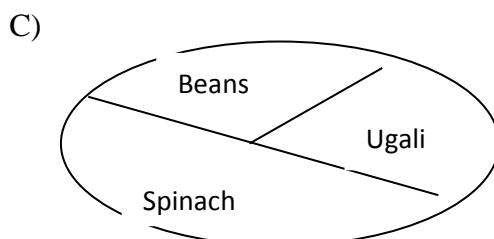
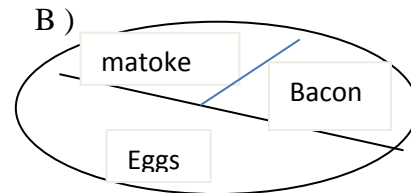
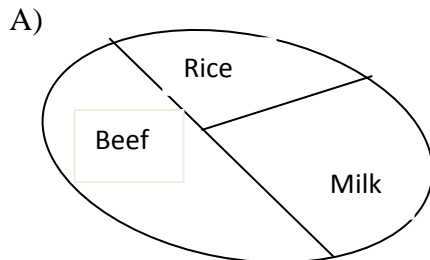
1. The body requires food rich in many nutrients. What do we call a meal rich in carbohydrates, vitamins, proteins and minerals_____
 - A) Balanced diet
 - B) Proper food
 - C) Protective food
 - D) Energy food

2. What people, animals and plant get from food is known as _____
 - A) Nutritionist B) Nutrients C) Energy D) Tissues

3. An expert in food and food nutrients is known as _____
 - A) Doctor B) Dentist C) Nutritionist D) Nutrition

4. Diseases which are caused by lack of a certain nutrient in the body are called _____
 - A) Sexually transmitted diseases B) Deficiency diseases C) Water-borne diseases D) Immunisable diseases

5. A pupil in class five found the plates given below in a certain dining room. Which plate would you have advised the child to take?



6. Lack of iron in the body leads to a deficiency disease called_____
- A) Kwashiokor B) Marasmus C) Anaemia D) AIDs
7. Which one of the following foods is **NOT** rich in iron_____?
- A) Kidney B) Leafy green vegetables C) Liver D) Common salt
8. Iron in the body helps in formation of_____ in the blood which prevents anaemia
- A) White blood cells
B) Haemoglobin
C) Plasma
D) Body fluid
9. Three of the following are signs and symptoms of anaemia **EXCEPT** one .Which one is it_____
- A) Pale eyes
B) Dizziness at times
C) White finger nails
D) Pot belly
10. Which one of the following foods is **NOT** grown in your homes?
- A) Spinach B) Oranges C) Coconut D) Kales
11. Which is the best way to prevent anaemia in children
- A) Feeding them with food rich in calcium
B) Feeding them with food rich in phosphorus
C) Feeding them with food rich in sodium
D) Feeding them with food rich in iron
12. Four pupils in class five were told to explain why children are supposed to take a balanced diet. Who gave the correct answer?
- A) Jane- To look beautiful and handsome
B) John- To prevent deficiency diseases and be healthy
C) Peter – To pass in exams
D) Susan- To be honest and obedient.
13. Before taking raw foods like fruits one should make sure they are.
- A) Cooked B) Roasted C) Washed D) Digested
14. Which one among the following meals is good for lunch meal
- A) Bread, ugali and juice
B) Chapati, oranges and soda
C) Ugali, kales and milk
D) Eggs, milk and bread
15. What do fruits and vegetables provide in the diet
- A) Energy nutrients B) Protective nutrients C) Body building nutrients D) Balanced diet

16. _____ Helps in the digestion and transportation of food in the body

- A) Blood B) Vitamins C) Water D) Fibre

17. Fruits and vegetables are destroyed by high temperatures. Which one among the following is the best method of cooking green vegetables?

- A) Baking B) Stewing C) Deep frying D) Roasting

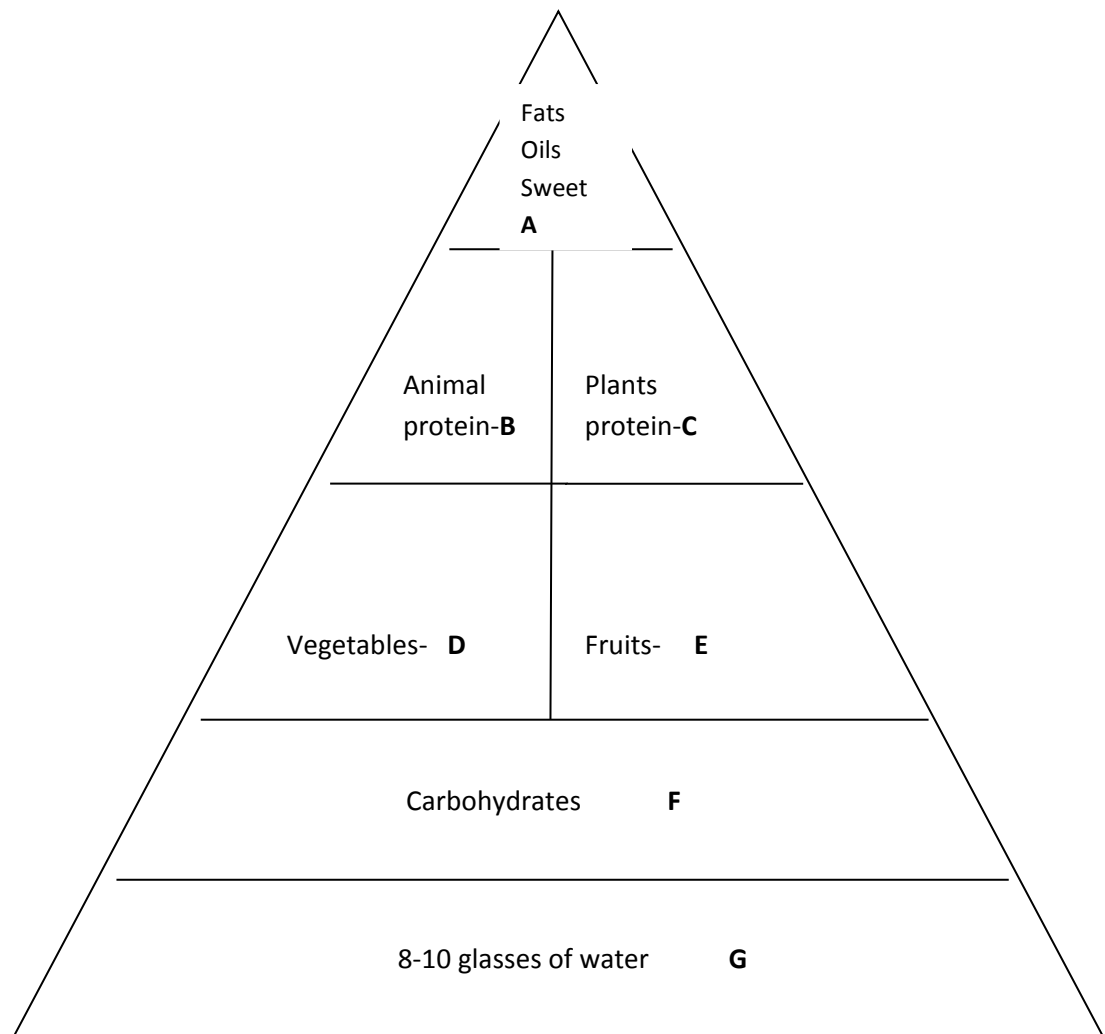
18. Roughage in a diet prevents

- A) Anaemia B) Constipation C) Marasmus D) Rickets

Use the diagram below to answer questions 19-26

19. Name any food which fits in part A in the pyramid below _____

20. Spinach can be filled in part marked _____



21. Part _____ and _____ provides protective food.

22. Part marked G contains water which is important in the body. It is used in _____

23. Kidneys and liver are good sources of iron, they are found in the part marked----- in the pyramid.

24. Which food among the groups marked A-G is required in small quantities by the body _____

25. A farmer requires a lot of food for his manual work. He should mostly take food from the group marked _____

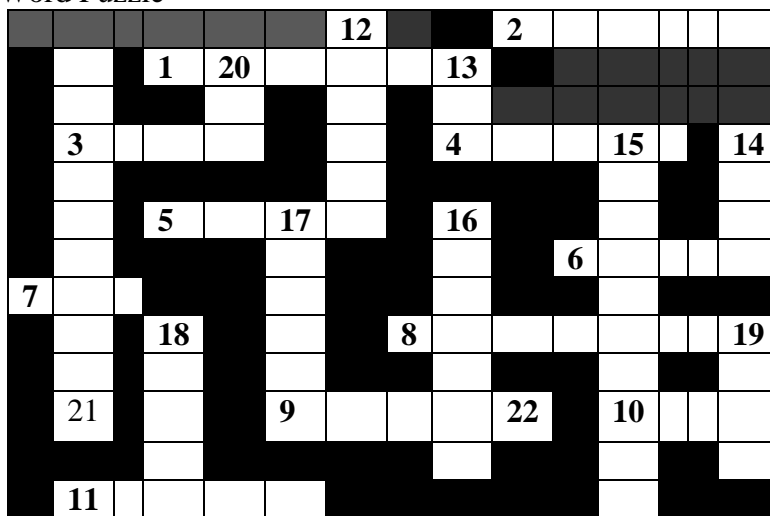
26. Write two examples of foods which fits in the part marked

I) B _____ and _____

II) E _____ and _____

III) F _____ and _____

27. Word Puzzle



Across

1. A sweet citrus fruit rich in vitamin C
2. A local fruit which we plant its suckers and when unripe it is a starch food, and when ripe it is a fruit
3. It is an animal that gives meat, eggs and feathers
4. A small fruit with many seeds and has red or white flesh and is very rich in vitamin C
5. It is a dicot (bean) that is very rich in proteins and minerals
6. It is a fruit that is eaten raw and is pumpkin like.
7. It is a state where food decays.
8. It is a traditional vegetable that is rich in minerals and vitamins.
9. It is a cereal whose flour is used to make bread.
10. It is a bitter citrus fruit.

11. It is a fruit which has one seed and has yellow flesh.

Up-down

- 12. A disease caused by lack of iron in the body.
- 13. An animal product rich in protein
- 14. A mineral required in the body to form red blood cells.
- 15. It forms a group of protective foods alongside fruits.
- 16. It is a kind of meat mainly beef rich in iron.
- 17. It is the colour of a ripe mango.
- 18. It is a sour citrus fruit
- 19. It is a type of iron which is easily absorbed in the body.
- 20. The colour of blood.

Down-up

21. It is the red pigment in the blood.

Up-Across

22. It prevents the absorption of iron if taken with meals.

28. Child's School Performance and position in class. Position T1____T2____T3____

- 1. Top ten
- 2. 11-20
- 3. 21-30
- 4. Above 30
- 5. NA

29. What is the source of water that you use at school?

- 1. River
- 2. Tap
- 3. Dam
- 4. Well/Spring
- 5. Roof catchments
- 6. Other specify

30. Do you wash hands after visiting the toilet at school? 1) Yes 2) No

31. If yes what facilities do you have for hand washing in school?

1) Leaky tin 2) Tap 3) Tank , 4) Tilting tin 5) Basin 6) Others specify

32. In addition to water, what else do you use to wash hands at school 1) Soap 2) Lemon 3) Nothing

33. Child's worm status.....

34. Child's Hemoglobin status.....

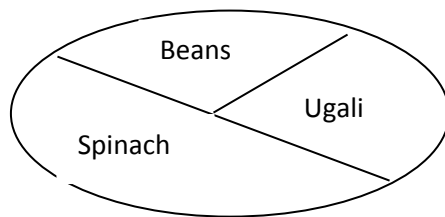
35. Child's malaria status.....

Appendix G: A Marking Scheme Used for Pre and Post- tests Assessment.

“EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Answers to appendix 1.5

1. A) Balanced diet.
2. B) Nutrients.
3. D) Nutritionist.
4. B) Deficiency diseases.
5. C)



6. C) Anemia.
7. D) Common salt.
8. B) Hemoglobin.
9. D) Pot belly
10. C) Coconut
11. D) Feeding them with food rich in iron.
12. B) John- To prevent deficiency diseases and be healthy.
13. C) Washed.
14. C) Ugali, Kales and Milk.
15. B) Protective nutrients.
16. C) Water
17. B) Stewing

18. *B) Constipation*
19. *Sweets, Sugar ,Fats or Oil*
20. *D*
21. *D &E*
22. *Digestion*
23. *B*
24. *Fat*
25. *F*
26. *i) Milk, eggs, Meat, Yoghurt, Mala ii) Mango, Orange, Pawpaw, passion fruit iii) Sorghum, Maize, Yams, Cassava, Sweet potato*
27. *Word puzzle*
- | | | | | |
|------------|--------------|-----------------|---------------|-----------------|
| 1.(orange) | 6.(melon) | 11.(Mango) | 16.(Red meat) | 21.(Hemoglobin) |
| 2.(Banana) | 7.(Rot) | 12.(anemia) | 17.(Yellow) | 22.(Tea) |
| 3. (bird). | 8.(Amaranth) | 13.(egg) | 18. (Lemon) | |
| 4. (guava) | 9.(Wheat) | 14.(Iron) | 19.(haem) | |
| 5.(soya) | 10.(lime) | 15.(Vegetables) | 20.(red) | |

Appendix H: Head Teacher’s In-depth Questionnaire for the Experimental Schools

“EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Name of the school.....

Total pupils’ population.....

Zone.....

Name of head teacher/deputy

Date.....

Please help me answer the following questions

1. Has nutrition education been taught to the children by anyone else before?
2. If no, would you support the teaching of nutrition education in your school?
3. If yes, who and how would you support?
4. Which time do you think is appropriate for teaching it? Give reason for the choice of time?
5. Do you support the involvement of parents in this study?
6. Is it possible to carry out biochemical tests on the pupils through the consent of the parents in the school?
7. Will you support the idea of utilizing the so required resources in the teaching and demonstrations?
8. Will you support the idea of forming a group of peer educators and a 4K club in this study?

Appendix I: Teachers' Questionnaire for the Experimental Schools.**“EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”**

1. Would you support the teaching of nutrition education to class 6 pupils?
1=yes 2=no. If no why?
2. When do you think is the best time to teach the lessons?
3. How long do you think the lessons should take?
4. What teaching aids would you recommend?
5. After how long do you think the pupils should be given written exams?
6. How effectively can we use some pupils as peer educators in teaching nutrition education?
7. What topics do you think are relevant to teach these pupils?
8. Are we able to form a class for teaching purpose in class six.

Appendix J: Pupils’ Questionnaire on Attitude, Preference of Taste–tests of Food Models

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

1. Recipes

1=very good 2=good 3=bad 4= very bad

Portion size

Taste

Texture

Colour

Smell

1. Explain how we carried out the procedure of food preparations.

2. Can you teach someone else to do it?

3. Do you think iron rich nutrients were adequate in the recipes?

4. Name some other iron rich foods that we can use to improve our diets and can replace the recipes we have.

1-----

2.....

3-----

5. Name the Vitamin C rich foods that enhance iron absorption that we used in our recipes

6. Name 3 grain foods, 3 protein foods, 3 vegetables that we used and are rich in iron

Grain_____

Protein_____ - _____

Vegetables-_____

7. Which of the following meals is good example of iron and Vitamin C foods?

a) Rice, spinach, beans and oranges.

b) Potatoes and cabbage.

c) Bananas,githeri

Appendix K: Teacher Process Evaluation Questionnaire Used to Measure Progress of the Intervention

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

1. How would you rate the progress of the intervention so far?
1=very good 2 =good 3= average 4 =bad 5= very bad

2. What are some of the issues/problems do you think need to be addressed to ensure success of the intervention?
 - How can we improve?
 - Learner participation
 - Peer educator reinforcement/confidence/ Agriculture officer participation
 - Teaching methods
 - Teaching aids

3. What should we do to help pupils who miss out some lessons?
1=ignore them 2= remedial teaching 3= homework

4. Do you think we shall achieve the objectives of the study?

5. If no, what can we do to improve?

Appendix L: Teacher Outcome Evaluation Questionnaire on the Effectiveness of the Intervention

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

1. How would you measure the effectiveness of the intervention programme in general?

1=very good 2 =good 3= average 4 =poor 5= very poor

2. Generally how would you rate procedures used to collect data?

1=very good 2 =good 3= average 4 =poor 5= very poor

3. How would you measure classroom activities?

1=very good 2 =good 3= average 4 =poor 5= very poor

4. How would you measure the peer educators/agriculture officer performance in general?

1=very good 2 =good 3= average 4 =poor 5= very poor

5. How would you measure the peer educators/agriculture officer's effectiveness on classroom activities?

1=very good 2 =good 3= average 4 =poor 5= very poor

6. Please rate class activities on the following;

- Time management
- Appropriaate teaching methods
- Appropriate teaching aids
- Learner participation

1=very good 2 =good 3= average 4 =poor 5= very poor

7. How would you rate you pupils on acquisition of knowledge?

1=very good 2 =good 3= average 4 =poor 5= very poor

8. How likely is it that pupils will retain this knowledge?

1=very likely 2 =likely 3= slightly likely 4 =not likely 5= not very likely

Observation Checklist

Please observe whether changes on the following aspects have occurred since the intervention began in the schools:

General hygiene in school.

1= How are toilets kept,
2=presence of hand washing equipment and materials

2. Attendance of 4K clubs meetings.

1=100%, 2 =80-99%,3=60-79%, 4 = 40-59%

3. Improved packed lunches with fruits and vegetables.

1=10-30 %,(fair), 2=31-50 %(good) , 3=51-70%(v Good) 4=above 71%

4. Use of clean utensils

1=very good 2 =good 3= average 4 =poor 5= very poor

5.Washing hands before eating and after visiting the toilet.

1=very good 2 =good 3= average 4 =poor 5= very poor

Appendix M: Home Follow-up to Assess Effect of Health and Nutrition Knowledge on Practice and Attitude

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Questions to be asked to parents/Guardians

1. How many technologies have been adopted since (name of pupil) joined the 4K club-(No of multistory gardens achieved, No of kitchen gardens achieved, No of rabbit projects achieved, No of poultry projects achieved, No of leaky tins achieved, no of improved cookstove (*jiko kisasa*) achieved, no of fireless cookers achieved)
2. What changes have occurred in the way (name of the pupil) prepares and cleansup since she/he joined the nutrition class
3. What changes have occurred in food selection and consumption patterns (name of pupil) that you can report? Please state them.....
4. What would you attribute the changes to?.....
5. Can (Name of pupil) explain why there are changes in their food choices
1=yes 2= no. If yes, please explain.
6. What new recipes has(name of pupil) mentioned or introduced at home?
7. What wood fuel conserving device at home has (name of pupil) mentioned to you? Have you tried to use any of them? Please explain how you are using them.....
8. Have you noticed any changes in hygienic practices since (name of pupil) joined the 4K club? 1=yes 2= no .if yes, please explain.
9. What device has he/she introduced and practicing on hygiene.
1=leaky tin, 2=tilting tin, 3=use of soap 4=other specify

Observation Checklist

Please observe whether changes on the following aspects have occurred since the intervention began

1. Presence of wood fuel saving devices in the kitchens
2. Presence of hygienic devices like the leaky tins next to toilets.
3. Presence of dish-racks
4. Multi-storey gardens, hanging gardens
5. Conventional kitchen gardens
6. Presence of a rabbitry or poultry project

Appendix N: A Sample Scheme of Work Page

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

Name of school.....Nutrition Education strategy.....

Method: teach	Class: 6	Term: 1	Week: 15					
Lesson	Topic	Sub-topic	Objectives	Peer educator/ Researcher/ agric. staff	Learner's activities	Teaching aids	References	Remarks
1. What do different foods give? 2. What is a balanced diet? 3. How does diet affect health? 4. Can I make some balanced meals for the family? 5. How do we preserve food and nutrients? 6. How can we have a good diet all year round? 7. When and why must we wash our hands? 8. Food, nutrition and personal health 9. Food preparation Hygiene and sanitation	Food classification Functions of food for health emphasis on iron rich foods Principles of healthy eating Food guides 1. (Balanced diet, 2. Deficiency diseases 3. Iron rich food sources 4. Signs & symptoms of anaemia 5. Prevention measures Importance of water in - 6. Preparation- Cooking Planning Serving Food Safety 7. Personal hygiene 8. Food safety and hygiene 9. Waste disposal 10. Diseases	To teach nutrition education To take responsibility for food related tasks in the household (food production, preparation, fetching water etc) To be able to grow and prepare simple meals Lesson on parasites, amoeba histolytica- ingestion-lifecycle, disease it causes, prevention and control. Hand washing with soap Use of leaky tins. Use of aqua guard.			Flip charts Foods Leaky tins Model gardens Anti-amoebas/helminths Pangas, Jembes Seeds, seedlings Rabbits. chicken	FAO classroom curriculum chart. WHO program Managers Iron Deficiency Assessment, Prevention and Control Guide for Program Managers. Class 5 and six text books		

Appendix O: A Sample Lesson Plan Page

“EFFECTS OF NUTRITION EDUCATION STRATEGIES ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA”

School..... Nutrition Education strategy.....

Class: Lesson: Time: 30-35 min

Subject:

Topic: Sub-Topic:

Objectives.....

References:

Lesson Presentation

Time/minutes	Stage	Teaching Aids	Resources(Text books)
Step 1- 5 Min	Introduction Review of previous topic/lesson Introduction of today’s lesson		
Step2- 20 Min	Body (Discussions and explanations) Main body of today’s lesson		
Step3- 5 Min	Conclusion Summary of today’s lesson Assignments in preparation for the next lesson		

Remarks _____

Appendix P: Overview of the Intervention and Implementation Plan

Strategy	Training methodology	Teaching aids	Who to involve
Experimental schools:	Use FAO classroom curriculum chart	Posters, flip charts developed with validation from teachers	Teachers, Education officers
1. Research facilitation	*Classes	Posters, Flip Charts	Five Pupils, Agric. Extension officer , intervention schools
2. Peer Facilitation 3. Agriculture Extension Officer facilitation	Teaching Nutrition education with demonstrations	Gardens, Food ingredients, Recipes, Hygienic materials like leaky tins	Health personnel Pupils Teachers
Control school	None	None	Pupils

*Topics covered

- Food, nutrition and personal health
- Food preparation
- Hygiene and sanitation
- Home gardens

Appendix Q: Intervention and Activities to be Carried Out

Study team members	Activities
Doctoral Student	-Develop teaching materials -Teach Nutrition Education to the agriculture extension worker and peer facilitating class six pupils -Develop improved iron rich recipes -Demonstrations on kitchen gardening -Trainings on hygienic practices -Facilitate in one experimental school -Administer pre/post -tests to all the study schools
Peers/Agriculture field extension staff	Teach nutrition education to their experimental schools
Head-teacher	Oversee the overall running of the study in the school
Teachers	Oversee order in the classroom Assist with the administration of assessment tools. Conduct process and outcome evaluation of the study
School Management Committee	Assist in the running of the study.
University supervisors	Provide guidance in the implementation of the study Conduct overall evaluation of the study
Kirwara Level 4 Sub-district Hospital	Provide Health worker, pharmacist, laboratory technician to conduct Haemoglobin, helminthes tests and clinical malaria observations, and drugs administering and public health and sanitation trainings.
Ministry of Agriculture, Ministry of health and sanitation and Ministry of education, Administration	Provision of professional support including literature
Parents	Attend initial meetings Participate in vegetable gardening, livestock production, health and sanitation By providing materials needed by the pupils Provision of some of information during the follow-up at homes and nutrition trainings.

Interventions were based on the idea that we remember:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we see and hear
- 80% of what we say ourselves
- 90% of what we say and do (FAO, 2005b)

Appendix R: Detailed Chronology of Data Collection and Intervention Activities

Phase	Component	Activities	Site	Duration
Phase 1 Baseline	Baseline information	Collection of baseline data Development of teaching materials	School & households	Sept 2011– Feb 2012
	Pre-tests	Nutrition knowledge, Hb levels, worm and malaria status, & technologies adopted	School	Feb-April 2012
Phase 2 Interventions	Deworming	Administration of anti-protozoa and anti-helminths	school	March 2012
	Peer educator	Training peer educators/ agriculture officer	School	March-April 2012
	Demonstrations	Vegetable production, cookery, small livestock production Hygienic practices	School	April-may
	Post -tests	Hb levels, worm and malaria status, Nutrition knowledge for Pupils	School	July-August 2012
	Hygienic practices	Personal and environment	School Home	March 2012 and June 2012
	Nutrition Education	During 4K clubs meetings	School	Jan 2012 and May 2012
	Home Visits	Assessment of nutritional and hygienic practices among study pupils	Home	January/Feb 2012 and August 2012

Appendix S: Food, Nutrition and Iron Deficiency Anaemia Notes

Lesson 1: 30 Minutes

Food and Nutrition:

Food is any substance that is taken into the body by either drinking or eating in order to maintain good health. The process of providing the body with foods necessary for growth and maintenance of good health is called nutrition. To maintain good health the body must continually be supplied with different types of food.

Uses of food in the body are to:

1. Produce enough energy needed for work and play
2. Build the various parts of the body
3. Repair parts that have been damaged by diseases
4. Protect against diseases
5. Stay alive and maintain good health

What people get from food is known as nutrients. An expert of food nutrients is known as a nutritionist. The body requires food rich in many nutrients and is called a balanced diet.

Lesson 2: 30 Minutes

Balanced Diet

The body requires different types of foods which supply different nutrients. **Nutrients** are the various food substances that the body needs in-order to maintain good **health**.

The food nutrients that the body requires are:

Carbohydrates- these are energy giving foods. They provide the body with energy to work and keep the body strong and warm e.g. wheat, millet, sorghum, maize. Unripe banana, potatoes, arrowroots, cassava.

Fats and oils-These are also energy giving foods. Fats are in solid form while oils are in liquid form. There are two types of fat. Animal (e.g. Lard) and vegetable

(Kimbo, kasuku) fats. Fats and oils are eaten together with other foods. If fats are eaten in large amounts, some are stored in the body for later use.

Proteins- These are also known as body building or repair foods. They are necessary for growth of muscles. They also repair parts of the body that may be damaged e.g. beans, eggs, milk, meat, fish.

Vitamins- These are also called protective foods. They protect the body against diseases. Fresh fruits and vegetables are the main sources of vitamins.

Mineral salts- These supply chemicals needed for growth and good health. They are required in the body in small quantities e.g. iron, calcium, phosphorous.

Lesson 3- 30minutes

Vitamins and Minerals are of different types. The following are the types with their sources and their use in the body

Vitamin	Sources	Use in the body
Vitamin A	Butter, liver ,fish, milk, Green vegetables, avocado, carrots	Good for eyesight
Vitamin B ₁	Yeast, wheat germ, bread, rice husk	Prevents beri-beri
Vitamin B ₂	Yeast, milk, meat, green vegetables	Prevents pellagra
Vitamin C	Fruits and vegetables	Prevents scurvy
Vitamin D	Sunlight, egg, milk	Prevents rickets
Vitamin E	Spinach, bread, butter, olive oil	Healthy reproductive system

Mineral salt	Sources	Use in the body
Iron	Green leafy vegetables, liver, kidney, spinach, beetroot, meat	Formation of haemoglobin which prevents anaemia
calcium	Milk, eggs, cheese, fish, pea-nuts, millet	For strong bones
phosphorous	Milk ,cheese , meat, grams	Strong bones and teeth

Balanced Diet

Carbohydrates	Proteins	Vitamins
Ugali	Beans	Spinach/ pear
Rice	Meat	Cowpea leaves/passion fruit
Mashed bananas	Green grams	Kales/Orange

Lesson 4: 30 Minutes

Food Groups

Food Guide Pyramid

The national healthy living pyramid is guidance on a nutritional way to eat, drink and remain healthy. Healthy eating means eating a variety of foods, as no single food can provide us with all the nutrients that our body needs. Different foods are composed of different nutrients such as proteins, carbohydrates, fats, minerals, vitamins, water and dietary fiber in varying amounts that help the body to function optimally. Food is necessary to stay alive, to give us energy and to provide the nutrients our body needs to grow and develop.



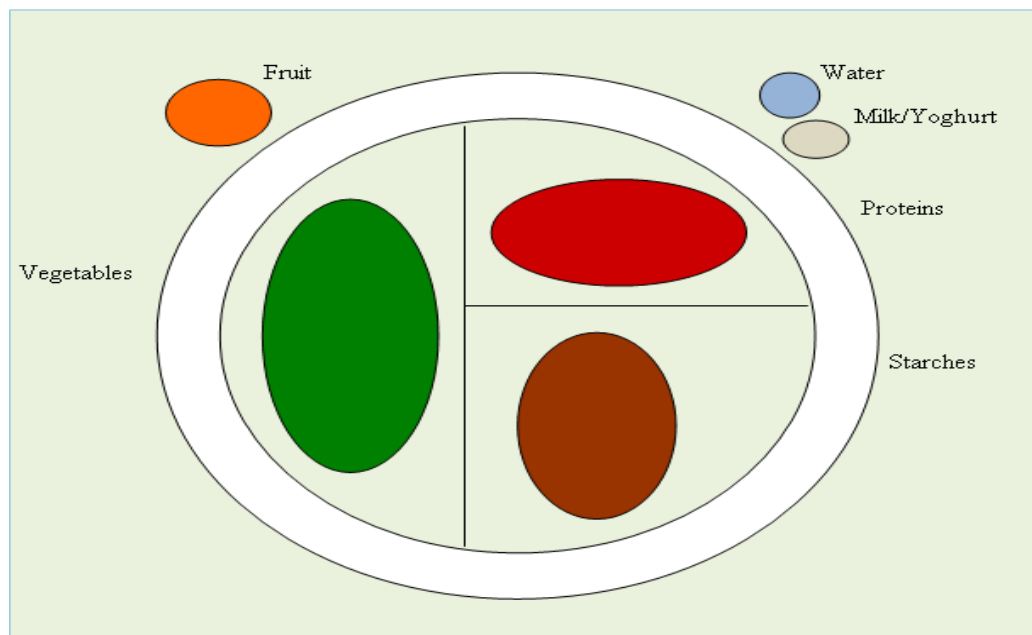
Adopted from MOPHS, 2012

1. **Food guide pyramid** is an excellent tool to help make healthy food choices. It assists in the selection of foods in order to provide your body with nutrients it needs and at the same time the right amounts of calories to maintain healthy weight.
2. **Bread, cereal, roots, tubers and pasta.** These foods form the base of the pyramid and should be consumed in abundance. They provide complex carbohydrates, which are an important source of energy. A total of 6 to 11 servings of these foods are required in a day. One serving is equivalent to $\frac{1}{2}$ cup cooked cereal, rice, pasta, or 1 slice of bread or 1 cup of potatoes or 1 cup ready to eat cereals.
3. **Fruits and vegetables.** These provide a good quantity of plant fibre, carbohydrates, vitamins and minerals. It is important to eat a variety of fruits and vegetables. It suggests 3-5 servings of vegetables and 2-4 servings of fruit each day. 1 serving of vegetable is equivalent to 1 cup of raw chopped vegetables or $\frac{1}{2}$ cup of cooked vegetables, while one serving of fruit can be 1 medium orange or banana or $\frac{1}{2}$ cup of fruit juice (fresh fruit juice not commercial formulations that are loaded with lots of sugar).
4. **Beans, eggs, lean meat and fish.** These contain important proportion of proteins, in addition to other nutrients. They should be eaten in moderation. The guide suggests 2-3 servings of foods in this group per day. 1 serving is equivalent to 50-90 gms cooked meat, fish or poultry, or 1 cup cooked dry beans or $\frac{1}{2}$ -1 cup nuts.

5. **Milk, yoghurt and cheese.** These provide protein, vitamins and minerals, especially calcium. The guide suggests 2-3 servings each day. 1 serving is equivalent to 1 cup of milk, or yoghurt.
6. **Fats and sweets.** The very top of the pyramid are foods such as fats, oils, sugar and sweets which peoples are urged to consume sparingly because they provide mostly energy with few micro-nutrients.
7. **Water.** It may well be the most essential nutrient, since without it most of us would die from effects of dehydration in less than a week. More than half of our body weight comes from water. Water provides the medium for nutrient and waste transport, control body temperature and functions in nearly all of our body's biochemical reaction. Adults require 6-10 glasses a day depending on the activity level and the environment.
8. **Physical activity.** Good nutrition should be combined with moderate levels of physical activity. To maintain a healthy weight people need to balance the amount of energy eaten with the amount of energy expended.

The Healthy Eating Plate

The healthy eating plate is a model used to plan meals. The plate is divided into portions, and food served to match the amount of vegetables, starches, and protein in the sample picture. A piece of fruit, glass of milk or yoghurt and glass of water should be served together with the meal as shown below.



Healthy Eating Plate (20cm diameter)

Lesson 5: 30 Minutes

Deficiency diseases

Lack of any type of food nutrients that is proteins, vitamins, mineral salts, carbohydrates and water may cause food related diseases. These diseases are called **deficiency diseases**. There is the importance of eating a balanced diet and the need to observe “the rule of three”. **Deficiency diseases** occur in an individual lacking

certain food nutrients. Deficiency diseases cannot be transmitted from one person to another.

The following are examples of deficiency diseases:

Kwashiokor	-	lack of proteins
Marasmus	-	Starvation
Anaemia	-	lack of iron
Dehydration	-	lack of water
Rickets	-	lack of calcium

Kwashiokor

It is caused by lack of proteins. Kwashiokor occurs in children under five years , mainly after they stop breastfeeding.

Signs and symptoms

Brownish and thin hair
 Stomach , arms, face and cheeks begin to swell
 The child cries and appears unhappy
 Hair falls off easily
 A child may become slow to learn in school
 May affect the liver and cause death

Prevention of kwashiokor

Feed foods rich in proteins e.g. milk, meat, beans
 Feed the child with a balanced diet

Marasmus

It is caused by starvation that is, taking enough food.

Signs and symptoms of marasmus

The child becomes very weak
 The shape of the bones becomes visible underneath the skin
 A child looks like an old man or woman.
 The child cries very often
 Marasmus affects the brain; the child therefore becomes a slow learner

Prevention and control

Take enough of all the food nutrients required by the body

Rickets

It is caused by lack of calcium . A child suffering from rickets has soft and weak bones. The legs become bow-shaped and the child is said to be **bow legged**.

Prevention and control

Feed the child with foods rich in calcium e.g. fish, liver, green vegetables and milk.

Lesson 6: 30 Minutes

Anaemia

Anaemia is caused by lack of **iron** in the blood. Iron is found in foods like meat, dark green vegetables, liver, kidney and green grams. Anaemia can occur to both young and old. It is more common in adolescent girls than in boys of the same age. When girls start getting their monthly period, they lose a lot of iron with the blood. Iron helps in formation of **haemoglobin** of red blood cells. Worms and malaria parasites also destroy the red blood cells which contain iron.

Signs and symptoms of anaemia

The skin appears pale

One feels light-headed, dizzy and unable to think clearly

One feels generally weak

The eyes, gums, palms and fingernails appear white

One easily gets out of breath and feels tired even after doing a small task.

Prevention and control of anaemia

Anaemia can be prevented by eating foods rich in **iron**. One should eat a lot of green vegetables such as spinach, amaranth, cowpea leaves, kales, beetroots, mrenda redmeat and liver, green grams. Girls and women should take foods rich in iron to replace the iron lost during their monthly period.

Lesson & 30 Minutes

Water and fibre

Together with a balanced diet, the body needs water in order to stay healthy

Importance of water in a diet

- Water helps in digestion of food.
- It helps to transport food to the body organs.
- Water dissolves the food so that it can easily be absorbed into the body organs
- It helps in making blood. It forms blood plasma
- Water removes waste products from the body through urine and sweat.
- Water cools the body when the weather is hot.
- Water prevents the skin from drying.

We should drink plenty of clean **boiled** water, especially after taking meals. Lack of water in the body is known as **dehydration**. Water lost through sweat, urine and tears should be replaced by drinking it, taking fruit juices, porridge, milk or by eating fresh fruits like oranges, pawpaws, watermelons and pineapples. Most vegetables also contain water.

Fibre

Fibre is the thread-like parts of foods in vegetables, fruits and outer skins of grains like maize and wheat. Fibre is not digested by the body and has no nutritive value. It however helps the body to get rid of waste products. It prevents one from constipating. **Constipation** is a condition when one is unable to empty his or her bowels well. Fibre is also called **roughage**.

Sources of fibre

Kales

Carrots

Oranges

Grains

Mangoes

Whole grains

Brown bread

Lesson 8: 30 Minutes

Availability of food sources rich in iron

The following foods are rich in iron- liver, kidney, meat, eggs. These are animal products which are mostly available in many areas of the country. Products from cattle are available in different climatic conditions but mostly in cool and wet climates there are dairy cows while in hot and dry areas there are beef cattle. Eggs from poultry are available in warm climates.

Plant sources of iron include green leafy vegetables (cowpeas, mrenda, spinach, kales, Fruits like the passion fruit. Roots like the beetroots. Fruits that are rich in Vitamin C like oranges, guava, lime, lemon, pineapple) help in absorption of iron.

Vegetables can be grown in small gardens by introducing irrigation or multistory (Garden in a sack) gardens.

Multistorey gardens, hanging gardens, moist gardens or key hole gardens

Technologies/Projects Promoted



Kales in a sack



Blacknight shade and amaranth in an old basin



Rabbits



chicken



Fireless cookers.

Lesson 9 10, & 11: 35 Minutes each

Practical on vegetable production, weeding and harvesting.

Lesson 12: 60 minutes : Cookery.

Appendix T: Iron Rich Foods Menu Plan for 5 (five) Days**DAY 1**

Time	Food Items	Amounts
Breakfast	milk	1 cup
	Boiled Arrowroot	1 piece
	Passion fruit	2 fruits
Snack	Avocado	¼ slice
Lunch	Cooked bananas	1½ bananas
	Beans stew	½ cup
	Mango	1 small
Snack Supper	Avocado	¼ slice
	Whole maize meal ugali	Small meal
	milk	1 cup
	Kales	½ cup
	Mango	1 small

6-10 glasses of water per day

DAY 2

Time	Food Items	Amounts
Breakfast	Wimbi porridge	1 cup
	milk	1 cup
	Water melon	1 slice
Snack	ripe banana	1 medium
Lunch	Rice	1½ bananas
	Beans stew	½ cup
	spinach	½ cup
	passion	1 small
Snack	Ripe banana	1 medium
Supper	Whole maize meal ugali	Small meal
	terere	½ cup
	egg	1 small
	watermelon	1 slice

6 glasses of water per day

DAY 3

Time	Food Items	Amounts
Breakfast	milk	1 cup
	Boiled sweet potato	1 piece
	guava	1 medium
Snack	ripe banana	1 ripe medium
Lunch	Githeri	1 cup
	kales	½ cup
	orange	1 small
Snack Supper	Avocado	¼ slice
	Arrowroot stew	Small meal
	Bean stew	1 cup
	Spinach	½ cup

orange 1 small

6 -10 glasses of water per day

DAY 4

Time	Food Items	Amounts
Breakfast	Fermented porridge milk Pawpaw	Wimbi 1 cup 1 slice
Snack	Avocado	¼ slice
Lunch	Cooked bananas Beans stew Mango	1 ½ bananas ½ cup 1 small
Snack	Avocado	¼ slice
Supper	Whole maize meal ugali Matumbo stew Terere pawpaw	Small meal 1 cup ½ cup 1 slice

6-10 glasses of water per day

DAY 5

Time	Food Items	Amounts
Breakfast	milk Boiled Arrowroot Passion fruit	1 cup 1 piece 2 fruits
Snack	Ripe banana	¼ slice
Lunch	Rice Meat stew Cabbage orange	1 ½ bananas ½ cup 1 small
Snack	Ripe banana	¼ slice
Supper	Mukimo pawpaw	Small meal 1 slice
Snack	milk	1 cup

6-10 glasses of water per day

Appendix U: Steps in the Construction of a Multi-storey Garden



Unused school portion of land



Manure



Mixing soil & manure



Support stick fixed



Filling bag



holes for planting dug in



Boys planting



Girls planting



Parents planting



Already planted bag



Growing crop



Crop ready for harvest

Appendix V: Demonstration on Hand Washing and Use of the Leaky Tin



Teaching on Prevention and control of Amoeba histolytica to pupils and parents



Hand washing demonstration

Boy pupil hand washing & sealing the leaky tin hole



Girl pupil using the leaky tin

Parent using the leaky tin

Health worker demonstrates

Appendix W: Research Approval 1

**KENYATTA UNIVERSITY
GRADUATE SCHOOL**

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
 Website: www.ku.ac.ke

P.O. Box 43844, 00100
 NAIROBI, KENYA
 Tel. 8710901 Ext. 57530

Internal Memo

FROM: Dean, Graduate School **DATE:** 16th August, 2011
TO: Ms. Gladys Njura Gitau **REF:** H87/11934/08
 C/o Foods, Nutrition & Dietetics Dept.

SUBJECT: APPROVAL OF RESEARCH PROPOSAL
 =====

This is to inform you that the Graduate School Board, at its meeting of 8th August, 2011, approved your research proposal for the Ph.D. degree.

You may now proceed with your data collection.

Thank you.

PETER K. MUCHEMI
FOR: DEAN, GRADUATE SCHOOL

c.c. Chairman, Foods, Nutrition & Dietetics Department

Supervisors:

1. Prof. Judith Kimiywe
Foods, Nutrition & Dietetics Dept.
2. Prof. Judith Waudo
Foods, Nutrition & Dietetics Dept.
3. Dr. Dorcas Mbithe David
Foods, Nutrition & Dietetics Dept.

PKM/cww

Committed to Creativity, Excellence & Self-Reliance

Appendix X: Research Approval 2**KENYATTA UNIVERSITY****OFFICE OF THE DEPUTY VICE-CHANCELLOR (ACADEMIC)**

Tel: (+254-20) 8710901-19 Ext 57481
 Fax: (+254-20) 8711380
 Website: www.ku.ac.ke

P.O. Box 43844-00100
 Nairobi, Kenya
 E-mail: dvc-acad@ku.ac.ke

Ref. KU/DVCACAD/IRT/VOL.2/27

23rd August, 2011

Ms. Gladys Njura Gitau
 C/o Foods, Nutrition & Dietetics Dept.
Kenyatta University

Dear Naomi,

REF: REQUEST TO CONDUCT RESEARCH – MS. GLADYS NJURA GITAU

The above subject refers.

Your request to collect data has been approved. You are expected to submit a hard copy and soft copy of your research report/thesis to Kenyatta University through the library and the Institute for Research Science and Technology.

Please liaise with the Director, Institute of Research before commencing data collection for further guidance.

Thank you.

PROF JOHN OKUMU
DEPUTY VICE-CHANCELLOR (ACADEMIC)

JO/gnm

Appendix Y: Research Authorization

REPUBLIC OF KENYA



NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telegrams: "SCIENCETECH", Nairobi
Telephone: 254-020-241349, 2213102
254-020-310571, 2213123.
Fax: 254-020-2213215, 318245, 318249
When replying please quote

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: **NCST/RRI/12/1/MED011/136**

29th August, 2011

Gladys Njura Gitau
Kenyatta University
P.O BOX 43844
Nairobi

Authorized
7/9/2011
[Signature]

**DISTRICT COMMISSIONER
GATANGA**

RE:RESEARCH AUTHORIZATION

Following your application for authority to carry out research on **Effects of nutrition education on iron deficiency anaemia among primary school pupils in the coffee growing area of Gatanga sub-county, Kenya**, I am pleased to inform you that you have been authorized to undertake research in **Gatanga District, Kenya** for a period ending **30th August 2013**

You are advised to report to **The District Commissioner, The District Education Officer and The District Medical Officer of Health Gatanga District** before embarking on the research project.

On completion of your research project you are advised to submit **one hard copy and one soft copy** of your thesis/ project to this office.

[Signature]
P.N NYAKUNDI
FOR: SECRETARY/CEO

Copy to:

The District Commissioner
Gatanga District

The District Education Officer
Gatanga District

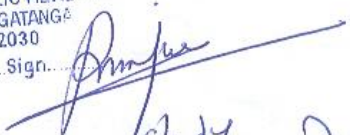
Authority has been granted to the madam Gladys N. Gitau to do the research in the District

**EDUCATION OFFICER
GATANGA DISTRICT**
[Signature]
P.O. Box 3253-01000
7/9/2011

The District Medical Officer of Health
Gatanga District

DISTRICT PUBLIC HEALTH
OFFICER-GATANGA
VISION 2030

Date 7/9/11 Sign...



*Its a viable study
hence authority granted
for the good of our children.*

Appendix Z: Research Permit

PAGE 2 **PAGE 3**

Research Permit No. NCST/RRI/12/1/MED011/130


THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs/Miss/Institution
Gladys Njura Gitau
of (Address)Kenyatta University
P.O. Box 438-14, Nairobi
has been permitted to conduct research in


Location	
Gatanga	
District	
Central	
Province	

on the topic: *Effects of nutrition education on iron deficiency anaemia among primary school pupils in the coffee growing area of Gatanga Sub-County Kenya.*


Date of issue **29th August 2011**

Fee received **KES 2,000**





Applicant's
Signature




Secretary
National Council for
Science and Technology

for a period ending 30th August 2013

CONDITIONS

1. You must report to the District Commissioner and the District Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed with-out prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2)/four(4) bound copies of your final report for Kenyans and non-Kenyans respectively.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice



REPUBLIC OF KENYA
RESEARCH CLEARANCE
PERMIT

GPk60553mt10/2011 **(CONDITIONS—see back page)**

Appendix Z1: Ethical Letter



KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: director-crd@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844
Nairobi, 00100
Tel: 8710901/12

Our Ref: KU/R/COMM/51/20

Date: September 21st, 2011

Gladys Njura Gitau,
Dpt. of Foods, Nutrition & Dietetics,
Kenyatta University.

Dear Gladys,

APPLICATION NUMBER PKU012/I10 OF 2011 - 'EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA'.

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic 'EFFECTS OF NUTRITION EDUCATION ON IRON DEFICIENCY ANAEMIA AMONG PRIMARY SCHOOL PUPILS IN THE COFFEE GROWING AREA OF GATANGA SUB-COUNTY, KENYA' *version 2* dated 19th September 2011.

2. APPLICANT

Gladys Njura Gitau,
Dpt. of Foods, Nutrition & Dietetics,
Kenyatta University.

3. SITE

GATANGA SUB-COUNTY, KENYA.

4. DECISION REACHED

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines, and is of the view that against the following elements of review,

- (i) Scientific design and conduct of study,
- (ii) Recruitment of research participant,
- (iii) Care and protection of research participants,
- (iv) Protection of research participant's confidentiality,
- (v) Informed consent process,
- (vi) Community considerations.

AND APPROVED that the research may proceed for a period of ONE year from 21st September, 2011.

5. ADVICE/CONDITIONS

5.1 General

- i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study,
- ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur,
- iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.

If you accept the decision reached and advice and conditions given please sign in the space provided below and return to KU-ERC a copy of the letter.



NICHOLAS K. GIKONYO, PhD.
CHAIRMAN ETHICS REVIEW COMMITTEE

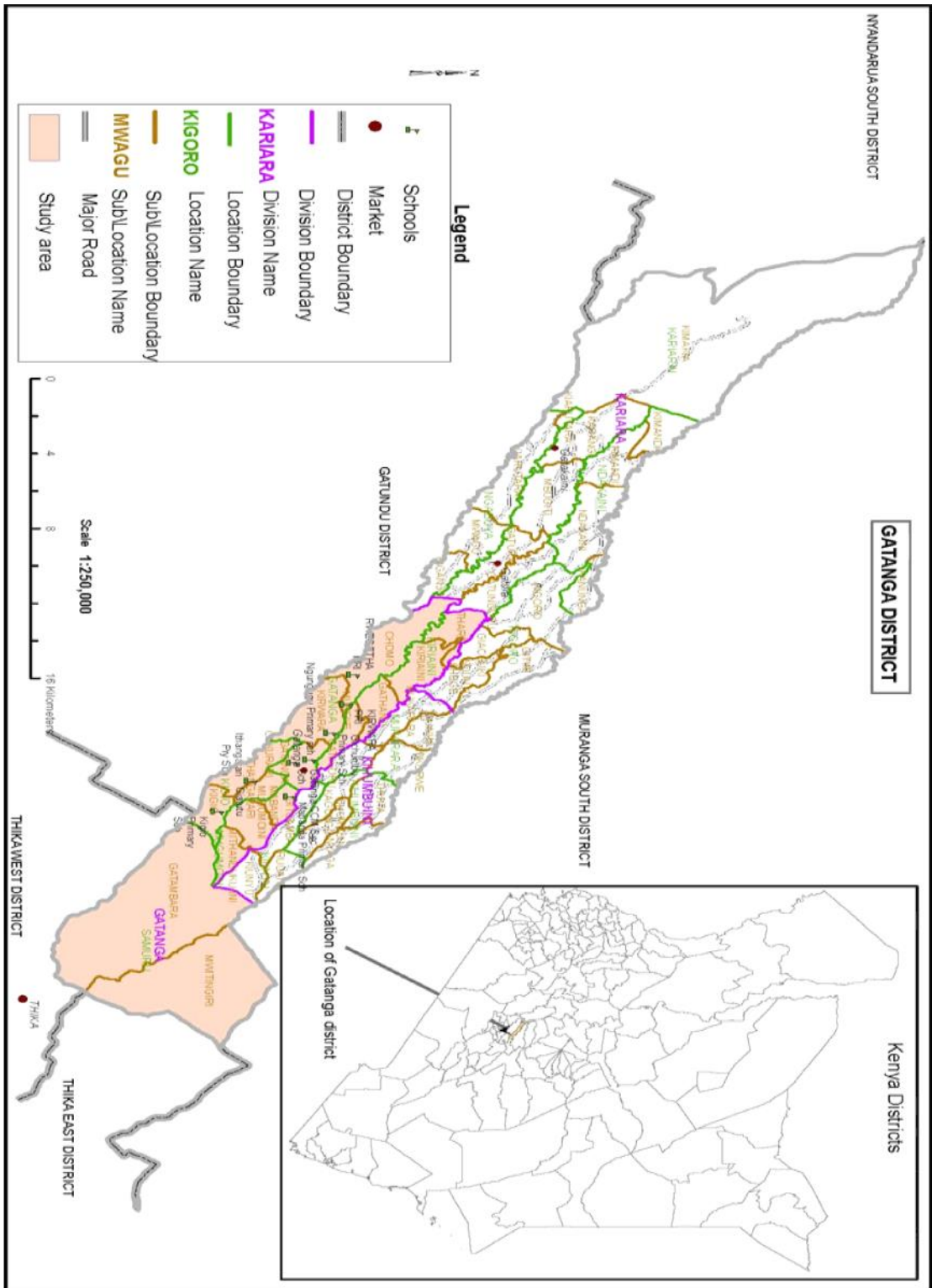
I GLADYS N. GITAU accept the advice given and will fulfill the conditions therein.

Signature  Dated this day of. 2011.

cc. Vice-Chancellor
Director: Institute for Research Science and Technology

JG/

Appendix Z2: Gatanga Sub-County Map



Appendix Z3: Flip Chart- Nutrition Education Materials

**LET'S TALK ABOUT FOOD, NUTRITION,
IRON DEFICIENCY AND ANAEMIA**



EAT WELL, GROW HEALTHY

Introduction

Uses of food in the body are to:

- a) Provide enough energy needed for work and play.



- b) Build the various parts of the body.



- c) Repair parts that have been damaged by diseases.



A Healthy Child



A Malnourished (thin) child

- d) Protect against diseases.
- e) Stay alive and maintain good health.

Nutritionists (Scientists who study food and nutrition) say you should eat a balanced diet with plenty of water and very little fats and sugars.

What is a balanced diet?

It is a diet that provides nutrients needed by the body in order to maintain good health.

It includes:

1) Proteins (Body building food):



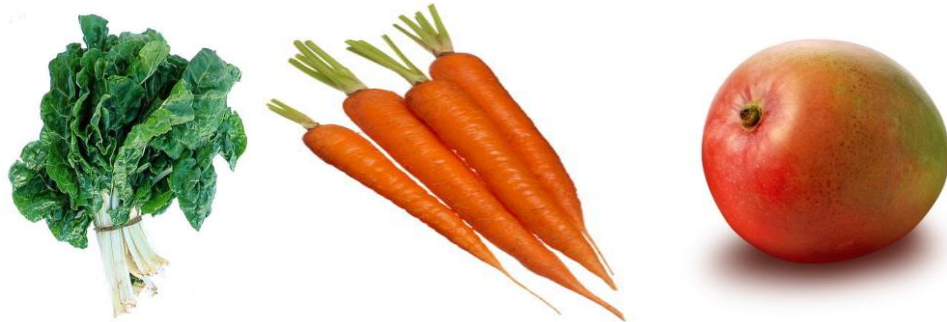
Meat, Eggs, Milk and Beans

2) Carbohydrates (Energy giving foods)



Unripe bananas, Cassava, Arrowroots, Yams and Maize

3) Vitamins (Protective foods)



Spinach, Cabbages, Carrots, Tomatoes, Mangoes, Oranges, Green peas

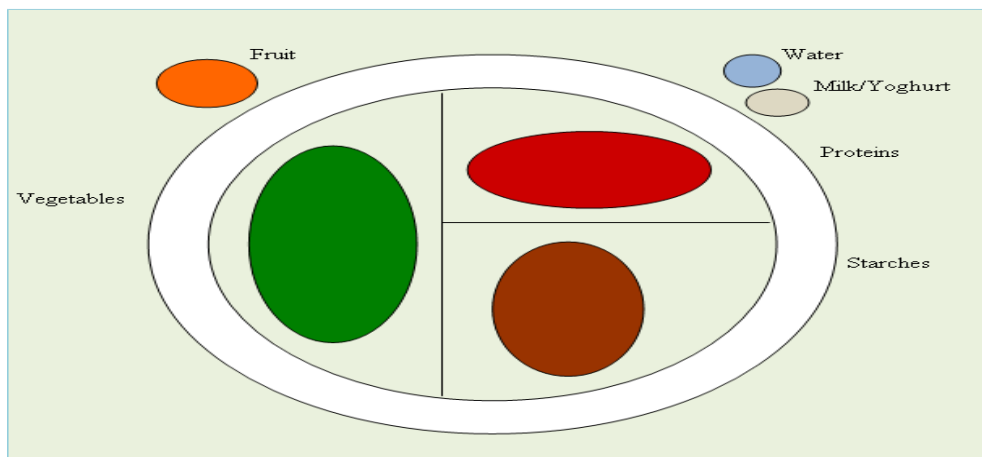
4) Minerals- from fruits and vegetables

The Food Guide Pyramid



- ✓ Use different kinds of food each day to meet your daily nutrient requirements.
- ✓ Drink 8-10 glasses of water each day.
- ✓ Avoid junk food.
- ✓ Eat foods rich in micro-nutrients like the traditional green leafy vegetables . And grains like millet, other green leafy vegetables,beans, eggs, redmeat, liver, kidney.

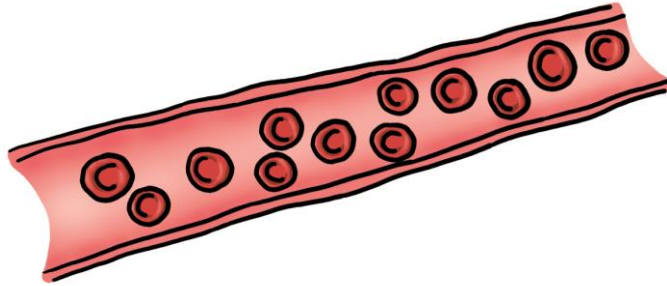
Food Portion Size (Healthy Eating Plate)



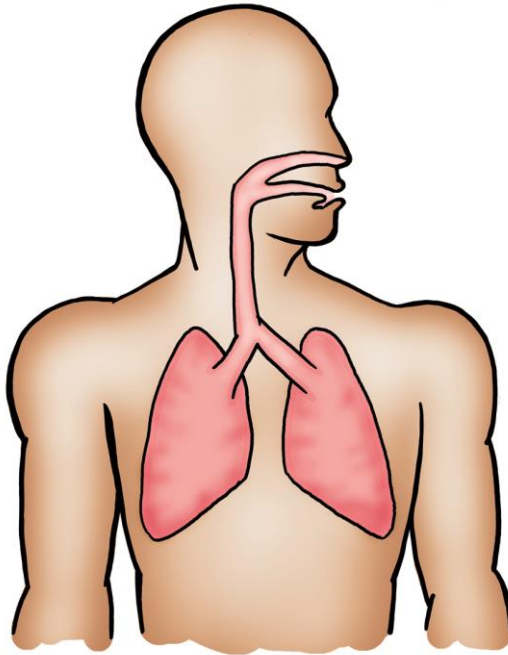
Approximate portion size of foods you should eat per meal (20cm diameter plate).

Importance of iron in the body:

- 1) It gives blood its red colour; haemoglobin.



- 2) Hemoglobin transports oxygen from lungs to tissue.



- 3) It builds new cells and eliminates old red blood cells.
- 4) It is used in energy utilization.

Examples of iron rich foods.

Crop products (non-heme)



Beans

Green leafy vegetables



Spinach



Mitoo-slenderleaf (*Crotalaria ochroleucia*)



Spiderplant

Animal Products (heme)



Red-meat



Liver



Fish

Anaemia

- It is caused by lack of iron in the blood.
- It occurs in both old and young.
- Adolescent girls get anaemia due to loss of blood in monthly periods.
- Parasites like malaria parasites, worms cause anaemia.
- Any bleeding that causes loss of blood leads to anaemia.

Signs and symptoms of anaemia

- 1) Skin appears pale.
- 2) One feels light-headed, dizzy and unable to think clearly.
- 3) One feels generally weak.
- 4) The eyes, gums, palms and finger nails appear white.
- 5) One easily gets out of breath and feels tired even after doing a small task.
- 6) May lead to death if not treated early.

Prevention of anaemia

Eat food rich in iron such as leafy vegetables (kales, spinach, amaranth (terere), red meat (liver, kidney), fish, eggs, soya beans, maize millets and sorghum.

To improve iron absorption:

- 1) Treat for worms and malaria.
- 2) Increase consumption of iron rich foods.
- 3) Increase consumption of fruits rich in vitamin C like guavas, oranges, lemon, lime, loquats, mangoes, gooseberries, tree tomatoes, etc at meal time.
- 4) Reduce consumption of tea, coffee with meals and take them 1-2 hours before or after meals. They inhibit absorption of iron into the body.

Growing iron rich foods

Multi-storey gardens



Cowpea garden



Rabbits and chicken for meat/eggs



Conclusion

School children should fight micro-nutrient deficiencies like anaemia by growing their own food at home and in school. These include crops and small livestock.

Eat a wide variety of foods since different foods contribute different nutrients.

Healthy eating habits include eating lots of vegetables and fruits and staying away from junk foods like chocolate, sweets, potato chips and soda.

