The Role of Agricultural Biodiversity, Dietary Diversity, and Household Food Security in Households with and without Children with Stunted Growth in Rural Kenya

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DECLARATION

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ABSTRACT

Research aim

The study aimed to explore the associations between agricultural biodiversity, household food security and dietary diversity in households with children aged 24 to 59 months in two rural areas of Kenya, of which one had higher rainfall and agricultural biodiversity than the other.

Methods

Study sample and location

The study adopted a cross-sectional analytical approach to investigate the associations in resource in poor households in two rural areas; Akithii and Uringu of Kenya. Of the 525 households randomly selected, 261 were from Uringu division and 264 from Akithii division. Two independent cross-sectional surveys were conducted; Phase one in September to October 2011 (during the dry season) while Phase 2 took place in March 2012 (during the rainy season). A questionnaire was developed to gather information on the socio-demographics of the household, breastfeeding and infant feeding practices, immunization and childhood illnesses.

Dietary intake was measured during each season by conducting a repeated 24-hour recall (24-hr recall) with the mother/care giver of the household. A nutrient adequacy ratio (NAR) was calculated for each nutrient as the percent of the nutrient meeting the recommended dietary intake (RDI) value for that nutrient. A mean adequacy ratio (MAR) was calculated for 11 nutrients as the mean of the NARs of these nutrients. Dietary diversity was measured using data from the 24-hour recalls and classifying it into nine food groups. A dietary diversity score (DDS) was calculated based on each different food group which was consumed during the period of recall up to a maximum of nine if the food had been consumed from each of the nine groups.

Household food security (HFS) was measured using the Household Food Insecurity Access Scale (HFIAS). The agricultural biodiversity was calculated by counting the number of different crops and animals eaten either from domestic sources or from the wild. Weight and height measurements of children and their mothers/care givers were taken. Weight for age (WAZ), height for age (HAZ) and weight for height z (WHZ) scores were determined for children, while body mass index (BMI) measurements were calculated for the adult women. The relationships between continuous response variables and nominal input variables were analyzed using appropriate analysis of variance (ANOVA) or pooled, paired and independent mean T-tests when only two groups were involved.

Results

Dietary intake was low with the majority of households not meeting the RDIs for most nutrients. The MAR was 61.3%; 61.8% for Phase 1 and 2 respectively. The DDS was low at 3.3 ±1.2 for both Phases. The majority of households were food insecure with a HFIAS mean of 12.8 ± 6.19 and 10.9 ± 7.49 for Phase 1 and 2 respectively. Agricultural biodiversity was low with a total of 26 items; 23 domesticated and 3 from the natural habitat. Two food items from the natural habitat originated from plants and one from animals. Exclusive breastfeeding up to the recommended six months was practiced at low rates of 23.4% while 39.3% of mothers in both divisions introduced complementary foods before 6 months of age.

Stunted growth among the children was high at a mean of 30.5% (n=291). Boys had higher stunted growth rates in both divisions compared to the girls. A significant positive relationship was established between the number of contributors to household income with height for age z-scores (HAZ) scores of the children (Spearman r=-0.15, p=0.02). The number of household assets also significantly influenced HAZ scores (Spearman r=-0.17, p=0.01), the higher the number of household assets, the lower HAZ scores were. During Phase 1 (dry season) (pooled t-test, p<0.001), levels of food insecurity were higher compared to Phase 2 (wet season) (pooled t-test, p<0.001); showing the influence of season on food security. Phases 1 & 2 showed that Akithii had a significantly higher level of food insecurity (Mann-Whitney U; $p<0.01$), and a lower DDS (chi-square test, $p<0.001$) compared to Uringu. Children in Akithii consumed a less diversified diet than those in Uringu.

Agricultural biodiversity was positively and significantly related to: HFIAS (Spearman r=-0.10, p=0.02); DDS (ANOVA, $p<0.001$); all NARs (Spearman, $p<0.05$) and MAR (Spearman, $p<0.001$).This implies that households with higher agricultural biodiversity were more likely to be food secure, have higher dietary diversity levels and a diet comprising a higher nutritional value. DDS was significantly correlated to MAR and NARs of all the nutrients studied in this study. Findings showed that DDS was also consistently significantly inversely correlated to Household Food Insecurity Access Prevalence (HFIAP) (R =-0.185, t (N-2)-3.889), p=0.0001). This correlation showed that an increase in dietary diversity inversely affected HFIAS. A significant relationship was found between HFIAP and MAR (ANOVA, p=0.00268); indicating that households with a higher MAR were more likely to be food secure. There was a significant correlation between the BMI of the mother/care giver and the WAZ scores of the children (r=0.1410, $p<0.001$); indicating that higher HAZ scores were found in mothers with higher mean BMI values.

There was a significant difference between households with and without children with stunted growth in DDS (ANOVA; p=0.047) and HFIAS (ANOVA; p=0.009) but not with agricultural biodiversity score (ANOVA; p=0.486). The agricultural biodiversity mean score for households with children presenting with stunted growth were, however, lower at 6.8, compared to 7.0 for those with normal growth however the p value was not significant. This indicates that households with children with stunted growth and those without are significantly different in DDS and HFIAS but not regarding agricultural biodiversity. This further implies that the potential of DDS and HFIAS to be used as proxy measures for stunting be further explored.

Conclusion

Agricultural biodiversity has a positive impact on household food security, dietary diversity, dietary adequacy and child growth. Food security is closely linked to dietary diversity and dietary adequacy; therefore improving one is likely to improve the other two and impact positively on child growth status. Interventions to improve child health and food security in resource poor rural households should aim at increasing dietary diversity through agricultural biodiversity.

OPSOMMING

Navorsingsdoel

Die studie is daarop gemik om die assosiasies tussen die landbou-biodiversiteit, huishoudelike voedselsekerheid en dieetdiversiteit in huishoudings met kinders tussen die ouderdomme van 24 tot 59 maande in twee landelike gebiede van Kenia, waarvan een 'n hoër reënval en landbou-biodiversiteit as die ander gehad het, te verken.

Metodes

Studie steekproef en plek

Die studie het 'n deursnit-analitiese benadering aangeneem om die assosiasies te ondersoek in hulpbron-arm huishoudings in twee landelike gebiede; Akithii en Uringu van Kenia. Van die 525 huishoudings wat ewekansig gekies is, was 261 van Uringu afdeling en 264 van Akithii afdeling. Twee onafhanklike deursnit-opnames is uitgevoer; fase een in September tot Oktober 2011 (tydens die droë seisoen), terwyl Fase 2 in Maart 2012 (gedurende die reënseisoen) plaasgevind het. ‘n Vraelys is ontwikkel om inligting oor die sosio-demografie van die huishouding, borsvoeding en babavoeding praktyke, immunisering en kindersiektes in te samel.

Dieetinname is gemeet tydens elke seisoen deur die uitvoer van 'n herhaalde 24-uur herroep met die moeder / versorger van die huishouding. ‘n Voedingstof toereikendheidsverhouding (VTR) is bereken vir elke voedingstof, uitgedruk as die persentasie van die voedingstof wat voldoen aan die aanbevole dieetinname (ADI) waarde vir daardie voedingstof. ‘n Gemiddelde toereikendheidsverhouding (GTR) is bereken vir 11 voedingstowwe uitgedruk as die gemiddelde van die VTR’s van hierdie voedingstowwe. Dieetdiversiteit is gemeet deur data vanuit die 24-uur herroepe, geklassifiseer in nege voedselgroepe. ‘n Dieetdiversiteit telling (DDT) is bereken op grond van elke verskillende voedselgroep wat gedurende

die tydperk van herroep ingeneem is tot 'n maksimum van nege, indien die voedsel verbruik is uit elk van die nege groepe.

Huishoudelike voedselsekerheid (HVS) is gemeet deur die huishoudelike voedselonsekerheid toegangskaal (HVOTS) te gebruik. Die landbou-biodiversiteit is bereken deur die som te bereken van die aantal verskillende gewasse en diere geëet óf van huishoudelike bronne óf uit die natuur. Gewig en lengte metings is geneem van die kinders en hul moeders / versorgers. Gewig vir ouderdom (GVO), lengte vir ouderdom (LVO) en gewig vir lengte (GVL) Z-tellings is bepaal vir die kinders, terwyl die liggaamsmassa-indeks (LMI) metings bereken is vir die volwasse vroue. Die verhoudings tussen aaneenlopende reaksie veranderlikes en nominale inset veranderlikes is ontleed met behulp van toepaslike analise van variansie (ANOVA) of saamgevoegde, gepaarde en onafhanklike gemiddelde T-toetse, indien slegs twee groepe betrokke was.

Resultate

Dieetinname was laag en die meerderheid van huishoudings het nie aan die ADIs vir die meeste voedingstowwe voldoen nie. Die GTR is 61,3% en 61,8% vir onderskeidelik fase 1 en 2. Die DDT is laag; 3,3 ±1,2 vir beide fases. Die meerderheid van huishoudings was voedselonseker met 'n gemiddelde HVOST van 12,8 ±6,19 en 10,9 ±7,49 vir onderskeidelik fase 1 en 2. Landbou-biodiversiteit was laag met 'n totaal van 26 items, 23 huishoudelike en 3 vanuit die natuurlike habitat. Twee voedselitems uit die natuurlike habitat was afkomstig van plante en een vanaf diere. Eksklusiewe borsvoeding, tot die aanbevole ses maande, was laag en beoefen deur 23,4%, terwyl 39,3% van die moeders, in beide streke, komplimentêre voedsel voor 6 maande ouderdom bekendgestel het.

Vertraagde groei onder die kinders was hoog met 'n gemiddeld van 30,5% (n=291). Seuns het hoër vertraagde groei in beide streke in vergelyking met dogters getoon. 'n Beduidende positiewe verhouding is gevind tussen die aantal bydraers tot huishoudelike inkomste en lengte vir ouderdom z-tellings (LOZ) van die kinders (Spearman r=-0,15, P=0,02). Die aantal huishoudelike bates het ook LOZ tellings (Spearman r=-0,17, P=0,01) aansienlik beïnvloed; hoe hoër die aantal huishoudelike bates, hoe laer die LOZ tellings. Tydens fase 1 (droë seisoen) (saamgevoegde t-toets, p<0.001), was vlakke van voedselonsekerheid hoër in vergelyking met fase 2 (nat seisoen) (saamgevoegde t-toets, p <0.001), wat die invloed van die seisoenaliteit op voedeselsekerheid uitwys. Fase 1 en 2 het gewys dat Akithii 'n beduidende hoër vlak van voedselonsekerheid gehad het (Mann-Whitney U; p<0.01) en 'n laer DDT (chi-square toets, p<0.001) in vergelyking met Uringu. Kinders in Akithii het 'n dieet laer in diversiteit ingeneem as die in Uringu.

Landbou-biodiversiteit is positief en beduidend verwant aan: HVOTS (Spearman r = -0,10, P = 0,02); DDT (ANOVA, p<0.001), alle VTR's (Spearman, p <0.05) en GTR (Spearman, p <0.001). Dit impliseer dat huishoudings met 'n hoër landbou-biodiversiteit, meer geneig is om voedselseker te wees, hoër dieetdiversiteit vlakke en 'n hoër voedingswaarde het. DDT is beduidend gekorreleer aan GTR en VTT's van al die voedingstowwe wat bestudeer is in hierdie studie. Bevindinge het getoon dat DDT konsekwent en beduidend omgekeerd gekorreleer is met huishoudelike voedselonsekerheid toegang prevalensie (HVOTP) (R=-0,185, t(N-2)-3,889), p=0,0001). Hierdie korrelasie toon dat 'n toename in dieetdiversiteit HVOTS omgekeerd beïnvloed het. 'n Betekenisvolle verhouding is gevind tussen HVOTP en GTR (ANOVA, p=0,00268); wat aandui dat huishoudings met 'n hoër GTR meer geneig is om voedselsekerheid te toon. Daar is 'n beduidende korrelasie tussen die LMI van die moeder / versorger en die GOZ tellings van die kinders (r=0,1410, p<0.001), wat aandui dat hoër LOZ tellings gevind is in moeders met hoër gemiddelde LMI waardes.

Daar is 'n beduidende verskil tussen huishoudings met en sonder kinders met dwerggroei se DDT (ANOVA; p=0.047) en HVOTS (ANOVA; p=0.009) maar nie die landbou-diversiteit telling nie (ANOVA; p=0.486). Die gemiddelde landbou-diversiteit telling vir huishoudings met en sonder kinders met dwerggroei is egter laer met 6.8 in vergelyking met 7.0 vir die met normale groei. Die p-waarde is egter nie beduidend nie. Dit dui aan dat huishoudings met kinders met dwerggroei en daarsonder beduidend verskillend is ten opsigte van DDT en HVOTS, maar nie met landbou-diversiteit in die studie nie. Dit impliseer verder dat die potensiaal van DDT en HVOTS om gebruik te word as alternatiewe metings vir dwerggroei verder ondersoek moet word.

Gevolgtrekking

Landbou-biodiversiteit het 'n positiewe impak op huishoudelike voedselsekerheid, dieetdiversiteit, dieettoereikendheid en groei van kinders. Voedselsekerheid is nou gekoppel aan dieetdiversiteit en dieettoereikendheid, daarom sal die verbetering van die een waarskynlik die ander twee positief beïnvloed asook ’n positiewe impak hê op die groei van kinders. Intervensies vir die verbetering van kindergesondheid en voedselsekerheid in hulpbron-arm landelike huishoudings moet poog om dieetdiversiteit te verhoog deur landbou-biodiversiteit.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
BMI	Body Mass Index
DDS	Dietary Diversity Score
DD	Dietary Diversity
ESWEC	Economic Strategy for Wealth and Employment Creation
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization
GOK	Government of Kenya
HAZ	Height for Age *Z*-scores
HFIAP	Household Food Insecurity Access Prevalence
HFIAS	Household Food Insecurity Access Scale
HFS	Household Food Security
KFSM	Kenya Food Security Meeting
KFSSG	Kenya Food Security Information Steering Group
KIHBS	Kenya Integrated Household Budget Survey
MAR	Mean Adequacy Ratio
MDG's	Millennium Development Goals
NAR	Nutrient Adequacy Ratio
RDI	Recommended Dietary Intake
SDHQ	Socio-Demographic and Health Questionnaire
SSA	Sub-Saharan Africa
UNICEF	United Nations Children's Fund

UN	United Nations
WAZ	Weight for Age Z-scores
WHO	World Food Organization
WHZ	Weight for Height Z-scores

DEFINITION OF TERMS

- Agricultural biodiversity: All components of biological diversity of relevance to food and agriculture. It also encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for, and in support of, food production and food security.[1]
- Dietary diversity: the number of different foods or food groups consumed over a given reference period.[2]
- Household food security: the ability of a household to physically and economically access food that is adequate in quantity, nutritional quality, safety and culturally acceptable to meet the needs of all its members at all times.[3]
- Food security: a state in which all people at all times have physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life.[4]
- Food access: Refers to a situation where individuals/households have adequate income or other resources for acquiring appropriate food for a nutritious diet.[3]
- Nutritional Status: Refers to a measurement of the extent to which the individual's physiologic need for a nutrient is being met.[5]
- 24-hour recall: A method used to assess dietary intake of an individual. The person is asked to recall everything eaten during the past 24-hours.[5]
- Body Mass Index (BMI): BMI defines the level of adiposity in the human body. The formula for calculating BMI = Weight(kg)/height^2(m^2).[5]
- Pastoralism: Subsistence practice in which people care for and domesticate animals, usually ungulates such as cattle, sheep, and goats. It also refers to the lifestyle of shepherds or pastoralists, moving livestock around larger areas of land according to seasons and availability of water and feed.[6]

- Peasant farming: Peasant Farming is the cultivation of crops and rearing of animals on a small scale for whereby small farming equipment mostly manual tools/ labor are used.[7]
- Hunger: The status of persons, whose food intake regularly provides less than their minimum energy requirements. The average minimum energy requirement per person is about 1800 kcal per day. The exact requirement is determined by a person's age, body size, activity level and physiological conditions such as illness, infection, pregnancy and lactation.[8]
- Malnutrition: A broad term for a range of conditions that hinder good health, caused by inadequate or unbalanced food intake or from poor absorption of food consumed. It refers to both under-nutrition (food deprivation) and over-nutrition (excessive food intake in relation to energy requirements).[8]
- Food insecurity: Exists when people lack access to sufficient amounts of safe and nutritious food, and therefore are not consuming enough for an active and healthy life. This may be due to the unavailability of food, inadequate purchasing power, or inappropriate utilization at household level.[8]
- Stunted growth is a consequence of longer-term poor nutrition in early childhood. Stunting is associated with developmental problems and is often impossible to correct. A child with stunted growth is likely to experience a lifetime of poor health and underachievement.[9]

CHAPTER 1: LITERATURE REVIEW AND MOTIVATION FOR THE STUDY

1.0 INTRODUCTION

Reducing hunger and food insecurity is an essential part of the international development agenda. The latest addition to this agenda is the Millennium Development Goals (MDG's) (Figure 1.1). The MDG's are a set of goals that were agreed on and signed by 189 countries at the United Nations Millennium Summit in 2000, highlighting the most pressing issues worldwide. MDG no 1 specifically addresses "Eradication of extreme poverty and hunger."[10]

Figure 1.1: The Millennium Development Goals[10]

Despite the substantial resources targeted towards combating hunger and malnutrition, there has been limited progress towards the attainment of this particular Millennium Development Goal (MDG 1) in most developing countries—especially in Sub-Saharan Africa (SSA). The 2009 UNICEF report on "Tracking progress on child and maternal nutrition" shows that between 1990 and 2008, the prevalence of malnutrition in the developing world declined from 40% to 29%. However, SSA made the least progress reducing the prevalence of malnutrition from 38% to 34% during the same period.[9]

A recent report[11] on the MDGs shows a significant reduction in numbers of people living at extreme poverty levels. In the developing region, the numbers fell from over 2 billion in 1990 to less than 1.4 billion in 2008 (prevalence of 47% to 24%) while in SSA, absolute number of people living in extreme poverty also fell from 395 million in 2005 to 386 million in 2008 (prevalence of 56% to 47%).[11]

A report by the World Bank however, still shows that the prevalence of hunger remains uncomfortably high in Sub-Saharan Africa. Consequently, the MDG goal of reducing malnutrition and hunger by half between 1990 and 2015 is unlikely to be met in SSA.[9] According to FAO, the high prevalence of hunger and malnutrition in SSA is likely to restrict progress towards the attainment of other MDGs since nutrition intake impacts on child and maternal mortality as well as school attendance and performance.[12]

The current pace of poverty reduction is too slow for the continent (Africa) to achieve MDG 1 by 2015, although it is faster than historical trends. Extreme poverty for Africa (excluding North Africa) has been forecasted at 35.8% in 2015 against the previous forecast of 38%.[13] Of 25 countries with recent data on this indicator (MDG 1) from international organizations, 20 countries show improvement in the achievement; however Kenya was among the 5 countries which regressed on this indicator.[14]

In the developing world, the progress of reducing malnutrition, with specific reference to undernutrition in children under the age of five years, has been marginal. Based on a subset of 86 countries with trend data for the period 1990 and 2008, covering 89% of the developing world's population, the proportion of underweight children decreased from 31% to 26% between 1990 and 2008.[9] Despite the progress noted in the decrease in underweight children in developing countries, it has been said that this progress is insufficient to reach the global target (14.5%) by 2015.[11] In the year 2010, 925 million people were found to be hungry while 129 and 195 million children under five years were underweight and stunted, respectively, with 90% of these children in 36 countries.[15]

Evidence from research shows that malnutrition is an underlying cause of death of 2.6 million children each year, which translates to one-third of the global total children's deaths.[16, 17, 18] About 170 million children are affected by stunting; one in every four children in the world are stunted while in the developing countries this figure is as high as one in three.[17, 19] Global progress in reduction of stunting has been extremely slow. The proportion of children who are stunted decreased from 40% in 1990 to 27% in 2010 – an average of just 0.6 percentage points per year. It is estimated that 450 million children globally will be affected by stunting in the next 15 years, if current trends continue. Childhood malnutrition can lessen productivity since stunted children are predicted to earn an average of 20% less when they become adults.[19, 20]

Despite strides made to reduce global hunger through, among others, increased cereal production, vulnerable people on a global scale are still hungry. The availability of cheap cereal foods has coincided with the erosion of agricultural biodiversity and reduction in dietary diversity.[21] Loss of agricultural biodiversity through the extinction of species, degrading of natural habitats and intensive modern agriculture, based on a few breeds of animals and plants are occurring throughout the world at unprecedented rates.[22]

In resource poor households across the globe, low quality monotonous diets are the norm. These diets generally constitute a large portion of starchy foods which include cereals and tubers and are low in vegetables, fruits and animal protein.[23] Lack of dietary diversity is one of the severe problems among poor populations in resource limited countries. These populations tend to rely mostly on starchy staples;

their diets are monotonous and often include little or no animal products with few fresh fruits and vegetables.[24]

The diets consumed tend to be low in a number of micronutrients, and the micronutrients they contain are often not bio-available, thus resulting in undernutrition.[24] The risk of micronutrient deficiencies is high, particularly in children under the age of five years. Every year, six million children under five years die of undernutrition and related preventable diseases while millions more become blind, suffer from delayed cognitive development and other disabilities that impair body functioning because of a lack of energy and specific micronutrients.[25]

Undernutrition in early childhood may lead to cognitive and physical deficits and may cause similar deficits in future generations as malnourished mothers give birth to low birth weight infants.[26] The effects of undernutrition on human performance, health and survival have been the subject of extensive research for several decades.[27] Studies show that undernutrition affects physical growth, morbidity, mortality, cognitive development, reproduction, and physical work capacity.[27] Evidence from research carried out in developed countries show that dietary diversity is strongly associated with nutrient adequacy. A few researchers from developing countries have also shown this association.[28-33]

A study in Kenya by Ekesa et al.[35] showed a strong relationship between agricultural biodiversity and dietary diversity. The findings showed that almost 50% of changes in dietary intake of preschool children were due to agricultural biodiversity. This implies that improving biodiversity can improve dietary diversity in this group which in turn can lead to an improvement in nutritional status.[35]

The paucity of data on the relationship between agricultural biodiversity and food security in Kenya and other countries in SSA prompted the current research study to build on the findings of the study by

Ekesa et al.[35] and to contextualize the associations between agricultural biodiversity, dietary diversity, food security and nutritional status of children. In addition, a recent systematic review on the contribution of edible plant and animal biodiversity to human diets by Penafiel et al.[34] showed a limited number of studies in this area and limited use of quantified dietary assessment; thus emphasizing the importance of this study.

1.1 FOOD SECURITY – CONCEPT AND GLOBAL SITUATION

At the national level, food insecurity entails inadequate food supplies for all citizens through local production, storage, food imports and food aid while at the household level, food insecurity occurs when all the potential sources of the household are strained or even threatened.[36] It is important to note that the concept of food security whether at the national or household level is defined differently by various organizations, in most instances as a working, rather than a technical definition. In this study, the researcher adopts the FAO[37] definition. Household food security as defined by FAO,[37] is the ability of the household to produce or buy adequate, safe and good quality food that is acceptable to meet the dietary requirements of all its members at all times.

Ideally, household food security implies physical and economic access to food that is adequate in terms of quantity, nutritional quality, safety and cultural acceptability to meet each person's needs. It therefore, depends on an adequate income and assets, such as land and other productive resources.[3] According to the World Food Summit Plan of Action adopted in November 1996, "food security exists when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life."[38] The other form of food security, apart from national and household food security, is individual nutritional security. Food security can be translated into good nutritional status if household members are nutritionally secure. The pre-requisites for nutrition security are food, health and care.[39]

It is estimated that more than one billion people worldwide are very poor and suffer from food insecurity of which nearly three-quarters in developing countries live in rural areas.[25] Estimates from the report on the state of food insecurity in the world[40] show that about 870 million people in the world have been undernourished in the period 2010-12. The majority of these people (852 million) live in developing countries where the prevalence of the undernourished is estimated at 14.9% of the population.[40]

The above estimates[25, 40] emphasize the need to target the rural areas if the eradication of extreme poverty (MDG 1) is to be realized since nearly three-quarters of the population in developing countries live in rural settings.[25] Many of the rural poor are small farmers at the edge of survival. They depend on agriculture for their earnings, either directly as producers, hired workers or indirectly in sectors which derive their existence from farming.[37] This implies that improvement in agricultural productivity and biodiversity may have an uplifting effect on their livelihoods. A recent report on the state of food insecurity in the world[40] states that *"economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition."*This report emphasizes the need for a "*nutrition-sensitive*" approach which focuses on better nutrition outcomes, opportunities for the poor to have dietary diversity, improvement in the access to safe drinking water and improved child care practices.

Nutrition-sensitive approaches, policies and interventions are now being promoted in economic growth, development, agriculture and food systems.[41,42,43] The various strategies that incorporate specific nutrition goals and actions have been recommended, which include: agriculture and food security; social safety nets; early child development; maternal mental health; women's empowerment; child protection; schooling; water, sanitation, and hygiene; health and family planning services.[44]

It has been urged by different experts that *nutrition sensitive* approaches should be used since they address the underlying determinants of undernutrition. They can be implemented on large scale hence are effective at reaching the poor. Researchers also contend that *nutrition sensitive* approaches can serve as delivery platforms for nutrition-specific interventions, which address immediate determinants of fetal, child nutrition and development.[44]

Experts have also emphasized that nutrition problems in the world can only be overcome when nutrition is addressed as a cross-cutting issue.[45,46] Additionally, the UN report on the progress of the MDGs indicates that malnutrition of children has negative spill-overs on other MDGs, and therefore requires assertive national policies.[11] To any society, the cost of preventing malnutrition is far lower than the cost of managing its side-effects and therefore the need for national policies that are targeted towards better nutritional outcomes.[26] Based on these arguments, good nutrition is therefore essential to sustainable economic growth.

Progress in reducing food insecurity has been uneven across the developing world with some countries losing ground. There is evidence that the momentum for change initiated in the 1990s has stalled and progress will likely be harder to achieve in the future.[25] FAO states candidly that the state of food insecurity in the world is not good and the progress in reducing undernutrition has considerably slowed since 2007.[37, 40] Where child malnutrition is concerned, SSA and Central America recorded increases in the prevalence of both stunting and underweight during the 1990s.[47] This calls for concerted effort geared towards developing mechanisms that can improve food security in developing countries.

1.2 FOOD SECURITY AND NUTRITION IN KENYA

Kenya is classified by FAO as a low-income-food deficit country.[48] Kenya is among the one third of African countries whose food availability showed an average daily caloric availability below the commended level of 2100 Kcal.[49] Over the years, the Kenya Government has strived to achieve national, household and individual food security throughout the country. The 2007 economic review indicated that 51% of the population lack access to adequate food.[50]

This inaccessibility to food is closely linked to poverty which stands at 46%.[51] The country has been facing serious food insecurity due to reduced cereal production, livestock diseases, rising food prices and poor rainfall. The food shortage situation was declared a national disaster at the beginning of January 2009 and May 2011 indicating that about 10 million persons were highly food insecure.[52, 53]

A survey by the Government of Kenya (GOK)[54] showed that about 46% of the Kenyan population suffered from absolute poverty with the rural households being worse off, at 49%. The food poverty levels were no better with 46% of the general population and 49% of rural households being classified as being food poor, hence the reduction of hunger and achievement of food and nutrition security is one of the primary goals of the GOK. The government's Economic Strategy for Wealth and Employment Creation (ESWEC) recognizes the role of human capital and puts emphasis on good nutritional status as critical in enhancing human development and overall productivity.[55] The ESWEC (2003-2007) launched in June 2003 intended to reduce poverty by promoting strong economic and employment growth. The goals for this strategy for poverty reduction were linked to the MDGs.[55]

The nutritional status of children under five years is one of the primary indicators of household food security. In Kenya, 1.8 million children are classified as chronically malnourished with poor breastfeeding and infant feeding practices contributing to more than 10,000 deaths per year.[51] Reduction of undernutrition has been very slow as trends over the past 15 years shows deterioration.[49, 51, 54] A national survey showed that 6.1% of under five year old children of the rural poor were found to be wasted (weight for height below -2SD of the reference population).[56]

Estimates from the Kenya Integrated Household Budget Survey (KIHBS) carried out in 2005/2006; suggest that chronic malnutrition among children below 5 years has not shown any significant improvement in the last decade. The level of stunting stood at 35% while underweight prevalence was

21%. Estimates also show that the Eastern province recorded the highest rate of stunting among children under five years of age (43%).[56] In a more recent 2008-09 KDHS, findings show that 7% of Kenyan children under five years old were wasted, with 2% severely wasted. The level of stunting increased to 35%, while 14% were severely stunted. Sixteen percent of these children were also found to be underweight, with 4% being classified as severely underweight.[57] Figure 1.2, shows the trends of undernutrition in Kenya from 1993 to 2008 according to the KDHS.

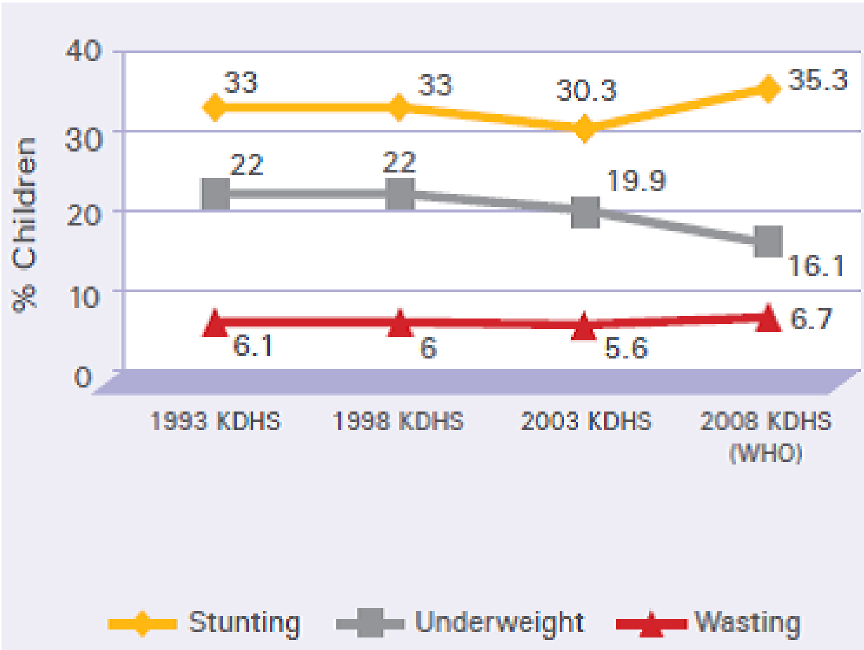

Figure 1.2: Trends in stunting, underweight and wasting in Kenya[18]

Research has shown that stunting, which is caused by long term deprivation of food or chronic undernutrition, has long term consequences. Stunting leads to delayed motor development, impaired immune function and generally affects cognitive development. Poor cognitive development may lead to diminished intellectual performance, decreased attention span and poor academic achievement. Furthermore, stunting leads to reduced work capacity, increased risk of delivery complications in women and diminished intellectual performance.[58, 59, 26] Stunting is also associated with a developmental delay and retarded achievement of the main child development milestones such as walking. This might create an overall comparative disadvantage in an already difficult environment. In Filipino children, severe stunting at age two years was associated with later deficits in cognitive ability,[60] in Guatemala reduced school performance has been observed in children with stunted growth.[61] Stunting is also associated with increased child morbidity and mortality.[62] A very low height-for-age is the single strongest predictor of childhood mortality in the first 5 years of life.[63]

Research shows that children have the same growth potential up to age five, irrespective of where they are born. In a healthy, well-nourished population only around 2% of children would naturally be short enough to be classed as stunted.[64] Stunting however, can have an intergenerational effect whereby a mother who is stunted may in turn give birth to a small baby, because the fetus's growth in the womb may have been restricted.[64, 9] In total, about 171 million children globally (27%) have stunted growth.[65]

Interventions to correct growth and development are possible at least until the age of 5 years and are justified; although the extent to which catch-up is possible and the long-term implication of this remain to be clarified.[59] Hence, the high prevalence of stunting in Kenya needs urgent attention to reduce long-term effects on the health of the population.

1.2.1 Measuring National and Household Food Security

There is no single way of measuring food security, since it is a broad concept that includes issues related to the nature, quality, food access and security of the food supply.[66] Most studies have concentrated on objective food security measures at the household level. These measures looked at the consumption of food (converted into calories) or expenditure data on food. Mallick & Rafi[67] argue that consumption has large seasonal volatility and most studies use data from one single survey, thus consumption data may systematically be under or over report the true food security situation.

Different components of food security have been assessed in the literature. For instance, in rural Pakistan, Khan and Gill, [68] analyzed the determinants of three components of food security i.e. food availability, accessibility and utilization. The determinants of the three components were analyzed by taking the data at district level. For each district, per-capita per-day food availability, accessibility and utilization was analyzed for a different set of explanatory variables. To estimate the determinants of each component, a series of models were created, in which each component of food security was a function of socio-economic variables. Ordinary Least Square Regression was used to estimate the coefficients. Food availability is achieved when sufficient quantities of food are available to all individuals while access to food is attained when household members have enough resources to acquire food and utilization is reflected by healthy nutritional status.[68]

The FAO method of assessing food security has been mostly based on the measurement of dietary energy intake, with "enough" defined with reference to a normative dietary energy requirement. *Hence, the FAO indicator is designed to capture a clearly – and narrowly – defined concept of undernourishment, namely a state of energy deprivation lasting over a year.* As such, the FAO indicator is not meant to capture short-lived effects of temporary crises. Furthermore, it does neither capture inadequate intake of other essential nutrients nor captures the effects of other sacrifices that individuals or households may make to maintain their consumption of dietary energy:[40] as such, many people suffer from nutrient deficiencies and/or overweight and obesity, regardless of classification.[69]

Following the recommendation that emerged from the Committee on World Food Security round table meeting on hunger measurement in 2011 and the follow-up meeting in 2012, FAO adopted a set of indicators aiming at capturing various aspects of food security. The choice of the indicators has been informed by expert judgment that the availability of data coverage is sufficient to enable comparisons across regions. Some of the indicators that have been used to measure household food security include; the Household Food Insecurity Access Scale (HFIAS), [70] Household Hunger Scale (HHS) and Months of Adequate Household Food Provisioning (MAHFP) indicators published by Food and Nutrition Technical Assistance (FANTA). Various indicators used by FAO[40] are shown in Table 1.1. The ticked (✓) food security indicators have been introduced for use for the first time to analyze data for the indicated coverage.

Table 1.1: Indicators used to measure food security

Type of indicator	*Actual tool/scale*	*Source*	*Coverage*	*New*
DETERMINANTS OF (INPUTS TO) FOOD INSECURITY				
Availability				
Average dietary supply adequacy	Household budget survey	FAO	1990–2013	✓
Food production index	Household food production, imports and exports of survey	FAO	1990–2013	
Share of energy supply derived from cereals, roots and tubers	Household expenditure survey	FAO	1990–2013	
Average protein supply	Household food expenditure survey	FAO	1990–2013	
Average supply of protein of animal origin	Household food expenditure survey	FAO	1990–2013	
Food price level index	Consumer price index survey	FAO/WB	1990–2010	✓
OUTCOMES				
Inadequate access to food				
Prevalence of undernourishment	Anthropometry	FAO	1990–2013	
Share of food expenditure of the poor	Household income & expenditure survey (HIES)	FAO	partial	✓
Depth of the food deficit	Individual dietary survey	FAO	1990–2013	✓
Prevalence of food inadequacy	Food consumption or dietary survey	FAO	1990–2013	✓

Source: FAO[40, 71]

1.2.2 Monitoring and Measuring of National and Household Food Security in Kenya

There has been a significant change in the institutional and operational framework of food security structures within Kenya since early 1999. These developments included a change in direction for the Kenya Food Security Meeting (KFSM) committee, the formation of Geographical Review Teams and the establishment of the Kenya Food Security Information Steering Group (KFSSG).The overall role of the KFSSG is to act as a technical 'think tank' and advisory body to all relevant stakeholders on issues of drought management and food security. The steering group provides effective guidelines on methods and approaches for the coordination of both information and appropriate response measures. Further, the KFSSG promotes, strengthens and supports the multi-agency approach to drought management and food security which has evolved in Kenya.[72]

The KFSM committee meets once a month and is chaired by the Government of Kenya's Office of the President. Its membership includes food security related line ministries, UN agencies, the Red Cross Movement, NGOs and food donors.[72] Measurement of food security at the national and household level in Kenya is done primarily using FAO validated instruments. In 2007, FANTA, FAO, and Tufts University conducted a study to evaluate the internal, external, and cross-cultural validity of the Household Food Insecurity Access Scale (HFIAS), a measurement scale used to assess the *access* component of household food insecurity in resource-poor areas. Kenya was one of the countries sampled for the validation of this instrument.[73] Kenya had earlier adopted the HFIAS, Household Dietary Diversity Score (HDDS) [74] and the Individual Dietary Diversity Score (IDDS).[74] The validation of the HFIAS which was assessed in this study was done to ensure adaptation of the language and so that the questionnaire could be interpreted in the same way across different settings.

1.3 AGRICULTURAL BIODIVERSITYAND FOOD SECURITY

"Agricultural biodiversity encompasses the variety and variability of animals, plants and micro-organisms which are necessary to sustain key functions of the agro-ecosystem, its structure and processes for and in support of food production and food security."[1]

In a systematic review of literature on the contribution of biodiversity in human diets, [34] Penafiel et al. conceptualized biodiversity as being both wild and agricultural products. It is also known as agro-biodiversity or agricultural biodiversity; which is the variety and variability of animals, plants and microorganisms, at genetic, species and ecosystem levels, relevant to food and agriculture.[34] Frison et al.[76] defines agricultural biodiversity as the components of biological diversity relevant to food and agriculture as well as the components of biological diversity that constitute the agro-ecosystem.[76]

The United Nations General Assembly declared 2010 to be the International Year of Biodiversity. This provided an unprecedented opportunity to raise awareness and promote the role that agricultural biodiversity plays in the lives of people, particularly those in low income countries.[77] Agricultural biodiversity is the basis of the food chain which contributes to food and livelihood security[78] especially in the developing countries which highly depend on own food supply and food based strategies rooted in the sustainable use of biological resources to improve local diets.

Agricultural biodiversity exists at several levels, from the different ecosystems in which people raise crops and livestock through the different varieties and breeds of the species, to the genetic variability within each variety or breed. It is important to note that agricultural biodiversity is an important asset that delivers substantial benefits in many different realms and that there is increasing evidence that diversity *per se* needs to be a central element of sustainable agricultural development.[76]

Protection of the world's biodiversity is regarded as being essential to the food supply. In this regard, there is a need to protect and manage the biodiversity of the eco-system which includes paying attention to traditional food resources and practices. Neglect of traditional food systems in Africa has contributed significantly to food insecurity.[77] While it may seem intuitive that agricultural biodiversity interventions have an impact on the nutritional status of households and communities in lower income countries, there has been little research to test its validity.[78] There is limited evidence in SSA of studies linking agricultural biodiversity with household food security and nutritional status. In order to improve nutritional status it is therefore crucial to study the role of biodiversity as a factor which impacts on household food security.[21]

Agricultural biodiversity helps to promote development and improves food security.[79] There has however been a decrease in agricultural biodiversity in many developing countries, which has led to a decrease in the variety of animals reared for food and plants grown by households or picked in the wild.[80] This has led to a simplification and decrease in diversity of diets of a large number of people to a limited number of energy food sources that may not confer specific micronutrients, essential amino acids and essential fatty acids.[81]

Agricultural biodiversity has steadily declined with a corresponding increase in dependence on a small number of food crops.[35, 82] According to Frison et al.[21] and FAO, [1] only three plant species (maize, wheat, and rice) currently supply the bulk of protein and energy needs for both developing and developed country populations. In the face of the global nutrition transition, [83] easy-to-prepare and refined, energy dense foods have gained dominance in diets at the expense of traditional and more nutritious foods. Other factors that have exacerbated the already food insecure situation and loss of dietary diversity in Sub-Saharan Africa include high rates of population growth with attendant ecosystem destruction associated with industrial and commercial development.[21]

Against a backdrop of biodiversity loss and dietary changes; a cross-cutting initiative on agricultural biodiversity and human nutrition was launched to mainstream the sustainable use of biological diversity in order to increase diversity in the diet and to tackle both under and over nutrition.[84] This initiative was to work within the existing programme of work on agricultural biodiversity of the Convention on Biological Diversity, together with relevant organizations in order to strengthen existing initiatives on food and nutrition, enhance synergies and fully integrate biodiversity concerns in their programmes.[84] The main objective of the initiative is to contribute to reaching MDG 1 of reducing hunger and poverty and to ensure environment sustainability (MDG 7). This initiative acknowledged the need to establish links between biodiversity and human nutrition. Hunter[85] that agricultural biodiversity has a key role to play in food and nutritional security and can be a safeguard against asserts hunger as well as a source of nutrients for improved dietary diversity and quality. It can also strengthen local food systems and environmental sustainability since availability of food does not necessarily ensure food security or better nutrition.[86]

1.3.1 Measuring Agricultural Biodiversity

While the positive relationship between agricultural biodiversity, dietary diversity and health seems clear but based on anecdotal evidence, there is a pressing need for this relationship to be confirmed based on empirical evidence.[87] Due to the complexity and multidisciplinary nature of agricultural biodiversity in terms of definition and understanding, consensus has been difficult, therefore, there has not been clear standardized methodologies to measure and document agricultural biodiversity[34] and hence various researchers have used different methods to assess agricultural biodiversity and its relationship with nutrition outcomes.

Penafiel et al.[34] categorized the various methodologies used by different researchers into three types. These include; Dietary assessment methods (tools to describe or record diets), nutrition assessment methods (tools to estimate the nutrient content of the investigated food items) and local biodiversity assessment methods (records to record, identify and list the local edible plant or animals included in the diet). Often some researchers combine the three methodologies. Further, FAO [12, 88] has also proposed indicators for consumption of food biodiversity which comprise a list of dietary assessment methodologies which were recommended to record the diversity of plants, animals and other organisms used for food. Some of the methodologies that were ranked high in their potential of being adapted for use, were: the food frequency questionnaire: repeated 24 hour recall, food records and inventory of food biodiversity from key informants and interviews or focus group discussions.

To understand the contribution of agricultural biodiversity and nutrition; Ekesa et al.[35] measured both agricultural diversity and dietary diversity of preschool children in western Kenya. *Agricultural* *biodiversity* was measured by the variety of food plants grown, animal reared for food and wild edible plants. The study showed that agricultural biodiversity of a household positively influenced the dietary diversity. The correlation between dietary diversity and nutritional status was low, although positive among preschool children.

Other studies have shown that the consumption of different species and cultivars within a species may have an impact on nutritional status due to considerable differences in nutrient composition within and between food species.[89, 90, 91] An assessment of traditional food systems of the Awaju´ n in the Peruvian Amazon was undertaken by Roche et al.[81]They used various indicators such as: a dietary assessment; traditional food diversity score and ranking of local foods. *Traditional food diversity scores* were calculated from repeated 24-hour recalls. These traditional food items included all foods obtained through cultivating, hunting, gathering, fishing and raising of animals. *Ranking of local foods* - the 10 most significant contributors of overall energy, protein and fat, total iron, vitamin C and vitamin A were determined by ranking the mean number of nutrients provided in the diet.

Other researchers have emphasized that assessing the contribution of agricultural biodiversity to food and nutrition in traditional food systems requires an interdisciplinary multiple-methodology ethnographic approach.[93, 94, 95, 96] This approach was used by Englberger et al.[97] to gain an in-depth understanding about people's behaviors, activities and information on the production, consumption, acceptability, and distinguishing characteristics of foods. They collected information and selected cultivars for analysis by using the key informant interviews, informal focus group discussions, observation, photography, structured sample collection and a literature review.

Biodiversity International,[87] developed a manual which describes the process and procedures for collecting important information required to assess local farming systems and agro-biodiversity, household food consumption norms and the nutritional status of vulnerable groups within a given population using specific indicators. Additionally, this guide provides a framework for practical implementation of a holistic programme that focuses on creating a customized intervention based on community-specific data. The manual strives to combine perspectives from the following models and approaches previously developed which include: Farming Systems Model (FAO/WB); Agro Ecological Model (NAFRI, FAO); [98] Indigenous Food Culture Documentation (CINE/IDRC/FAO); [99] Measuring Nutritional Functional Diversity (Columbia EI); [100] FANTA Nutritional Assessment Guides (USAID);[101] Food Security and Livelihoods Model;[102] Ethno Botanical Documentation and A User's Model (ICH/UNESCO).[103]

For the current study, the researcher adopted (with alterations) the methodology used by Ekesa et al.[35] in rural areas of Kenya; whereby using a cross-sectional survey design, agricultural biodiversity was measured by listing the types of food plants grown, animals reared for food and food items obtained from natural habitats. The researcher adapted and improved the methodology used by Ekesa et al by including focus group discussions and key informant interviews to validate the data collected using questionnaires. An agricultural biodiversity score was also developed based on the inventory of food biodiversity established from the data collected using the questionnaire, focus group discussion and key informant interviews.

1.3.2 Agricultural Biodiversity and Nutritional Status

During the World Nutrition Rio Congress 2012, experts emphasized the importance of agricultural biodiversity in ensuring a nutritionally adequate diet which is composed of a variety of foods. The executive director of the secretariat of the Convention on Biological Diversity (CBD) Braulio Dias said that, *"To meet the challenge of feeding the world population of around nine billion by 2050, we need to consider not only sustainably producing sufficient food but also working towards diversified nutrition,* *which means providing a healthy diet for all, agricultural biodiversity plays a central role in meeting this challenge".*[104]

The link between agricultural biodiversity and nutrition is not direct because of the complex nature of food security and nutrition. There are many arguments on how human nutrition is affected by agriculture through several pathways of which producing sufficient food is just one of them.[69] Agricultural and food system approaches are said to enhance food availability and diet quality through improved local production, better crop storage and efforts to further agricultural biodiversity.[105]

Frison et al.[106] contend that maintenance of diverse diets founded on diverse farming systems delivers better nutrition and greater health with additional benefits for human productivity and livelihood. These, according to Frison et al, [106] are the benefits of agricultural biodiversity and hence the need to assess the role of agricultural biodiversity in sustainable and secure food production regions. This approach, they urged, is pertinent in areas where diverse production systems still prevail, most notably marginal areas. Local biodiversity has the potential for contributing to food security and nutrition as well as enhancing adaptation to global climate change.

It is a fact that some species of plants and animals are high in nutritional value and have multiple uses.[107] Improving dietary diversity through agricultural biodiversity could make an important contribution to nutrition-sensitive intervention programmes which could hold a promise for supporting nutrition improvements and hence addressing the underlying determinants of undernutrition.[44]

1.4 DIETARY DIVERSITY

Dietary diversity is a quantitative measure of food consumption that reflects household access to a variety of foods and is also a proxy for nutrient adequacy of the diet of individuals.[88] The most commonly used indicators to measure dietary diversity are; dietary diversity score (DDS), food variety score (FVS) and dietary serving score (DSS).[108] Recent studies have explored the validity of DDS and FVS indicators in a cross-sectional sense and established their reliability.

1.4.1 Measuring Dietary Diversity

Various methods that have been used to measure dietary diversity:

- Food Variety Score (FVS) is measured using a simple count of different food items consumed over specific period of time usually 24 hours.[29]
- Dietary Diversity Score (DDS) is calculated by summing the number of unique food groups consumed during a recorded time period.[109] The number of food groups which are used can vary between 6, 9, 13, and 21 groups, according to the selection of the researcher.[110] A food group is only counted once if an individual has eaten a food from that group. Many researchers use a minimum intake of 1-15g from a group in order for the group to be counted. In this study, DDS was calculated using nine food groups without consideration of a minimum quantity[112] (refer to 2.9.5).
- For dietary Serving Score (DSS), six major food groups are considered for a scoring system and a maximum score of 20 is allocated for each of these food groups.[108] Vegetables, fruits and dairy groups each receive a maximum of 4 points for each two recommended servings and 4 points are received for 4 recommended servings of cereals/roots. A maximum of 2 points are received for each 1 recommended serving of plant and animal protein groups.[108,111]

For this study, the standardized FAO, DDS for measuring dietary diversity was used.[112] The tool uses an open recall method to gather information on all the foods and drinks consumed by the household or individual over the previous 24 hours. The recall period of 24 hours was chosen by FAO as it is less subject to recall error, less cumbersome for the respondent and also conforms to the recall time period used in many dietary diversity studies.[113, 114, 30, 31,110] Moreover, analysis of dietary diversity data based on a 24-hour recall period is easier than with longer recall periods.IFPRI,[193] highlights a shortcoming of using the DDS as the fact that there is no known study to date that explores the validity of this indicator in making cross-country comparisons, which means comparisons across countries should be done with caution.

1.4.2 Association between Agricultural Biodiversity and Dietary Diversity

Declining agricultural biodiversity has been one of the reasons for the increasing attention to dietary diversity, particularly because the latter is often thought to be a logical result of the former.[91, 115] A similar relationship has been suggested between dietary diversity in urban and peri-urban centres.[116] A study carried out in western Kenya on preschool children showed a positive relationship between agricultural biodiversity of a household and diversity of the diets.[35]

A human diet consistently requires at least 51 nutrients in adequate amounts.[117] It has been argued that changes in agricultural systems from diversified to simple, cereal based cropping systems have contributed to poor dietary diversity, micronutrient deficiencies, and resulting malnutrition.[119] It has been argued that the focus on simple cereal based cropping could be due to the fact that cash cropping of non-food crops is more financially lucrative.[118] Even though the link between agricultural biodiversity and dietary diversity is not automatic,[119] it is agreed that the decrease of agricultural biodiversity to some extent, places considerable strain on the ease with which households are able to enjoy diversified, balanced diets.

Accordingly, a number of initiatives have come forth in recognition of the importance of diversified diets, notably the International Conference on Nutrition, ICN, [120] the 2003/2004 Joint Food and Agriculture Organization/World Health Organization[121] Consultations and the Scaling Up Nutrition Framework, [88] all of which acknowledged, explicitly or implicitly, the indispensable role of dietary diversification for enhanced food security and nutrition outcomes.

Despite the links between agricultural biodiversity and dietary diversity and the fact that a diversity of food items benefits the individual by enhancing the body's ability to digest, absorb and use the essential nutrients;[122] there are major gaps in knowledge about the importance of agricultural biodiversity conservation in relation to diversity and nutrient content of diets consumed. Relatively few studies have investigated the relationship between overall agricultural biodiversity and dietary quality.[81, 22]

1.4.3 Association between Dietary Diversity and Nutritional Status with Regard to Micronutrients

Dietary diversity score reflects nutrient adequacy of the individual or group. Several studies have been carried out in different age groups which have shown that an increase in DDS is related to increased nutrient adequacy of the diet.[28,29,30,31,33] DDS has also been validated for several age/sex groups as a proxy measure for macro and/or micronutrient adequacy of the diet.[30,31,110] Based on the various studies, dietary diversity scores have been positively correlated with adequate micronutrient density of complementary foods for infants and young children,[74] and macronutrient and micronutrient adequacy of the diet for non-breastfed children, [123, 113, 30, 31] adolescents[124] and adults.[125, 126,110] Dietary diversity has long been recognized by nutritionists as a key element of high quality diets.[127] Lack of dietary diversity is a particularly severe problem among poor populations in the developing world because their diets are predominantly based on starchy staples. These plant-based diets are low in protein and a number of micronutrients and those present may be low in bioavailability.[127]

A consistent positive association between dietary diversity and child nutrition has been found in a number of countries. Most notably, results from 11 developing countries indicated that, after controlling for confounding factors such as household wealth, there remained a strong relationship between dietary diversity and child development as measured by height-for-age Z scores.[113] Dietary diversity thus contributes to reducing stunting. Reducing malnutrition of children greatly improves childhood survival in developing countries[128] and has a direct positive impact on economic productivity as adults.[129]

Evidence from a multi-country analysis suggests that household level dietary diversity is strongly associated with household food security.[130] In order to understand the nature of the association between all the elements that affect food security and child nutrition, it is necessary to study these factors in the target population.[24] The potential of household level dietary diversity indicators to accurately reflect household food security and overall socio-economic status also needs to be confirmed[24] as well as the contribution of agricultural biodiversity.

Several studies in developing countries have shown significant correlations between dietary diversity and nutritional status both for adults and children. A study in Burkina Faso among women of child bearing age showed a positive association between dietary diversity with nutritional status of women expressed as Body Mass Index (BMI). BMI decreased during the seasonal food shortage.[114] In Ghana, household dietary diversity was positively associated with child stature ($p<0.05$) but this association was limited to children of the head of household.[131] A study by Ekesa et al.[35] among preschool children also showed a positive but low correlation between dietary diversity and nutritional status although the researcher noted that morbidity also played a role in determining the nutritional status of children.

In South Africa, a food consumption survey among children aged 1-9 years old, showed significant correlations of dietary diversity score with height-for-age and weight-for-age z-scores indicating a strong relationship between dietary diversity and the nutritional status of children. Furthermore, there was also a positive correlation between DDS and nutrient adequacy ratios[30] (Figures 1.3, 1.4 and 1.5.)[30]

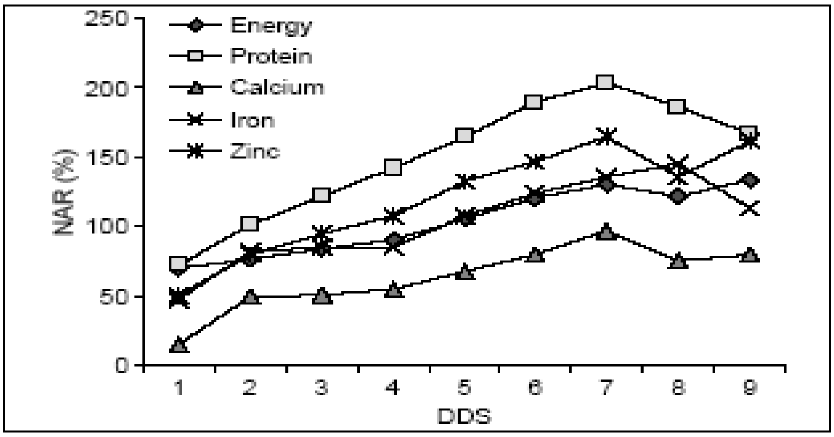

Figure 1.3: Mean NAR as % of energy and nutrients at different levels of DDS[30]

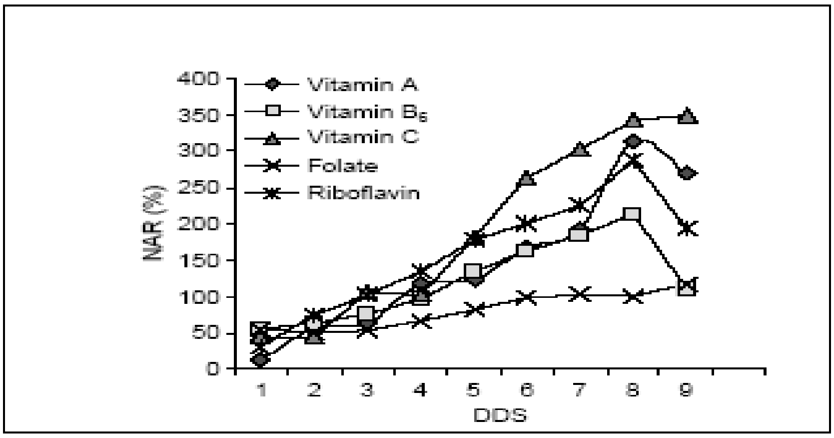

Figure 1.4: Mean NAR as % of vitamins at different levels of DDS[30]

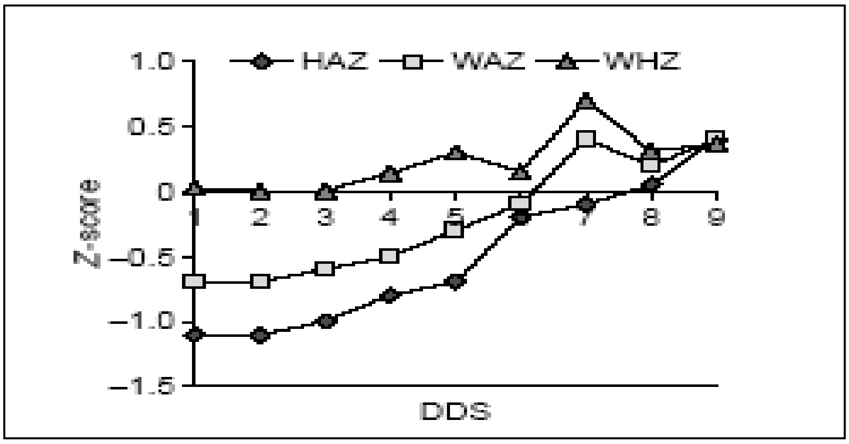

Figure 1.5: Mean anthropometric Z-scores at different levels of DDS[30]

While there is a lot of evidence on the relationship between dietary intake and nutritional status of children, it is important to note that controlling for confounding factors such as socio-economic conditions is important since they are likely to affect the relationships. Arimond and Ruel in earlier texts have indicated that the results of 11 developing countries, showed a strong relationship after controlling for confounding factors.[113] Other researchers have also confirmed that socio-economic factors such as the people's education, women's empowerment, cultural beliefs, infant and young child feeding practices, intra-household food distribution and social norms are key determinants of people's access to adequate and nutritious food and their dietary behaviors and can themselves be affected by changes in diets and nutritional status of children.[119,89]

1.5. MOTIVATION FOR THE STUDY

An analysis of the progress towards meeting Millennium Development Goals undertaken in 2005 estimated that Kenya would be on Target for achieving MDG 1. Unfortunately, more recent data from the Kenya Integrated Household Budget Survey (KIHBS 2005/6) and Kenya Demographic and Heath Survey (KDHS 2008/09) show little improvement in malnutrition.[54,57] According to UNICEF,[9] targets cannot be achieved unless policies change significantly and available resources are made available to implement these strategies.

The food security situation in Kenya is disturbing. According to the 2005/2006 KIHBS, one out of every two people was undernourished and about 51% of the population had a dietary intake below the minimum dietary energy requirement.[54] In 2004, 2009 and 2011, ten million Kenyans experienced chronic hunger which was not only attributed to non-availability of food but also the lack of access to food and to poverty.[132, 52, 53] According to the 2008-09 KDHS findings, 35% of Kenyan children were stunted, while 14% were severely stunted. The prevalence of stunting varied by province from 29% in Nairobi to 43% in Eastern Province,[57] the latter being the site of the current study.

The Kenyan government has put numerous initiatives in place to conserve its agricultural biodiversity and to promote food security through the Ministry of Agriculture. Despite this, Kenya's agricultural biodiversity is under serious threat. The country is constantly confronted with food shortfalls and the rate of malnutrition remains high. According to Keino,[133] these food shortfalls are attributed to many factors including little emphasis, support and commitment from the government on traditional drought-resistant food crops and animal breeds and over-dependence on a limited number of crops and animal breeds.

The Kenya National Development Plan (KNDP) (2002-2008) states that because of population growth of 2.7%, and due to urbanization, Kenya has experienced deforestation rates of 30 times greater than reforestation.[134] Farmers throughout the country, as in the rest of the world, are engaged in developing better and higher-yielding crops of the three prime staples: maize, wheat and rice. This practice is compromising the nutritive value obtained from a variety of local foods.[135] The local species that are abundant, fulfilling a variety of needs and adapted to different conditions as well as genetically variable, are being abandoned and lost forever in favor of fewer, newly developed ones.[136] Dietary diversity tends to increase with income and wealth, thus the association between dietary diversity and child nutrition may be confounded by socio-economic factors that may affect a child's growth. Past research[24, 113] has emphasized the need for further research to reveal the relationships between agricultural biodiversity, dietary diversity, household food security and nutritional status. Understanding these relationships is necessary to pave the way for possible preventive and promotive interventions.

The researcher believes that measures to address food insecurity in Kenya should be multi-sectorial and multi-factorial in order for food security to be achieved. The intention of this study was to shed light on the associations between agricultural biodiversity, dietary diversity, nutritional status in children and household food security for the purpose of recommending practical mechanisms for improving these variables. (Refer to conceptual framework: Fig 1.6). In 2007, Kenya reported improvements in economic growth, but sadly there has been no improvement in the levels of malnutrition. While a national food and nutrition policy has been prepared and approved by cabinet, its implementation is yet to bear positive results[53, 54] and efforts to improve agricultural biodiversity have not been integrated into this policy.

There is a paucity of data on Kenya and the rest of the world on the relationships between food security, agricultural biodiversity, dietary diversity and nutritional status of children due to the complexity of linking agricultural and health research.[34] Building on the recommendations of a study by Ekesa et al. the present study was carried out during two different seasons, in two areas of different agricultural biodiversity based largely on differing rainfall figures. Household food security as measured by HFIAS (Addendum 2) was included as a variable in this study. The study also used a repeated 24 hour recall to assess the variability of the diet in the households and added focus group (Appendix 6) discussions to validate the data collected using the household questionnaire (Appendix4). Information from this study can be used for future *nutrition sensitive* interventions to develop multi-sectorial strategies which are aimed at improving agricultural biodiversity, household food security, dietary diversity and nutritional status of children.

Stunted growth was chosen as the primary indicator of undernutrition in this study based on the fact that it is as much a reflection of poor maternal nutrition as it is of poor infant and young child feeding. Half of the stunting at two years of age is caused by poor growth in utero and half is due to poor growth in the first two years of life.[26] It is also important to note that stunting is largely irreversible by two years of age, providing a very important "window of opportunity" for delivery of nutrition interventions from conception to two years of age, the so-called first 1000 days of life.[137]

1.6 OPERATIONALIZATION

The researcher has conceptualized the associations between agricultural biodiversity, dietary diversity, household food security and child nutrition (Figure 1.6).

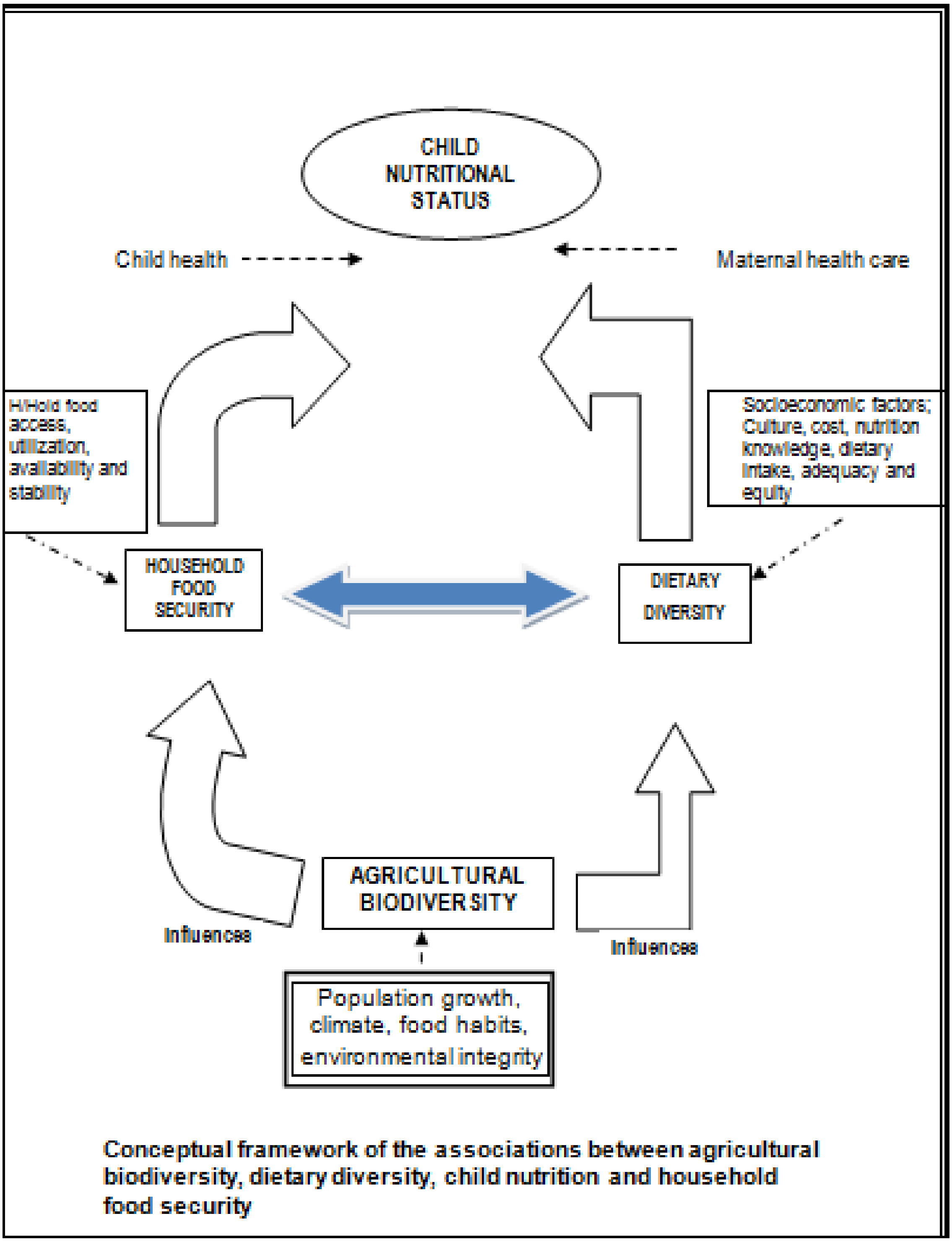

Figure 1.6: Conceptual framework

This figure shows that agricultural biodiversity is impacted on by population size, climate, food habits, and environmental integrity. Agricultural biodiversity is shown to influence household food security, dietary diversity and child nutrition status. Improved dietary diversity leads to improved diet quality hence affecting the child's nutritional status. Dietary diversity, however, is impacted by social and economic factors, such as: cost of food, culture, nutrition knowledge, and food availability. Increased household food security, in conjunction with food diversity, improves child nutritional status. Household food security however, is influenced by household food access, utilization, availability and stability. In addition to food security and dietary diversity, nutritional status is also influenced by maternal health care and the health of the child.

CHAPTER 2: METHODOLOGY

2.1 OVERALL AIM

The overall aim of the study was to explore the associations between agricultural biodiversity, household food security and dietary diversity in households with and without children with stunted growth in rural areas of Kenya.

2.2 SPECIFIC OBJECTIVES

i) To assess dietary intake and dietary diversity of the study population.

ii) To assess food security of the study population, including measurements of hunger (access), and household food availability.

iii) To assess agricultural biodiversity of the study area.

iv) To assess the anthropometric status of children aged between 24 and 59 months (2-5 years).

v) To assess the anthropometric status of mothers/care givers of children aged between 24 and 59 months (2-5 years).

vi) To assess the relationships between agricultural biodiversity with (i) (ii) and (iv).

vii) To compare households with children with and without stunted growth in relation to dietary diversity, agricultural biodiversity and food security.

viii) To compare households in Akithii and Uringu divisions in relation to (i) (ii) and (iv) above in the two different seasons.

ix) To make recommendations to policy makers regarding ways to improve the elements of (i) to (viii)

2.3 RESEARCH HYPOTHESES

The study sought to test the following hypotheses:

(i) There is no relationship between dietary diversity and anthropometric status in children.

(ii) There is no relationship between dietary diversity and household food security.

(iii) There is no relationship between household food security and anthropometric status in children.

(iv) There is no relationship between agricultural biodiversity and household food security.

(v) There is no relationship between agricultural biodiversity and dietary diversity.

(vi) There are no differences in dietary diversity, agricultural biodiversity and food security of households with and without children with stunted growth.

(vii) There is no relationship between the anthropometric status of the mother/care giver and anthropometric status in children.

(viii) Seasonal variations (rainfall) do not influence dietary diversity, household food security, and/or anthropometric status in children.

2.4 STUDY DESIGN

The study adopted a cross-sectional analytical approach to investigate associations between agricultural biodiversity, dietary diversity, household food security and the nutritional status of children (24 to 59 months old) in resource poor households in rural Kenya during the dry and rainy seasons. To reduce bias, the survey sampling adopted a randomized design.

2.5 STUDY AREA

The study was carried out in Akithii and Uringu divisions of Tigania west in the Eastern part of Kenya. The Kenya Integrated Household Budget Survey (KIHBS) undertaken in 2005/2006 showed that the national level of stunting was 35% while the Eastern province, where Tigania west lies, recorded the highest number of stunted children in survey findings of 2007 and 2009 at (43%)[49] and (42%)[57] respectively making the province the ideal choice for the scope of the study. There was, however, no data on stunting available specifically for Akithii and Uringu divisions within Tigania west.

The Eastern province has varying agricultural potential, reflecting a typical picture of Kenya where some districts are arid or semi-arid while others have high agricultural productivity. Some parts of this district are also prone to drought, severe food shortages and scarcity of water while others are more food secure. Akithii and Uringu divisions (areas) were purposefully selected for this study because they have different levels of agricultural biodiversity (ref; to Table 2.1). The difference within and between the divisions with distinct agro-ecological zones will provide policy makers with evidence on the importance of evidence-based geographical targeting for interventions at district level. Figure 2.1 provides data on rainfall in the two divisions. It can be noted that with a few exceptions, rainfall was higher in Uringu in 2011 and 2012.

Akithii is a semi-arid region which, according to the Drought Monthly Bulletin, [138] is categorized as an agro-pastoral livelihood zone while Uringu is a division with high agricultural productivity. It is categorized as a mixed farming livelihood zone.[138] The differences in the two divisions are shown in Table 2.1.

Table 2.1: Demographic differences between Akithii and Uringu divisions of Tigania west

AKITHII	URINGU
Semi-arid with low agricultural biodiversity	High agricultural productivity
Low agricultural biodiversity resulting in low quality diet	High agricultural biodiversity resulting in high quality diet
Suspected high stunting levels	Suspected low stunting levels
Low rainfall (Total rainfall for 2011 at 766mm and 2012 at 843mm) (Fig 2.1)	High rainfall (Total rainfall for 2011 at 835mm and 2012 at 1178mm) (Fig 2.1)
Borders the arid regions in Kenya (Figure 2.2)	Borders the most productive areas in Kenya
Pastoral livelihood zone	Mixed farming livelihood zone

Source; EWS, Bulleting-Meru North[138]

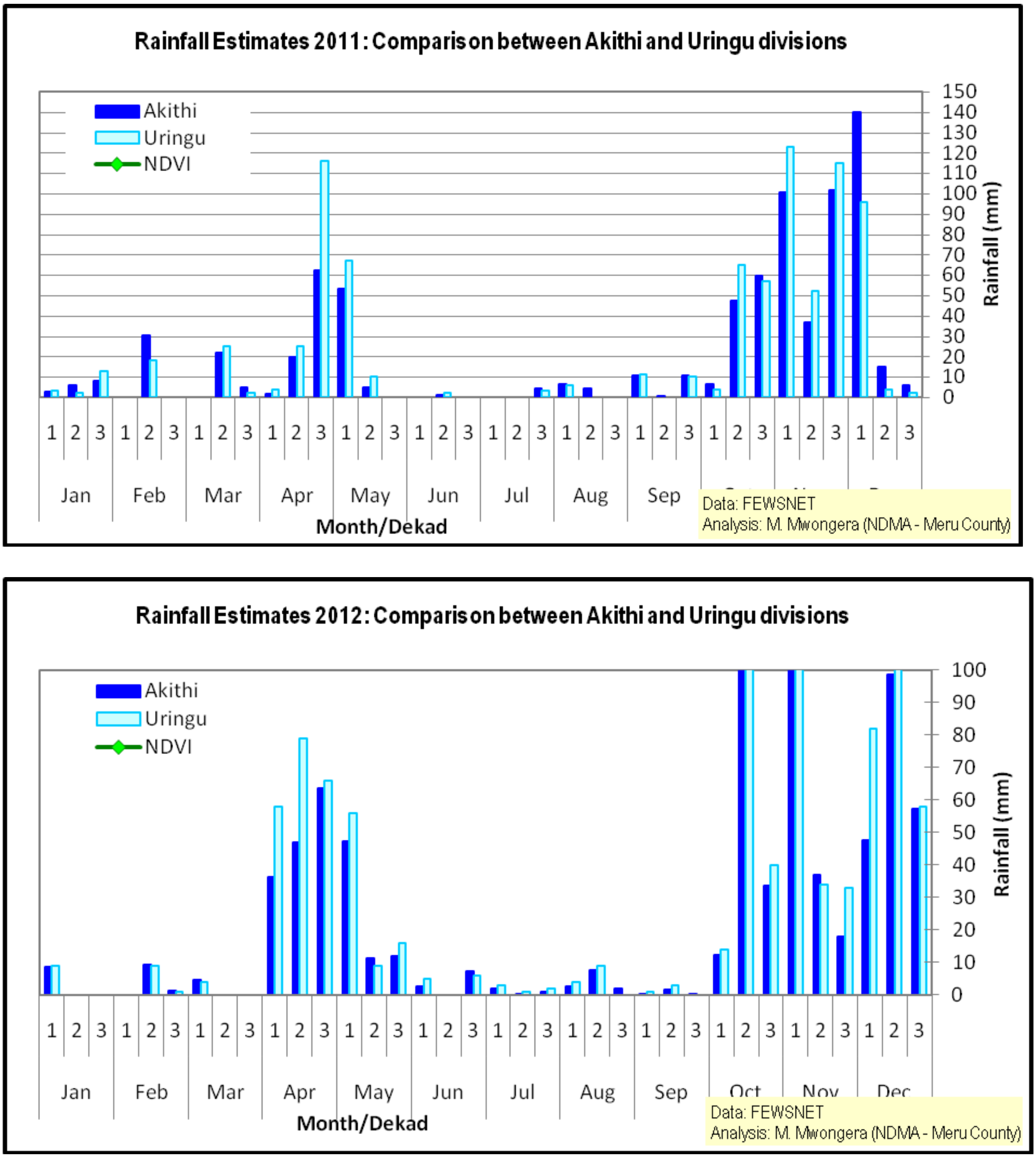

Figure 2.1: Rainfall estimates 2011/12 comparing Akithii and Uringu Divisions

Figure 2.2, shows the current food security situation in Kenya as reported by the Kenya Food Security Steering Committee. The arrow in Figure 2.2, points to the study area which has high levels of stunting.[138]

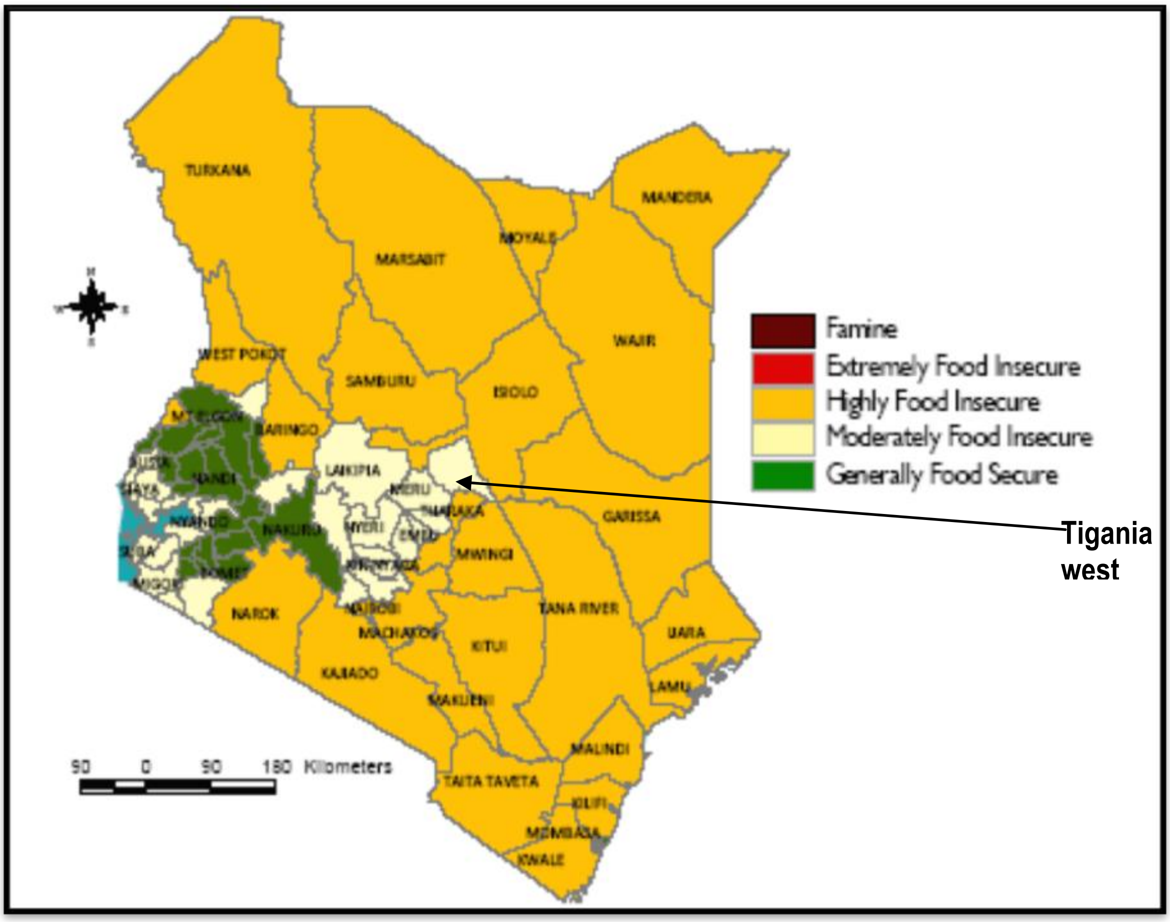

Figure 2.2: Location of Tigania west in Kenya

2.6 STUDY POPULATION

Tigania west has a population of 123,947. The district comprises of five administrative divisions namely Akithii, Uringu, Kianjai, Mituntu and Mbeu. Out of five divisions, Akithii and Uringu were purposively selected for the reason stated in 2.5. Akithii division has a population of 53,773 and 11,360 households distributed in four locations while Uringu has a population of 45,333 and 10,071 households distributed in four locations.[135, 139]

Over 95% of the population in Tigania west depends on agriculture and other related activities for their livelihood. The majority of the residents practice traditional farming methods and hence agricultural yields are low. Subsistence farming is the main practice in accordance with rainfall patterns with crops such as maize, beans, millet, sorghum and pigeon peas. Lack of proper and adequate storage facilities make it difficult for farmers to preserve their produce over the prolonged dry spell. Thus, many of them are forced to hastily dispose of the commodities at low prices which leave them vulnerable in times of drought. This leads to shortages of food at certain times which perpetuates poverty in the area. Between 60 and 70% of the inhabitants live below the poverty line because of these conditions and practices.[135] The main economic activity in Uringu is peasant mixed farming while Akithii division widely practices pastoralism as a form of economic activity besides peasant farming.[135]

2.7 SAMPLE SIZE

The required sample size was determined with the help of a statistician and was based on a power analysis for ANOVA (Analysis of Variance) to achieve an effect-size of 0.4 with 90% power and a significance level of 5%. Percent stunting was used to determine sample size calculation. Approximately 200 respondents were required to be interviewed in Twale and Mbeu sub-locations in the dry and rainy seasons. It was decided to aim for a sample of 500 randomly selected participants; 250 respondents in each of the sub-locations. The main variables that were considered in determining the sample size were the two regions, two different seasons and households with and without children with stunted growth.

2.8 SAMPLE SELECTION

Multistage sampling was used to select the sample, from each of the two divisions of Akithii and Uringu. Thinyaene (Akithii) and Mbeu (Uringu) locations were randomly selected to represent each of the two divisions in the study. Apart from the rainfall distribution the two divisions were regarded as being very similar with regard to socio-demographic characteristics. Each of the two locations has several sub-locations. From these sub-locations, Twale of Akithii, and Mbeu of Uringu were randomly selected. Each of the sub-locations has several villages. All the villages in the two sub-locations were included in the study. The villages included in the sample from Akithii were Kaale, Mailune, Nkurare, Gakumbone, Kiare, and Ndiiri. The villages included from Uringu were Kimerei Central, Kimerei lower, Mailu 1, Kaliati, Njia and Mailu-2. From each of the villages, random sampling was used to select the households to be included in the sample with children of 24 to 59 months (Figure 2.3).This sampling procedure was used for both divisions during the dry and rainy seasons

2.8.1 Inclusion Criteria and Exclusion Criteria

Inclusion Criteria

- Households with children of 24 to 59 months of age were included in the study.
- Mothers/ Care givers in the households with children of 24 to 59 months of age were included in the study.

Exclusion Criteria

- Households without children in the age bracket of 24 to 59 months of age were excluded from the study.
- Children who are ill for at least one month continuously before and including the time of the study were excluded since a chronic condition may also lead to stunting e.g. malaria.

The 24 to 59 month age group of children was chosen because at this age, the children are eating from the family pot and therefore their nutritional status will be a reflection of the type of diet the families are consuming. This age group was also chosen because stunting levels increase rapidly with age, peaking at 46% among children in the second year of life and remaining at 32-35% among older children.[57] The researcher prepared a list of the households from each village in the sub-locations included in the sample population with assistance from village elders. Using this list, the researcher randomly selected households to be included in the study with the help of random number tables, as provided by Dawson and Trapp.[140]

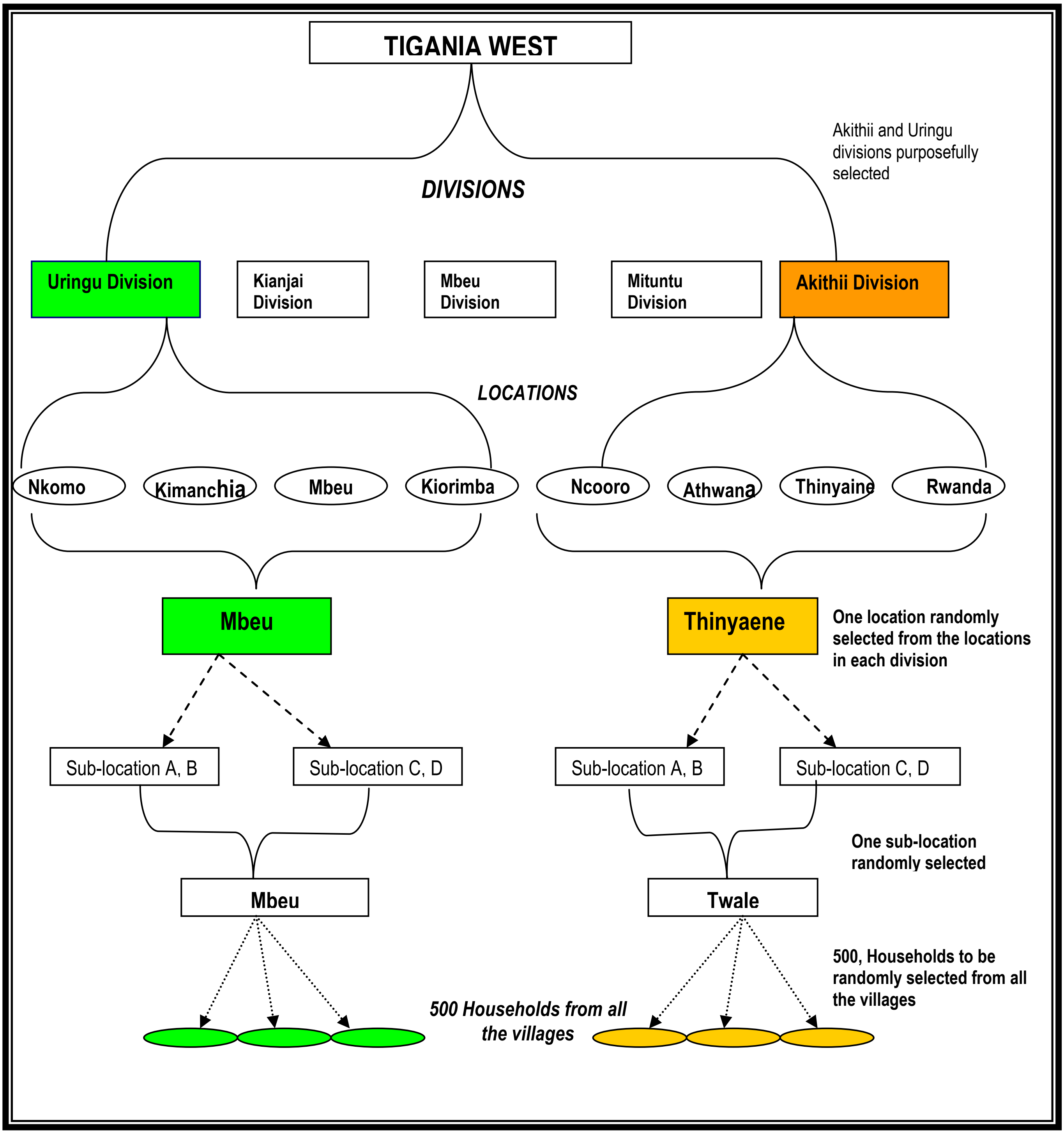

Figure 2.3: Diagrammatic representation of the sampling frame used in the study

2.9 DATA COLLECTION

Data were collected over a period of six months, staggered over the two main seasons (Figure 2.3). The data were collected at the end of each of the seasons in order to ensure that the impact of the seasonal variations was reflected in the data. Phase 1 of data collection took place in September to October 2011, while Phase 2 was done in March 2012. The households sampled in Phase 1 were different from the households sampled in Phase 2.

The interviews were conducted in the local language (Kimeru) and the national language, Kiswahili at the homes of the respondents. Field workers followed a specific data collection procedure:

- The field workers introduced themselves with the help of the village elder; explained the purpose of the interview and obtained written consent from the mother/care giver if she was willing to participate. Illiterate respondents expressed their willingness to participate in the interview by making a thumb print on the consent form and a witness signed the consent form.
- Respondents were also informed that participation in the study was voluntary and those who did not want to take part were free to decline.
- Participants were reassured regarding confidentiality on the information they were requested to provide and encouraged to answer questions freely.
- Participants who preferred a family member to witness the interview and procedures were allowed to do so.

During Phase 1, the following activities were done:

- The Socio-Demographic and Health Questionnaire (SDHQ) was completed;
- Anthropometric measurements were taken (weight, height, and arm circumference where necessary);
- Repeated 24-hour dietary recalls were conducted (5 days apart);
- The Household Food Insecurity Access Scale (HFIAS) was completed;

- The agricultural biodiversity questionnaire was completed

During Phase 2, the following were done:

- Anthropometric measurements were taken (weight, height, and mid-upper arm circumference, where appropriate);
- Repeated 24-hour dietary recalls were conducted (5 days apart);
- The HFIAS was completed;
- The field worker lastly thanked the respondents for participating in the interview.

Focus group discussions on agricultural biodiversity (Addendum 6) were conducted in Phase 2 at a central venue at the local primary school. Key informants and other select members of the community from the two divisions were invited to participate in the focus group discussions. Four discussions were conducted within each division. The groups comprised of 8 to 12 participants. The fieldworker welcomed the participants and requested each of the participants to introduce themselves. The fieldworker summarized the purpose of the discussion and informed the members that the discussions were being recorded. The fieldworker guided the focus group using the discussion guide (Addendum 6).

Data were collected from different agro-ecological zones to allow the different levels of biodiversity to be compared in relation to dietary diversity, food security and nutritional status of children.

2.10 SELECTION OF FIELD WORKERS

Thirteen field workers (nutritionists) were recruited according to the following criteria:

- They could speak English and Kiswahili.
- They had at least 2 years of experience in working with mothers and children.
- They had at least 1 year experience in carrying out anthropometric measurements.

2.11 TRAINING OF FIELD WORKERS

Training of the field workers was done by the researcher and the researcher's supervisors over a period of 5 days for quality control purposes and to ensure accuracy and consistency in taking measurements and in questioning the respondents. A training manual (Addendum 9) was developed by the researcher and comprised of standard procedures for performing anthropometric measurements (weight, height, arm circumference). Demonstrations and role plays were used to demonstrate interviewing techniques. The field workers carried out anthropometric measurements on children at a nursery school and the measurements were compared with the ones from the experienced researchers for validation. The researcher observed the field workers while they practiced, to ensure accuracy of measurements (ref; 2.12.2 and 2.12.3) and corrections were done as appropriate until the field worker was judged to be competent.

2.12 DATA COLLECTION INSTRUMENTS

The survey instruments included a socio-demographic and health questionnaire (SDHQ) (Addendum 1); a household food insecurity access scale (HFIAS) (Addendum 2); a repeated 24-hour dietary recall (Addendum 3); an agricultural biodiversity questionnaire (Addendum 4); focus group discussion guide on agricultural biodiversity (Addendum 6) and anthropometric measurements (weight, height) (included in Addendum 5).

Quality control measures were employed throughout the survey. Validity and reliability of the data collection instruments were assured by the researcher choosing instruments that had been validated in other surveys and those that were internationally accepted. During the training and pretesting of the research instruments (ref; 2.13) measurements were taken by the field workers in order for them to practice sufficiently to ensure reliability during the data collection. The questionnaires were administered to the mother or the care giver where the mother was not available.

2.12.1 Socio-Demographic and Health Questionnaire (SDHQ)

The SDHQ was used to collect basic demographics on the households of the participants (Addendum 1). The SDHQ was previously used in Kenya for the Kenyan Adult Women Study.[141]

The socio-demographic part of the questionnaire elicited information on the socio-economic status of the household and child health status. The questionnaire included questions on marital status, highest level of formal education, decision maker on the types of food bought and amount of money spent on food in the household. The question on marital status provided the researcher with information on whether the household was female headed or not since this might have an influence on the economic status of the household which could in turn influence household food security and dietary diversity.

Other questions included: the number of people eating from one pot at least 4 days a week, the number of rooms per house (excluding bathroom/toilet), the type of toilet and the sources of drinking water for the household. These questions were indicative of family size and hygiene which was likely to affect the nutritional status of children. Other questions included the fuel used for cooking, employment status of the care giver, number of contributors to the total household income, agricultural land size and number and type of assets which have an influence on the economic status of the household which could in turn influence household food security and dietary diversity. With regard to the health status of the child, questions included: immunization status of the child and whether the child had been ill in the past two weeks. These questions were regarded as important because the health of a child influences the nutritional status.

The other section of the questionnaire was on breastfeeding and complementary feeding. This part of the questionnaire elicited information on breastfeeding and care practices.

Child feeding and care indicators included in this study included the following; [142]

- Percentage of children, who were exclusively breastfed (< 6 months),
- Percentage of children who were still breastfed after introduction of complementary food (6-9 months) and
- Percentage of children who were breastfed until 20-23 months.[142]

2.12.2 Anthropometric Status of Mothers/Care Givers

Body Mass Index (BMI) was used to determine the anthropometric status of adult women who were either the mothers or care givers of the child in the sample. BMI is a simple index of weight-for-height[2] that is commonly used to classify underweight, overweight and obesity in adults. It is defined as the weight in kilograms divided by the square of the height in meters squared (kg/m^2). The international classification of adult underweight, overweight and obesity according to BMI is: < 18.5 (underweight), 18.50 - 24.99 (normal range); ≥25.00 (overweight); ≥30.00 (obese).[143, 144]

In cases where the mother/care giver was pregnant, mid-upper arm circumference (MUAC) was taken with the arm hanging loosely and comfortably at the side. MUAC was measured in the midline of the posterior aspect of the arm (over the shoulder top), over the triceps muscle, at a level midway between the lateral projection of the acromion process at shoulder and the olecranon process of the ulna (at the point of the elbow). With the elbow flexed to 90°, the midpoint was determined by measuring the distance between the two landmarks using a tape measure calibrated in centimeters. The lateral side was marked with a visible marker (chalk, pen) then measurements were taken. The person taking the measurement ensured that the tape was not twisted and was parallel to where the marking was placed. Measurements were recorded to the nearest 0.5 mm.[145]

Anthropometric measurements for non-pregnant mothers/care givers were undertaken using the following parameters:

Age: Identity card was used to ascertain and record the age.

Weight: Weight was taken with minimum clothing, after emptying the bladder. The scale required a flat surface to ensure the correct measurement was taken. All the scales were calibrated by measuring a known weight to ensure that the correct measurement was achieved. The Electronic scales (Camry-model EB9318) were used and the weight measured to the nearest 0.5gm. The weight measurement was done according to standardized procedures.[146] Each of the measurements was taken twice and an average taken to ensure accuracy.

Height: The adults were measured in the standing position, using a free standing stadiometer. Before taking the reading, the field worker ensured that the mother/care giver was bare feet and that the heels, buttocks, shoulders and the back of the head touched the height board. Height was measured to the nearest 0.1mm. Each of the measurements was taken twice and an average taken to ensure accuracy.[146]

2.12.3 Anthropometric Status of Children

Anthropometric measurements for the children were undertaken using the following parameters:

Age: The clinic card, birth certificate, or baptism card were used to ascertain and record the age. In situations where the mother/care giver did not have the documents to ascertain the age, they were asked to identify a child from the neighborhood who was born almost the same time. A calendar of events such as public holidays, circumcision ceremony, was also developed by the researcher with input from village elders to help the respondents' estimate the age of the children in situations where the mother/care giver did not have documents to ascertain the age. The information from the documents of the other child was used to estimate the age. Children were excluded if they were younger than 24 months or older than 59 months.

Height: Children were measured in a standing position, using a free standing height/length board. Before taking the reading, the field worker ensured that the child was bare feet and that the heels, buttocks, shoulders and the back of the head touched the height board. Height was measured to the nearest 0.1mm. Each of the measurements were taken twice and an average taken to ensure accuracy.[146]

Weight: Children were weighed on an electronic scale (Camry-model EB9318) to the nearest 10gms. Children were weighed with minimum clothing, after emptying the bladder and without shoes.[146] All the scales were calibrated by measuring a known weight to ensure that the correct measurement was achieved. Each of the measurements were taken twice and an average taken to ensure accuracy.

The children's anthropometric status was determined using the latest World Health Organization[147] growth standards z scores. Children with a z score of less than -3 SD for height-for-age were categorized as being severely stunted, those with a z score of -3 to -2 SD were categorized as stunted while those between -2 to -1 SD were categorized as mildly stunted or at risk of stunting. Those classified within -1 to +1 SD were categorized as having normal height.[147]

Children with a z score less than -3 SD weight for-height were categorized as being severely wasted, those with a z score of -3 to -2 SD were categorized as wasted, while those between -2 to -1 SD were categorized as mildly wasted or at risk of wasting. Those with a weight-for-height of -1 to +1 SD were categorized as normal.[147]

Children with a z score of less than -3 SD for weight-for-age were categorized as being severely underweight, those with a z score of -3 to -2 SD were categorized as underweight while those between-2 to -1 SD were categorized as being mildly underweight or at risk of being underweight. Those with a weight between -1 to +1 SD were categorized as having normal weight. Those children with a z score of above +2 were categorized as being overweight.[147]

WHO[148] classifies the prevalence of underweight, stunting and wasting levels in a country as follows:

Level in %→ Category ↓	Low	Medium	High	Very high
Under weight	<10	10-19	20-29	>30
Stunting	<20	20-29	30-39	>40
Wasting	<5	5-9	10-14	>15

2.12.4 The Household Food Insecure Access Scale (HFIAS)

Food security was assessed by means of the HFIAS developed by Coates et al.[70] (Addendum 2). The HFIAS is internationally used and validated.[70]

This assessment tool was used to estimate the prevalence of food insecurity in the area of study. It is based on the principle that the experience of food insecurity causes predictable reactions and responses that can be captured and quantified through a survey and summarized in a scale. These feelings include the following:

- Feelings of uncertainty or anxiety over food (situation, resources, or supply);
- Perceptions that food is of insufficient quantity (for adults and children);

- Perceptions that food is of insufficient quality (includes aspects of dietary diversity, nutritional adequacy, preference);
- Reported reductions of food intake (for adults and children);
- Reported consequences of reduced food intake (for adults and children); and
- Feelings of shame for resorting to socially unacceptable means to obtain food resources[70].

The HFIAS questionnaire consists of nine occurrence questions that represent a generally increasing level of severity of food insecurity (access) and nine "frequency-of-occurrence" questions that are asked as a follow-up to each occurrence question to determine how often the condition occurred. The frequency-of-occurrence question is skipped if the respondent reports that the condition described in the corresponding occurrence question was not experienced in the previous four weeks (30 days).[70]

Some of the nine occurrence questions inquire about the respondents *'perceptions'* of food vulnerability or stress (e.g., did you worry that your household would not have enough food?), others ask about the respondents' *behavioral responses* to insecurity (e.g., did you or any household member have to eat fewer meals in a day because there was not enough food?).[70]

The questions address the situation of all household members and do not distinguish adults from children or adolescents. All of the occurrence questions ask whether the respondent or other household members either felt a certain way or performed a particular behavior over the previous four weeks. The nine questions are described as follows;

Q1: 'Worry about food'

'This question asks the respondent to report their personal experience with uncertainty and anxiety about acquiring food during the previous month'.

Q2: 'Unable to eat preferred foods'

'One domain of food insecurity (access) is having limited choices in the type of food that a household eats. This question asks whether any household member was not able to eat according to their preference due to a lack of resources'.

Q3: 'Eat just a few kinds of foods'

'This question asks about dietary choices related to variety – i.e. whether the household had to eat an undesired monotonous diet (little diversity in the different types of foods consumed)'.

Q4: 'Eat foods they really do not want eat'

'This question, which also captures the dimension of limited choices, asks whether any household member had to eat food that they found socially or personally undesirable due to a lack of resources. Often these are foods or food preparations that are consumed only under hardship.'

Q5: 'Eat a smaller meal'

'This question asks whether the respondent felt that the amount of food (any kind of food, not just the staple food) that any household member ate in any meal during the past four weeks was smaller than they felt they needed due to a lack of resources'.

Q6: 'Eat fewer meals in a day'

'This question asks whether any household member, due to lack of food, had to eat fewer meals than the number typically eaten in the food secure households in their area'.

Q7: 'No food of any kind in the household'

'This question asks about a situation in which the household has no food to eat of any kind in the home. This describes a situation where food was not available to household members through the household's usual means (e.g., through purchase, from the garden or field, from storage, etc.).'

Q8: 'Go to sleep hungry'

'This question asks whether the respondent felt hungry at bedtime because of lack of food or whether the respondent was aware of other household members who were hungry at bedtime because of lack of food.'

Q9: 'Go a whole day and night without eating'

'This question asks whether any household member did not eat from the time they awoke in the morning to the time they awoke the next morning due to lack of food' (quotations from Coates et al.[70]).

The nine-item scale uses a four-week recall period and was constructed to capture three larger dimensions of household food insecurity: anxiety and uncertainty about household food access (item 1); insufficient quality (items 2-4) and insufficient food intake and its physical consequences or hunger (items 5-9).[74,70]

The information generated by the HFIAS was used to assess the prevalence of household food insecurity and to detect changes in the household food security situation of the population during the two seasons, namely the dry (shortage season = Phase 1) and rainy season (after harvest season = Phase 2) (Figure 2.4).Since the study period included both seasons, HFIAS generic questions were adapted and translated to ensure that questions were understood in their cultural context. Phase 1 took place when the food stores were low. October-November is a period when respondents are most hungry in Tigania West since it was before the rains came. Phase 2, took place when the food stores were normally good in this area since it was after the harvest of the short rain period.

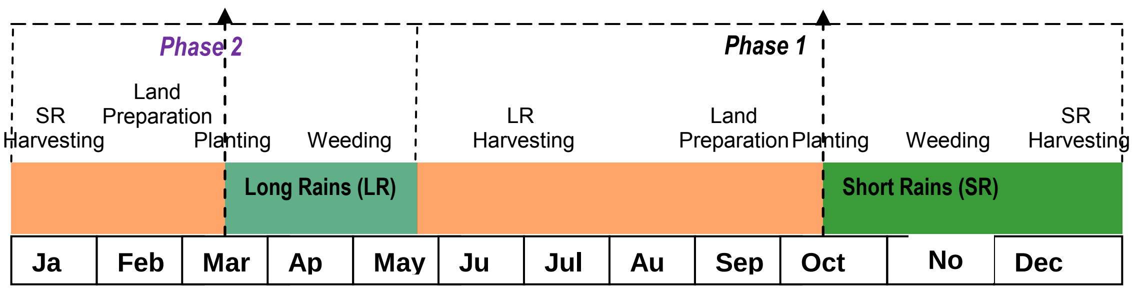

Figure 2.4: Seasonal calendar of the study area by which agricultural activities take place.[138]

The HFIAS (Addendum 2) was used to report prevalence of household food insecurity. The HFIAS is a continuous measure of the degree of food insecurity in the household in the past four weeks (30 days). First, a HFIAS score variable was calculated for each household by summing the codes of each frequency-of-occurrence question. The maximum score for a household is 27 (the household response to all nine frequency-of-occurrence questions was “often” coded with response code of 3; the minimum score is 0 (the household responded “no” to all occurrence questions, frequency-of-occurrence questions were skipped by the interviewer and subsequently coded as 0 by the data analyst. The higher the score, the more food insecurity (access) the household experienced. The lower the score, the less food insecurity (access) a household experienced.[70]

In order to report household food insecurity (access) prevalence (HFIAP) and make geographic targeting decisions,[70] the HFIAP indicator was used to categorize households into four levels of household food insecurity: i) Food secure, ii) Mildly food insecure, iii) Moderately food insecure and iv) Severely food insecure. The HFIAP indicator, [70] was calculated as follows:

i. HFIA category = 1 if [(Q1a=0 or Q1a=1) and Q2=0 and Q3=0 and Q4=0 and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

ii. HFIA category = 2 if [(Q1a=2 or Q1a=3 or Q2a=1 or Q2a=2 or Q2a=3 or Q3a=1 or Q4a=1) and Q5=0 and Q6=0 and Q7=0 and Q8=0 and Q9=0]

iii. HFIA category = 3 if [(Q3a=2 or Q3a=3 or Q4a=2 or Q4a=3 or Q5a=1 or Q5a=2 or Q6a=1 or Q6a=2) and Q7=0 and Q8=0 and Q9=0]

iv. HFIA category = 4 if [Q5a=3 or Q6a=3 or Q7a=1 or Q7a=2 or Q7a=3 or Q8a=1 or Q8a=2 or Q8a=3 or Q9a=1 or Q9a=2 or Q9a=3]

2.12.5 Dietary Diversity

Dietary diversity is defined as the number of individual food items or food groups consumed over a given period of time.[149] Dietary diversity was assessed by the Individual Dietary Diversity Score (IDDS) derived from the information collected using the 24-hour recall according to the guidelines developed by FAO.[112]

FAO has published operational guidelines for measuring dietary diversity in a standardized way, based on a tool originally developed by Food and Nutrition Technical Assistance (FANTA).[74, 116] At individual level, dietary diversity reflects dietary quality, mainly micronutrient adequacy of the diet. The reference period can vary, but is most often the previous day or week.[150, 116] The FAO data collection tool uses an open recall method to gather information on all food and drinks consumed by the household or individual over the previous 24 hours.

In this study, two repeated 24-hour recalls were used to collect data on the dietary intake and diversity of the children based on a similar study by Torheim et al.[29] The 24-hour recall was administered to each household and repeated on a separate day. The two days were staggered with five days between the recalls to take care of the variations in foods eaten over the weekend and week days. No prior notice of the repeat visit was given to mothers/caretakers in case they altered their intake. To assess the differences caused by seasonality, two recalls were conducted in the rainy season and two in the dry season in each of the sample areas per respondent. The repeated 24-hour dietary recall has been internationally used and validated.[30]

The mean daily dietary intake of children in the present study was assessed from the questionnaire (Addendum 3) adapted to the context of shared plate eating. The 24-hour recall is a method used to determine the food intake of an individual during the immediate preceding 24 hours as remembered by the subjects. Two 24-hour recalls were conducted for each child in the study. Food intake was assessed in terms of household measures. The researcher used the Dietary Assessment and Education Kit (DAEK) to determine portion sizes of foods eaten as accurately as possible.[151] The adaptation consisted of flash cards and the food photo manual for the identification of food items, the preparation method used and the portion sizes eaten. Data was collected by thirteen trained local field workers (nutritionists). To minimize interviewers' bias, the recording days were randomly attributed to the field workers.

To minimise bias of respondent memory lapses, interviews were held following a standardized schedule. First, the mothers/care givers were asked to mention all the foods and drinks the child in the study had consumed during the preceding day, including snacks and drinks. Then they were asked to describe the foods and beverages consumed in more detail, including ingredients, cooking methods of mixed dishes and the place and the time of consumption. Finally, the amounts of all foods, beverages, ingredients of mixed dishes consumed were estimated using the food photo manual which contained photos of life-sized food portions.

Based on data collectedusing from the 24-hour recalls, the amounts of all foods, beverages and ingredients of mixed dishes consumed were estimated using the Food Photo Manual. The dietary diversity score was based on nine food groups as recommended by FAO[112] which included:

(1) Cereals, roots, and tubers.

(2) Vitamin A rich fruits and vegetables.

(3) Non-rich vitamin A (other) fruit.

(4) Non-rich vitamin A (other) vegetables.

(5) Legumes and nuts;

(6) Meat, poultry, and fish.

(7) Fats and oils.

(8) Dairy.

(9) Eggs.

Other remaining items such as; tea, sugar, and sweets were not used in DDS.

Dietary diversity scores were calculated by summing the number of food groups consumed by the child as reported over the 24-hour recall period. This was done after creating food group variables for those food groups that needed to be aggregated and by creating a new variable termed as DDS.

To assess nutrient adequacy, the nutrient adequacy ratio (NAR) values of the key nutrients were calculated by first identifying the appropriate recommended nutrient intake (RNI) value of the FAO/WHO.[152]

The calculation was as the following example for vitamin C:

nar_vitc (vit_c/rni_vitc)*100;

if the NAR value was greater than 100%,which is the ideal value, then truncation to 100% was done as follows nart_vitc=nar_vitc;

nar_vitc>100 then nart_vitc=100

The mean adequacy ratio (MAR) was calculated as the sum of all the NARs of all micronutrients (vitamins and minerals) divided by the number of NARs (micronutrients) evaluated. MAR was used as a composite indicator of micronutrient adequacy.[30]

2.12.6 Agricultural Biodiversity

Semi-structured questions were included at the end of the socio-demographic and health questionnaire used to collect data on agricultural biodiversity. The questionnaire development was based on the FAO guidelines for developing indicators for monitoring agricultural biodiversity.[116] This questionnaire was pretested to improve on its validity.

To assess agricultural biodiversity, four focus group discussions were carried out in each sub-location. Each of the groups had about 8-12 participants. The participants were nominated with the help of the village chief based on their knowledge of the agricultural biodiversity of the area in the past and present. The participants' consent was sought and they were informed of the day for the discussion. The discussion was guided by one of the field workers who introduced herself/himself and welcomed the participants. The purpose of the discussion was expounded and the participants informed that the discussion would be recorded.

In addition, key informant interviews were held with the chief, sub-chiefs, district agricultural officer and the district nutrition officer in order to validate the information from the focus group discussions. The researcher developed key informant interview questions based on the focus group discussions questions which were used to collect information on present and past agricultural biodiversity (see Addendum 4) and to validate the information collected during the focus group discussions. The focus group discussion interviews were carried out by the field workers and data was recorded for further analysis.

Agricultural biodiversity was measured by determining the variety of food plants grown, animals reared for food and food items obtained from natural habitats in the last one year. A list of all food items grown, all animals reared, hunted and other food items obtained from natural habitats through gathering or trapping was established.

No instrument to measure agricultural biodiversity had been developed and validated to the knowledge of the researcher and hence the researcher constructed a questionnaire using guidelines from FAO[88] and a similar study in Kenya.[35]

A few key informants, including the chief and the deputy chiefs who were familiar with the conditions and experiences of household food insecurity in the area of study were used to review the questions in the agricultural biodiversity questionnaire and the focus group discussion guide. Participation by the key informants was voluntary. The key informants were interviewed as a group, so that any discrepancies in their suggestions could be clarified at the same time.

2.13 PRE-TESTING/PILOTING OF RESEARCH INSTRUMENTS

Pre-testing/piloting of the research instruments was undertaken; first the field workers practiced on one another, then 14 households were assessed to afford each field worker the opportunity to do interviews before the main study. The households included in this exercise were drawn from an area with similar characteristics to the sample population. The length of time needed for the interview at each household was determined during the training session. A meeting was held with the field workers after the pre-testing/piloting in order to clarify any problems with the tools and also to evaluate the quality of data collected by the different interviewers. The researcher and two of the research supervisors also accompanied the field workers during some of the interviews to clarify some of the issues that arose as well as for quality control purposes, as stipulated by the Division of Human Nutrition Postgraduate Committee. The focus group discussions questionnaire was also piloted for quality control as were the other data collection instruments. Four field workers were given an opportunity to lead a focus group discussion with the other field workers acting as the groups. This conversation was recorded for review so as to improve on the instrument and ensure its validity.

2.14 DATA ANALYSIS

The entry of the raw data was done using Microsoft Access 2003 and exported to MS Excel 2003. Data cleaning was done before the data was transported to the data analysis packages. STATISTICA version 9 (StatSoft Inc. (2009) STATISTICA (data analysis software system)(www.statsoft.com.), Statistical Package for Social Sciences (SPSS Version 11.5) and Food Finder 3 software[153] were used to analyze the data.

Food finder 3[153] was used to analyze the dietary data that was collected using the 24-hour recall. This is a software product developed by the Medial Research Council of South Africa.[153] The most commonly eaten Kenyan foods were added to the South African Tables from Kenyan National Food Composition Tables.[154] The food tables do not distinguish between home grown or shop bought products. Mean dietary intake, nutrient adequacy ratios, mean adequacy ratio and dietary diversity scores were calculated. Summary statistics were used to describe the variables. Distributions of variables were presented with histograms and or frequency tables. Medians or means were used as the measures of central location for ordinal and continuous responses and standard deviations and quartiles as indicators of spread.

Relationships between two continuous variables were analyzed with regression analysis and the strength of the relationship measured with the Pearson correlation or Spearman correlation if the continuous variables were not normally distributed. If one continuous response variable was to be related to several other continuous input variables, multiple regression analysis was used and the strength of the relationship measured with multiple correlation.

The relationships between continuous response variables and nominal input variables were analyzed using appropriate analysis of variance (ANOVA) or pooled, paired and independent mean T-tests when only two groups were involved. When repeated measures were taken on the same respondents like the initial measurements and the 24-hour recall, it was done with the paired t-test**.** When ordinal response variables were compared versus a nominal input variable, non-parametric ANOVA methods were used. For randomized designs the Mann-Whitney test or the Kruskal-Wallis test were used. The relation between two nominal variables was investigated with contingency tables and likelihood ratio chi-square tests. A p-value of $p < 0.05$ represented statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters.

2.15 ETHICS

Participation in this study was entirely voluntary and respondents were free to decline to participate. Respondents were free to withdraw from the study at any point without consequences. The respondents were not segregated in any way by virtue of their participation in the study. Children who were identified as being malnourished were referred for treatment to the government health facilities.

2.15.1 Ethics Approval

The study was submitted to the Committee for Human Research, Faculty of Medicine and Health Sciences, Stellenbosch University for ethics approval. Ethics approval was obtained (ethics reference no.N11/02/037) (Addendum 7) and each participant was provided with an informed consent form (Addendum 8). The respondents were verbally asked for consent. The respondents were then asked to sign or thumb print on the space provided on the consent form. A number was assigned to each participant and this number was used in the data capturing process. No names were linked to the participant numbers and the results were reported for groups and not individuals. The researcher also obtained permission to conduct the research from the National Council for Science and Technology (Kenya).

CHAPTER 3: RESULTS

3.0 INTRODUCTION

This chapter presents findings on Phase 1 and Phase 2 of data collection in Akithii and Uringu Divisions in Tigania west. Results of the recruitment process are presented first, followed by the data from Phase 1 and 2 of the study. Finally the results on association between the key variables are presented.

Data in Phase 1are related to demographic and socio-economic characteristics of the households in the study population, dietary diversity, household food security, agricultural biodiversity, child health care practices, morbidity prevalence for children of 12-59 months, infant and young child feeding practices, anthropometric status of children of 12-59 months and anthropometric status of mothers/care givers of the children of 12-59 months.

The socio-demographic information was not collected in Phase 2 because the essence of Phase 2 was to assess the effect of seasonality on specific variables. The socio-demographic information was initially collected to have background information of the participants and their households. This however means that the generalisation of the interpretation of the relationships between socio-demographic characteristics with the key variables of both phases of data collection should be done with caution, although it is unlikely that they would have differed significantly between the two phases. Data in Phase 2 are related to dietary diversity, household food security, anthropometric status of children of 12-59 months and anthropometric status of mothers/care givers of the children of 12-59 months.

3.1 RECRUITMENT PROCESS

Two independent cross sectional surveys were conducted. Phase one of data collection took place in September to October 2011 and 525 households with children of 24-59 months of age were sampled from Tigania west. Of the 525 households, 261 were from Uringu division and 264 from Akithii division.

Phase 2 of data collection took place in March 2012, during which 497 households with children of 24-59 months of age were sampled. Of the 497 households, 233 were from Akithii while 264 were from Uringu division (refer to the sampling frame-Figure 9).The type of data collected in each Phase was discussed in section 2.8-Data collection. Oversampling was done in order to compensate for participant drop-out.

FINDINGS AT PHASE 1

3.2 DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF THE STUDY POPULATION

Overall, the majority 87.8% (n=459) of the mothers/care givers were married, 40.6% (n=209) were casual laborers, 19.5% (n=100) were homemakers while 18.7% (n=96) had no specific occupation (Table 3.1a).

About 10.1% of the mothers/care givers were petty traders, 5.4% were unemployed, 4.5% were self-employed and 1.2% were wage earners. The majority (84.6%) of mothers/care givers had attained a primary level of education, 5.0% had no formal education whereas 5.0% had some secondary education and 4.4% had completed secondary education. Worthy of noting is that only 0.9% of the sampled population had attained tertiary education. A significant difference was found to exist between the two divisions in the marital status ($p<0.001$) and the occupation of the care giver ($p<0.001$). However, no significant difference was found to exist between the two divisions regarding the education of the mother/care giver ($p=0.263$).

Forty-one percent of households obtained their drinking water from communal taps, 36.0% from rivers, dams or lakes while 19.8 % consumed water from wells or boreholes. About half (43.7%) of the households had 1-2 and 3-4 roomed (43.3%) houses, while a very small percentage of 1.7% had houses with seven or more rooms. Most of the households had pit latrines (91.0%) with 6.1% of them being ventilated improved pit latrine (VIP) while 2.8% did not have toilets. The majority (95.8%) of the households used wood as the fuel for cooking while charcoal and gas were used by 1.9% and 1.7% respectively. A significant difference was found to exist between the two divisions in the sources of water used ($p<0.001$). However, no significant difference was found to exist between the two divisions in the number of household rooms ($p=0.29$), cooking fuel used ($p=0.825$) and the type of toilet available ($p=0.618$).

Table 3.1a: Demographic and socio-economic characteristics of households of the study population in Phase 1

Demographic and socio-economic characteristics		***AKITHII***		***URINGU***		***Total for both divisions***		**Chi-square test p-values**
		N	%	N	%	N	%	
Education of mother/care giver	Primary	222	85.4	217	83.8	439	84.6	X= 5.251
	No formal education	16	6.2	10	3.7	26	5.0	p=0.263
	Some secondary	9	3.5	17	6.6	26	5.0	
	Completed secondary	10	3.8	13	5.0	23	4.4	
	Tertiary	3	1.2	2	0.8	5	0.7	
Marital status of mother/care giver	Married	247	94.3	212	81.2	459	87.8	X=5.323
	Single	8	3.1	28	10.7	36	6.9	p<0.001*
	Divorced/separated	1	0.4	14	5.4	15	3.0	
	Widowed	6	2.3	7	2.7	13	2.5	
Occupation of mother/care giver	Casual laborer	91	35.0	118	46.5	209	40.7	X=31.414
	Homemaker	49	18.9	51	20.1	100	19.5	p<0.001*
	Petty trader	36	13.8	16	6.3	52	10.1	
	Unemployed	7	2.7	21	8.3	28	5.4	
	Self employed	15	5.8	8	3.1	23	4.5	
	Wage-earner	1	0.4	5	2.0	6	1.2	
	Others	61	23.5	45	13.8	96	18.7	
Sources of drinking water	Communal tap	183	70.4	30	11.5	213	41.0	X=208.454
	River/lake/dam	49	18.8	138	53.1	187	36.0	p<0.0001*
	Well/borehole	17	6.5	86	33.1	103	19.9	
	Own tap	11	4.2	3	1.2	14	2.7	
No. of rooms	1-2 rooms	105	40.4	122	46.9	227	43.7	X=3.747
	3-4 room	123	47.3	102	39.2	225	43.3	p=0.290
	5-6 rooms	27	10.4	32	12.3	59	11.3	
	7 rooms above	5	1.9	4	1.5	9	1.7	
Cooking fuel	Wood	249	95.8	248	95.8	497	95.8	X=1.511
	Charcoal	6	2.3	4	1.5	10	1.9	p=0.825
	Gas	4	1.5	5	1.9	9	1.7	
Toilet type	Pit	235	92.2	231	89.9	466	91.0	X=1.784
	VIP	13	5.1	18	7.0	31	6.1	p=0.618
	None	7	2.7	7	2.7	14	2.7	

Significance * at p <0.05:*at p <0.001**

In the majority (59.8%) of households, mothers/ care givers (50.5%) followed by husbands/partners (31.6%), grandmothers/fathers (5.6%) and mothers/in-laws (2.7%) made the decision on how much money was spent on food. A majority of the households in both divisions had 3-4 or 5-6 persons eating from the same pot. There was a significant difference (chi-squire, $p<0.001$) in the number of people eating from the same pot between Akithii and Uringu divisions, probably due to Akithii having a smaller percentage of people in the 3-4 persons category. The number of persons contributing to household income in the majority (55.7%) of households were two persons, followed by one person (40.0%) and three to four persons (3.1%). About 22.3% of the households spent Kes 1401 to Kes 2000 per week on food.

A significant difference was found to exist between the two divisions in the decision on the types of food to be purchased for a household ($p=0.007$), the decision on the amount of money to be spent on food ($p=0.013$) and on the amount of money spent on a weekly basis on purchasing food ($p<0.0001$).There was however no significant difference in the number of contributors to household income between the two divisions ($p=0.29$).

Table 3.1b: Demographic and socio-economic characteristics of households of the population in Phase 1

Demographic and socio-economic characteristics		***AKITHII***		***URINGU***		***Total for both divisions***		**Chi-square test p-values**
		N	%	N	%	N	%	
Decision on types food purchased	Mother/care giver	171	65.5	141	54.0	312	59.8	X=17.590
	Husband/partner	78	29.9	87	33.3	165	31.6	p=0.007**
	Grandmother/father	10	3.8	19	7.3	29	5.6	
	Mother/In law	2	0.8	12	4.6	14	2.7	
Decision on the amount of money spent on food	Husband/partner	133	51.0	130	50.0	263	50.5	X=20.997
	Mother/care giver	114	43.7	94	36.2	208	39.9	p=0.013*
	Grandmother/father	10	3.8	18	6.9	28	5.4	
	Mother/In law	2	0.8	10	3.8	12	2.3	
No. of people eating from the same pot	1-2 persons	9	3.5	18	6.9	27	5.2	X=26.166
	3-4 persons	62	23.8	100	38.5	162	31.1	p<0.0001***
	5-6 persons	111	42.7	102	39.2	213	41.0	
	7-8 persons	67	25.7	31	11.9	98	18.8	
	Above 9	11	4.2	9	3.4	20	3.8	
No. of contributors to h/hold income	1 Person	108	41.7	99	38.4	207	40.0	X=5.501
	2 Persons	143	55.2	145	56.2	288	55.7	p=0.240
	3-4 Persons	5	1.9	11	4.3	16	3.1	
	More than 5 persons	3	1.2	3	1.2	6	1.2	
Amount of money spent on food weekly (Kes)	0-800	18	7.0	37	14.3	55	10.7	X=37.381
	801-1400	70	27.2	103	39.9	173	33.6	p<0.0001***
	1401-2000	56	21.8	59	22.7	115	22.3	
	2001-2600	60	23.3	46	17.8	106	20.6	
	2601 and above	53	20.6	13	5.3	65	12.6	

1US Dollar is approximately equivalent to 86 Kes (Kenya Shillings) as at March 2012; 1 SA Rand equivalent to Kes 8.78: significance * at p <0.05;p<0.01;***at p<0.001**

3.2.1 Type of Housing Construction Material

Overall, most of the houses (95.2%) in the two divisions had tin/mabati as the main roofing material (Table 3.2).Twenty-one percent used grass thatch for their roofs while only 0.8% used tiles.

Most houses had a floor made from traditional mud (79.4%), concrete (16.9%) or wood (3.5%). Three types of walling materials were mainly used, namely planks (54.7%), mud (35%) or bricks (8.6%).

Table 3.2: Comparison of type of housing construction material used in the two study divisions in Phase 1

	Type of construction material	***Akithii***		***Uringu***		***Total for both divisions***		**Chi-square statistic and p-values**
		N	%	N	%	N	%	
Roof	Tin/*mabati*	217	98.6	227	92.6	492	95.2	X=6.234
	Grass thatched	3	1.3	16	6.5	21	4.1	p=0.044*
	Tiles	0	0	2	0.8	4	0.8	
Floor	Traditional mud	184	83.6	185	76.1	408	79.4	X=0.151
	Bricks/concrete	30	13.6	47	19.3	87	16.9	p=0.161
	Plank/wood	6	2.7	10	4.1	18	3.5	
Walls	Plank/wood	106	48.2	149	61	282	54.7	X=14.947
	Traditional mud	96	43.6	65	26.7	180	35.0	p=0.002**
	Brick/concrete	16	7.3	23	9.5	44	8.6	
		2	0.9	6	2.5	8	1.6	

Significance * at p <0.05; **p<0.01

There were significant differences between the two divisions in the type of roofing material (p=0.044) and the type of walling material (p=0.002) used but there were no significant differences between the two areas in the type of flooring material used (p=0.161).

3.2.2 Land Used for Food Production

Ninety-six percent of the respondents owned land which was under food production and all (100%) had a food or grain store in their homes. All (100%) the respondents were small scale farmers (Figure 3.1). The mean acreage of land under food production for both divisions was 1.4 ± 1.1. There was a significant difference in the size of farms under food production between Akithii and Uringu [Akithii 1.5 ± 1.04, Uringu 1.2 ± 1.00 (pooled t-test, p<0.001)]. Respondents from Akithii had relatively larger farms under food production compared to those in Uringu.

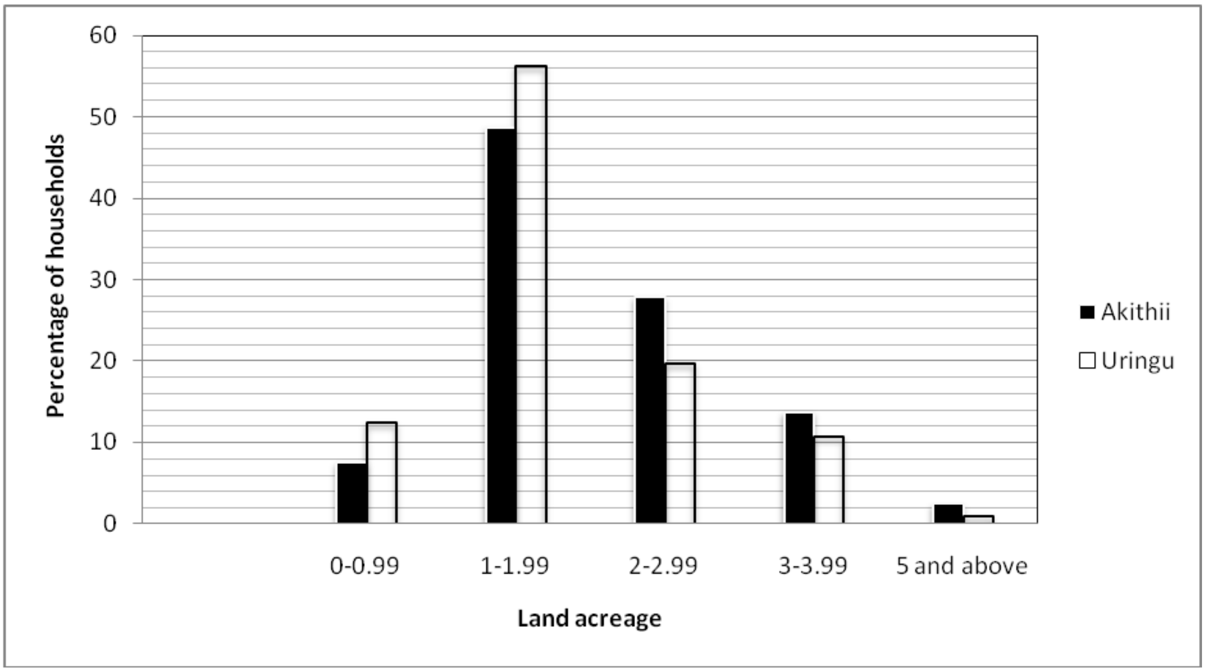

Figure 3.1: Comparison of land under food production in the two study divisions in Phase 1

3.2.3 Ownership of Household Assets

Overall, in both divisions, participants owned their homes (99.1%) (Table 3.3). Furthermore, the majority had cell phones (Akithii, 74%, Uringu 69.8%) and radios (Akithii, 59.5%, Uringu 69.1%). Other assets owned by a substantial number of households were sofa sets, vegetable gardens and fruit trees. Significant differences between the two divisions were found in the ownership of radios (p=0.019), sofa sets (p=0.002), vegetable gardens (p=0.015) and fruit trees (p<0.0001).

A greater number of residents of Uringu had vegetable gardens and fruit trees while a greater number of residents in Akithii had bicycles, sofa sets and cell phones.

Table 3.3: Comparison of ownership of household assets in the two study divisions in Phase 1

Household assets	***Akithii***		***Uringu***		***Total for both divisions***		***Chi-square p-values***
	N	%	N	%	N	%	
Own home	261	99.6	258	98.5	519	99.1	X=1.829;p=0.176
Television set	34	13	39	14.9	73	14.0	X=0.421; p=0.517
Radio	156	59.5	181	69.1	337	64.3	X=5.487; p=0.019*
Video cassette machine	11	4.2	21	8.0	32	6.1	X=3.370; p=0.066
Vehicle	2	0.8	6	2.3	8	1.6	X=2.047; p=0.153
Motor cycle	13	5.0	21	8.0	34	6.5	X=2.046; p=0.153
Bicycle	135	51.5	121	8.0	256	29.8	X=0.017; p=0.896
Wheelbarrow	23	8.8	25	9.5	48	9.2	X=0.100; p=0.751
Sofa set	134	51.1	100	38.2	234	44.7	X=9.202; p=0.002**
Cell phone	194	74.0	183	69.8	377	71.9	X=1.204; p=0.272
Vegetable garden	75	28.6	101	38.5	176	33.6	X=5.940; p=0.015*
Fruit trees	81	30.9	206	78.6	287	54.8	X=119.689; X=p<0.0001***

Significance*at p <0.05; ** p<0.01; ***p<0.001

Ownership of domestic animals was found to be high (Figure 3.2). Chicken were the most commonly owned animals in both divisions, followed by cattle and goats. Almost half of the households owned cattle and goats respectively [Akithii 58%, 42%; Uringu 55.3%, 46.9%].

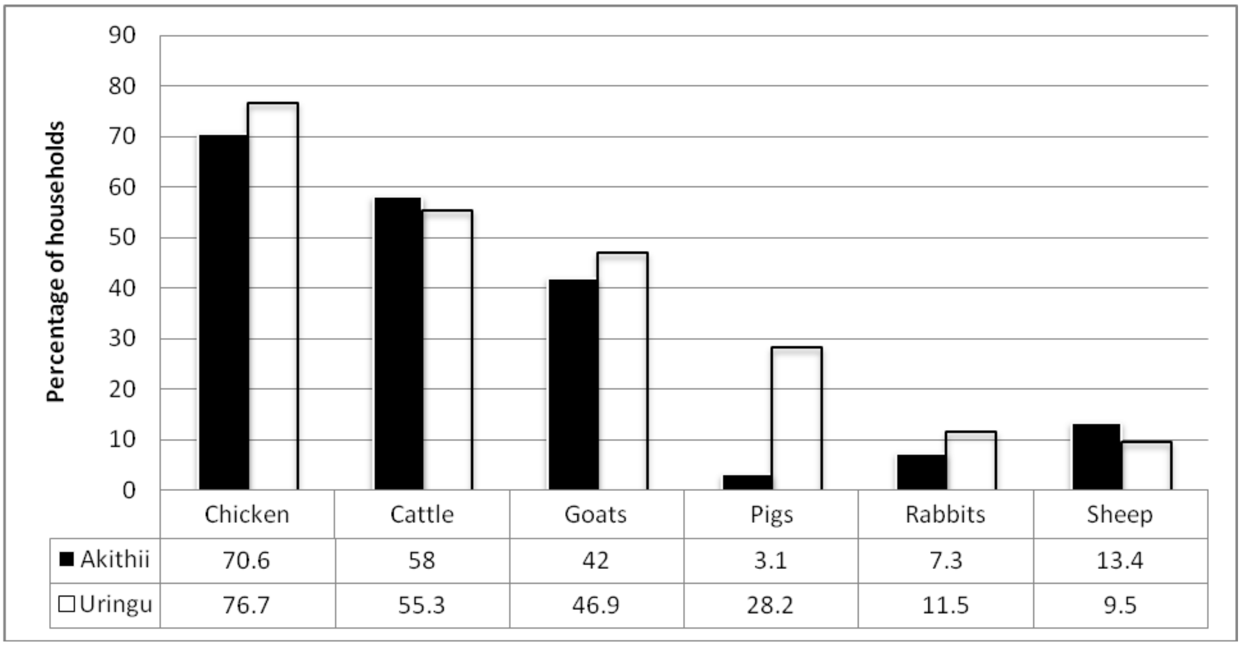

Figure 3.2: Livestock ownership by households in Akithii and Uringu divisions in Phase 1

3.3 DIETARY INTAKE

3.3.1 Dietary Intake by Repeated 24-hour (hr) Recall

Dietary data was collected using a repeated 24-hr recall. Comparison was made using a paired t-test, between the means of the repeated 24-hour recalls and pooled T-test for comparison between the divisions. Adequacy of nutrient intake was interpreted based on the FAO and WHO [152,156,157,158] recommended dietary intake (RDI) for the study population. RDI do not have a value for carbohydrates, therefore the RDA of the Food and Nutrition Board of the USA was used.[155] Tables 3.4 and 3.5 show the analysis for macronutrients in Akithii and Uringu respectively.

Table 3.4: Mean dietary intake of macronutrients of children in Akithii Division in Phase 1

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p value****	***FAO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Energy (kJ)	3643	2908	3081	1921	3392	2069	0.002**	4276-5656
Carbohydrate (g)	132	90	120	68	127	67	0.041*	130#
Added sugar (g)	7.5	29.38	2.9	9.46	5.2	15.76	0.019**	No RDI
Total protein (g)	20.6	13.20	20.4	17.18	20.6	12.33	0.839	14-22.2
Animal protein (g)	1.6	3.89	1.3	4.17	1.4	3.11	0.274	No RDI
Vegetable protein (g)	18.9	11.99	18.9	16.31	19.1	11.51	0.909	No RDI
Total fat (g)	22.0	37.13	12.5	19.97	17.5	22.95	p<0.001***	No RDI
Poly-unsatured fat (g)	5.9	9.70	3.5	4.46	4.9	5.90	p<0.001***	No RDI
Saturated fat (g)	5.1	8.23	2.9	5.77	4.1	5.45	p<0.001***	No RDI
Fiber (g)	13.9	9.59	13.2	9.14	13.7	7.68	0.394	19-25

N=234; Significance * at p <0.05: p<0.01; *** p<0.001: [155, 156, 157,158]; # RDA used because there is no RDI for carbohydrate; SD=standard deviation**

In Akithii, there were significant differences between the mean intake of energy (p=0.002), added sugar (0.041), carbohydrates (0.019), total fat (p<0.001), polyunsaturated fat (p<0.001) and saturated fat (p<0.001) between 24-hr recall 1 and 24-hr recall 2 (Table 3.4). Comparison of the mean nutrient intake of macronutrients with the RDI showed that the respondents consumed inadequate mean energy and fiber intakes. Mean protein intakes appeared to be in the adequate range. Carbohydrate values were around the minimum RDA value of 130 g.

Table 3.5: Mean dietary intake of macronutrients of children in Uringu Division in Phase 1

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p value****	***FAO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Energy (KJ)	4012	2232	3507	1872	3684	1599	0.004**	4276-5656
Carbohydrate (g)	141	72	130	67	134	55	0.050	130#
Added sugar (g)	8.3	20.49	3.6	17.27	6.0	14.43	0.011**	No RDI
Total protein (g)	23.3	15.17	21.9	13.14	22.3	11.98	0.230	14-22.2
Animal protein (g)	2.0	3.22	2.6	6.66	2.1	3.47	0.268	No RDI
Vegetable protein (g)	19.6	14.24	17.9	9.67	18.7	10.47	0.111	No RDI
Total fat (g)	25.7	28.30	18.5	19.43	21.1	17.86	p<0.001***	No RDI
Poly-unsaturated fat (g)	8.5	10.69	5.3	5.47	6.6	6.37	p<0.001***	No RDI
Saturated fat (g)	5.9	7.26	4.5	5.82	4.9	4.57	0.023*	No RDI
Fiber (g)	16.7	9.95	15.2	8.72	15.7	7.39	0.063	19-25

N=218; Significance* at p <0.05:p<0.001*** p<0.001: [155, 156, 157,158]; # RDA used because there is no RDI for carbohydrate; SD=standard deviation**

In Uringu there were significant differences between the mean intakes of energy (p=0.004), added sugar (p=0.011), total fat (p=0.001) and polyunsaturated fat (p=0.001) between the two 24-hr recalls; with the first recall generally being higher than the second. Comparison of the mean nutrient intakes of macronutrients with RDI showed that the respondents consumed an adequate mean protein and carbohydrate intake. Mean energy intakes were lower than the RDI, particularly at the second recall. Mean fiber intakes were also below the RDI. Comparison of the mean intake of micronutrients for Akithii and Uringu divisions are shown in Tables 3.6 and 3.7.

Table 3.6: Mean intake of micronutrients of children in Akithii in Phase 1

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Calcium (mg)	163.0	150.17	126.5	118.49	146.4	108.74	p<0.001***	500-600
Iron (mg)	4.9	3.56	4.3	3.13	4.6	2.76	0.039*	6.0
Zinc (mg)	2.7	1.79	2.5	1.84	2.6	1.51	0.261	4.1-5.1
Vitamin A (ug)	673.4	774.09	468.0	582.83	581.9	577.14	p<0.001***	400-450
Vitamin C (mg)	45.4	57.34	28.0	33.60	37.8	38.58	0.001***	30
Folate (ug)	174.5	140.29	197.2	417.03	186.8	227.39	0.410	160-200
Thiamin (mg)	0.5	0.46	0.5	0.97	0.5	0.56	0.841	0.5-0.6
Riboflavin (mg)	0.3	0.23	0.3	1.11	0.3	0.57	0.793	0.5-0.6
Niacin (mg)	3.3	3.33	3.1	9.77	3.3	5.31	0.757	6-8
Vitamin 6 (mg)	0.5	0.53	0.4	0.50	0.5	0.40	0.022*	0.5-0.6
VitaminB12 (ug)	0.2	0.52	0.2	1.41	0.2	0.81	0.854	0.9-1.2

N=235; Significance* at p <0.05: *** p<0.001; [152]; SD=standard deviation

In Akithii, there were significant differences between the two mean 24-hr recalls in calcium (p<0.001), iron (p=0.039), vitamin A (p<0.001), vitamin C (p<0.001) and vitamin B6 (p=0.022) with the first recall often producing higher values than the second. Comparison of the mean intake of micronutrients with RDI show that the respondents consumed considerably less calcium, iron, zinc, riboflavin and vitamin B12, while vitamins A, C, folate, other B vitamins were consumed in adequate amounts.

Table 3.7: Mean intake of micronutrients of children in Uringu in Phase 1

Nutrient	*24-hr 1*		*24-hr 2*		*Both 24-hrs*		*Paired T-test p value**	*FAO/WHO RDI*
	Mean	SD	Mean	SD	Mean	SD		
Calcium (mg)	196.7	166.24	202.6	195.79	196.9	137.39	0.708	500-600
Iron (mg)	5.7	3.77	5.4	3.63	5.4	2.79	0.308	6
Zinc (mg)	3.4	2.93	3.0	1.65	3.1	1.81	0.037*	4.1-5.1
Vitamin A (ug)	561.8	614.87	573.2	620.69	587.0	532.40	0.816	400-450
Vitamin C (mg)	66.7	73.31	56.3	53.06	61.5	51.05	0.044*	30
Folate (ug)	210.9	144.90	195.6	129.58	212.8	184.26	0.188	160-200
Thiamin (mg)	0.6	0.37	0.5	0.32	0.6	0.46	0.069	0.5-0.6
Riboflavin (mg)	0.3	0.42	0.3	0.26	0.3	0.48	0.639	0.5-0.6
Niacin (mg)	5.2	6.56	3.9	2.91	4.6	5.37	0.003**	6-8
Vitamin B6 (mg)	0.7	0.53	0.6	0.42	0.6	0.41	0.002**	0.5-0.6
Vitamin B12 (ug)	0.2	0.36	0.3	0.56	0.2	0.33	0.673	0.9-1.2

N=218; Significance* at p <0.05; **p<0.01; *** p<0.001;[152]

In Uringu there were significant differences between the mean intakes of 24-hr recall 1 and 24-hr recall 2 in zinc (p=0.037), vitamin C (p=0.044), niacin (p=0.003) and vitamin B6 (p=0.002) with the values in the first recall being higher than the second recalls. Comparison of the mean nutrient intake of micronutrients with RDI showed that the respondents consumed considerably less calcium, iron, zinc, riboflavin and vitamin B12 while mean vitamin A, C, thiamin and folate were consumed in amounts meeting the RDI.

3.3. 2 Comparison of the Dietary Intake by Repeated 24-hour (hr) Recall of Akithii and Uringu Divisions

A comparison of the mean nutrient intakes of the macronutrients and micronutrients between the two divisions was also done (Table 3.8). The Comparison between Akithii and Uringu showed that there were significant differences in the mean dietary intakes of animal protein (p=0.030), polyunsaturated fat (p<0.001) and fiber (p=0.003). Apart from vegetable protein, Akithii had lower mean dietary intakes for all the macronutrients compared to Uringu. Overall, both divisions had low energy, carbohydrate and fiber intakes when compared with the RDI. Mean protein intakes met the RDI but comprised mainly of vegetable protein. Fat intake was more or less equally composed of saturated and poly-unsaturated fats.

Table 3.8: Comparison of mean intake of macronutrients in Akithii and Uringu in Phase 1

Nutrient	***Akithii***		***Uringu***		***Pooled T-Test P value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD		
Energy (KJ)	3392	2069	3684	1599	0.077	4276-5656
Carbohydrate (g)	127	67	134	55	0.192	130#
Added sugar (g)	5.2	15.76	6.0	14.43	0.534	No RDI
Total protein (g)	20.6	12.33	22.3	11.98	0.133	14-22.2
Animal Protein (g)	1.4	3.11	2.1	3.47	0.030*	No RDI
Vegetable protein (g)	19.1	11.51	18.7	10.47	0.749	No RDI
Total fat (g)	17.5	22.95	21.1	17.86	0.055	No RDI
Poly-unsaturated fat (g)	4.9	5.90	6.6	6.37	p<0.001***	No RDI
Saturated fat (g)	4.1	5.45	4.9	4.57	0.050	No RDI
Fiber (g)	13.7	7.68	15.7	7.39	0.003**	19-25

Akithii (N=240); Uringu (N=246); Significance* at p <0.05;p<0.01;***p<0.001; [155, 156, 157, 158]; # RDA; SD=standard deviation**

The Comparison of mean micronutrient intakes between the two divisions is shown in Table 3.9. There were significant differences in the mean dietary intakes of calcium (p<0.001), iron (p<0.001), zinc (p<0.001), niacin (p=0.004) and vitamin B6 (p<0.001) (Table 3.9). Apart from riboflavin and vitamin B12, Akithii had lower mean dietary intakes for all the micronutrients compared to Uringu. Mean intakes of calcium, zinc, iron, riboflavin, niacin and vitamin B12 did not meet the RDI for either division.

Table 3.9: Comparison of mean intake of micronutrients in Akithii and Uringu in Phase 1

Nutrient	***Akithii***		***Uringu***		***Pooled T-test p value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD		
Calcium (mg)	146.4	108.74	196.9	137.39	p<0.001***	500-600
Iron (mg)	4.6	2.76	5.4	2.79	p<0.001***	6
Zinc (mg)	2.6	1.51	3.1	1.81	p<0.001***	4.1-5.1
Vitamin A (ug)	581.9	577.14	587.0	532.40	0.919	400-450
Vitamin C (mg)	37.8	38.58	61.5	51.05	p<0.001***	30
Folate (ug)	186.8	227.39	212.8	184.26	0.159	160-200
Thiamin (mg)	0.5	0.56	0.6	0.46	0.365	0.5-0.6
Riboflavin (mg)	0.3	0.57	0.3	0.48	0.204	0.5-0.6
Niacin (mg)	3.3	5.31	4.6	5.37	0.004**	6-8
Vitamin B6 (mg)	0.5	0.40	0.6	0.41	p<0.001***	0.5-0.6
Vitamin B12 (ug)	0.2	0.81	0.2	0.33	0.712	0.9-1.2

Akithii (N=240); Uringu (N=246); Significance* at p <0.05;p<0.01; ***p<0.001; [152]; SD=standard deviation**

3.3.3 Nutrient Adequacy of the Children's' Dietary Intake

Nutrient adequacy is described in terms of nutrient adequacy ratios (NARs). The percent at which a nutrient meets the RDI is given, with 100% being the ratio that completely meets the RDI. Mean adequacy ratio (MAR) is the mean of all the NARs shown in Table 3.10. Children in Uringu consumed consistently higher amounts of macronutrients and micronutrients than those from Akithii. The lowest NAR values were found for vitamin B12 and calcium. Vitamin B12 values were less than 25% of the requirement and calcium less than 40%. Energy and protein adequacy ratios were all less than 50% of the RDI. The highest NARs of 70% and above were found for vitamin A, B6, C, thiamin, folate and iron. When combining the 11 micronutrients to give a MAR value, it was found to be 61.3% for both divisions combined, 55.3% for Akithii and 66.8% for Uringu.

Table 3.10: Comparison of nutrient adequacy ratios (NARs) in Akithii and Uringu in Phase 1

Energy and nutrients	***Akithii***		***Uringu***		***Both divisions***		***Independent T-test***
	Mean NAR %	SD	Mean NAR %	SD	Mean NAR %	SD	P-value*
Energy	36.2	21.1	39.5	16.1	37.9	18.7	0.05
Protein	41.5	21.62	44.4	19.77	43.0	20.73	0.11
Vitamin A	66.2	39.83	73.5	34.14	70.0	37.12	0.027*
Vitamin B6	67.1	30.72	85.8	20.23	76.8	27.52	0.001**
Vitamin B12	15.4	26.01	21.9	26.65	18.7	26.57	0.001**
Vitamin C	66.4	38.81	89.4	24.35	78.3	34.15	0.001**
Niacin	43.7	25.52	60.0	26.71	51.9	27.34	0.001**
Riboflavin	45.0	26.84	54.7	23.92	50.0	25.83	0.001**
Thiamin	77.7	24.25	84.0	21.43	80.9	23.12	0.002*
Folate	74.4	30.96	85.0	22.08	79.9	27.26	0.001**
Iron	67.0	29.88	77.4	23.59	72.4	27.27	0.001**
Calcium	28.1	20.73	36.8	22.25	32.6	21.98	0.001**
Zinc	57.5	27.46	67.1	24.04	62.4	25.94	0.001**
MAR##	**55.3**	**23.65**	**66.8**	**17.19**	**61.3**	**21.23**	**0.001****

Akithii (N=241); Uringu (N=258); Significance *at p <0.05; ** p<0.01; ***p<0.001; #= Nutrient adequacy ratio truncated; ##=Mean adequacy ratio; SD=standard deviation

Comparison of the means of the two divisions showed significant differences in all the NARs (p<0.05) with the exception of Energy (kJ) (p=0.11) and protein (p=0.05). Worth noting is that Uringu consistently had higher means for all the NARs, which means that the children in Uringu had a higher MAR than those in Akithii, reflecting a diet of better quality.

3.3.4 Foods and Food Groups Commonly Consumed by the Children

The findings of the analysis of the foods that were commonly consumed by the children in the two divisions are shown in Table 3.11.The most commonly consumed food was maize meal (*ugali)* with 81.3 % consumers in Akithii and 86% in Uringu. Other foods eaten by more than 50% of the children in both divisions were maize and beans (*githeri*) and tea.

Table 3.11: Foods commonly consumed by children in Akithii and Uringu divisions in Phase 1

Type of food	*Akithii*			*Uringu*		
	% Consumers	Mean portion size consumers (g	Per capita amount (g)	% Consumers	Mean portion size consumers (g)	Per capita amount (g)
Maize meal (*Ugali*)	81.3	216.82	176.3	86.1	201.9	173.7
Maize and beans	71.4	264.1	188.5	62.4	229.3	143.1
Brewed Tea	61.4	375.5	230.6	76.0	383.8	291.5
Porridge	60.2	363.5	185.5	28.3	295.5	83.6
Kales	41.5	125.7	52.2	39.2	120.7	47.2
Sugar	34.4	11.7	4.0	29.8	14.4	4.3
Spinach & potatoes	33.2	120.2	39.9	15.5	112.9	17.5
Tomatoes fried	24.9	107.1	26.7	29.5	111.0	32.7
Boiled maize	22.8	181.3	41.4	27.5	139.1	38.3
Chapati (roti)	14.5	186.5	27.1	3.9	125.0	4.8
Beans (dry)	11.2	95.4	10.7	14.3	91.5	13.1
Potatoes	10.8	139.3	15.0	16.7	127.8	21.3
Avocadoes	10.8	63.6	6.9	9.7	71.1	6.9
Rice boiled	7.5	102.3	7.6	7.4	91.3	6.7
Cowpeas green	5.0	82.0	4.1	15.89	93.0	14.8

As indicated in Table 3.11, almost all the children ate some kind of a cereal, root or tuber in the two divisions with 98.5% and 96.2% in Akithii and Uringu respectively consuming starches. Further, in Uringu, a higher percentage of children (91.3%) consumed vitamin A rich fruits and vegetables compared to 74.5% in Akithii (p= 0.07). Children in Uringu also consumed more legumes and nuts, dairy products and fats and oils than those in Akithii. These differences were significant with respect to legumes and nuts and dairy products.

Analysis of the consumption of foods from the other food groups revealed that children in Akithii consistently consumed less of these food groups compared to those in Uringu division (Table 3.12) with significant differences being observed in legumes and nuts (p=0.007), dairy products (p=0.003) and beverages (p=0.01).

Table 3.12: Percent of children consuming foods from different food groups in Phase 1

Food group	***Akithii***		***Uringu***		***Both divisions***		***Independent T-test***
	%	SE	%	SE	%	SE	p-value
Cereals, roots and tubers	98.5	1.0	96.2	3.8	97.4	1.8	0.61
Vitamin A rich fruits & vegetables	74.5	4.2	91.3	2.8	82.9	5.3	0.07
Other fruits & vegetables	13.6	6.0	47.7	7.4	30.6	21.1	0.07
Sugars, syrup and sweets	26.7	2.1	28.4	3.0	27.6	2.6	0.68
Legumes & nuts	17.9	2.5	46.4	0.2	32.1	8.3	0.007*
Meat, poultry, fish	1.7	0.01	2.1	0.4	1.9	0.2	0.41
Fats & oils	13.8	5.3	18.9	1.9	16.3	2.7	0.46
Dairy products	50.4	2.5	79.4	4.9	64.9	8.7	0.03*
Eggs	0.4	0.003	1.1	0.2	0.7	0.2	0.09
Beverages	0.8	0.3	0.9	0.03	0.9	0.6	0.01*

Significance *at p <0.05; ** p<0.01; ***p<0.001; SE=standard error

3.3.5 Dietary Diversity Score for Children from the Two Divisions

The DDS was calculated based on the number of food groups eaten by the children daily from the mean of the two 24-hr recalls. Table 3.13 shows the mean DDS for the two divisions. The highest possible DDS was 9 based on nine food groups (ref 2.12.5) while the acceptable minimum being 4 food groups.

Akithii had a mean DDS of 2.9 ± 1.1 while Uringu had a mean score of 3.7 ± 1.1, with the mean for both divisions being 3.3 ± 1.2.The difference in the mean DDS between Akithii and Uringu was significant (p<0.001) and therefore it can be stated that children in Akithii consumed a less diversified diet compared to children in Uringu, though both divisions did not meet the minimum acceptable dietary diversity score of four. A comparison of children who attained the minimum dietary diversity of consuming from at least 4 different food groups is shown in Figure 3.3.

Table 3.13: Dietary diversity scores of children in the study in Phase 1

DDS	***Akithii***	***Uringu***	***Both divisions***	***Independent T-test P-value***
Mean DDS	2.9	3.7	3.3	P<0.0001***
SD	1.10	1.12	1.20	
SE	0.1	0.1	0.1	
Lower 95% CI	2.7	3.6	3.2	
Upper 95% CI	3.0	3.9	3.4	

Akithii (N=240); Uringu (N=258); SD- standard deviation; SE=standard error; CI= 95% confidence interval; Significance ***at p <0.001

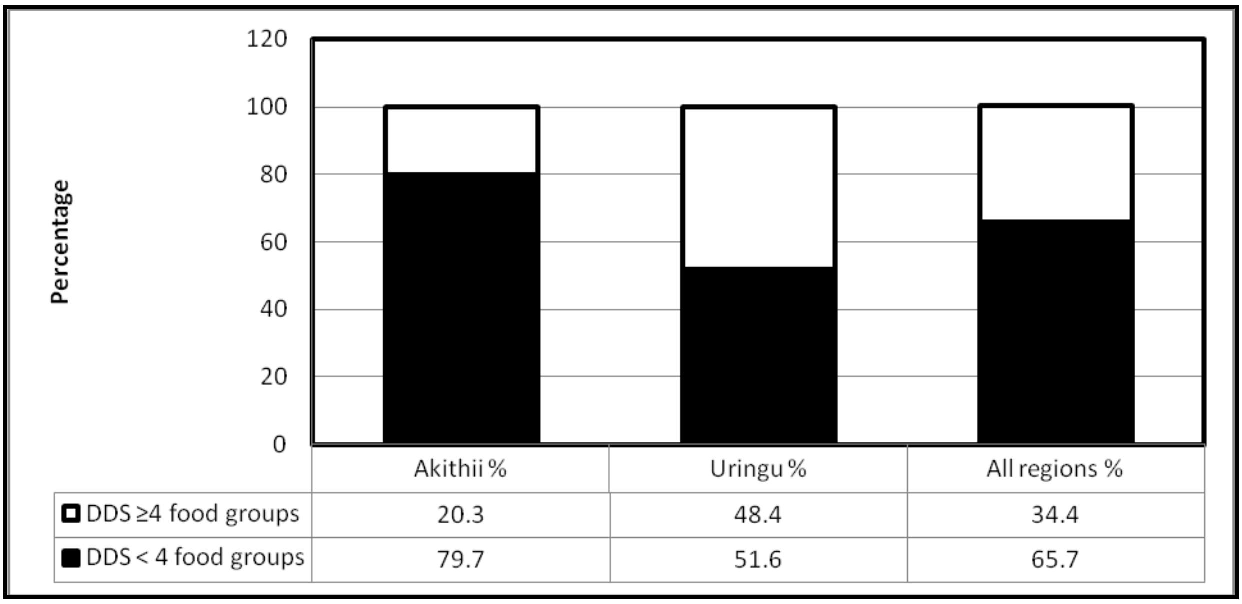

Figure 3.3: Dietary diversity of children by divisions in Phase 1

About one-third (34.4%) of the children in the two divisions had a minimum DDS equal or greater than 4 and 65.7% had a DDS less than four. Furthermore, (79.7%) of the children in Akithii consumed less than four food groups a day compared to Uringu with a slightly lower figure of 51.6%.The percentage of children who consumed four or more food groups a day was 20.3% in Akithii and 48.4% in Uringu.Comparison of dietary diversity in Akithii and Uringu showed that there was a significant difference between the two divisions (chi-square test, $p<0.001$). Children in Akithii consumed a less diversified diet as compared to those in Uringu (20.3%, 48.4).The DDS was significantly correlated with MAR and NARs of all the nutrients studied (Spearman rank, $p<0.001$) in all the divisions in the study. This means that an increase in the DDS was associated with higher NARs and MAR.

3.3.6 Correlating Nutrient Adequacy Ratios with Mean Adequate Ratio

The MAR was also correlated with all the NARs studied using Spearman's rank correlation coefficient. There was a significant positive correlation ($p<0.001$) for each correlation (Table 3.14). Increase in the NARs for all the nutrients led to an increase in the MAR in the two divisions.

Table 3.14: Correlation of nutrient adequacy with the mean adequacy ratios of 11 nutrients in Phase 1

NARs	***Akithii***			***Uringu***		
	Spearman R	**T(n-2)**	**p-value**	**Spearman R**	**T(n-2)**	**p-value**
Energy (kJ)	0.82	21.97	0.001***	0.7	17.9	0.001***
Protein	0.87	27.12	0.001***	0.8	20.4	0.001***
Vitamin 12	0.60	11.68	0.001***	0.5	9.2	0.001***
Vitamin C	0.73	16.66	0.001***	0.5	9.6	0.001***
Calcium	0.92	36.36	0.001***	0.8	20.5	0.001***
Folate	0.74	16.95	0.001***	0.5	9.7	0.001***
Iron	0.88	28.58	0.001***	0.8	18.3	0.001***
Niacin	0.88	28.74	0.001***	0.8	22.5	0.001***
Riboflavin	0.94	42.64	0.001***	0.9	33.2	0.001***
Thiamin	0.80	20.46	0.001***	0.7	16.9	0.001***
Zinc	0.91	34.00	0.001***	0.9	26.4	0.001***

Akithii (N=240); Uringu (N=258) ; Significance ***at p <0.001

3.4 HOUSEHOLD FOOD SECURITY

Household food security was assessed by the Household Food Insecurity Access Scale (HFIAS) developed by Coates et al.[70]

3.4.1 Measuring Household Food Security in the Two Divisions

Table 3.15 shows the mean HFIAS score of the two divisions. Akithii had a mean HFIAS score of 15.6 ± 7.0, while Uringu had a score of 10 ± 6.9, which shows that Akithii had a higher level of food insecurity compared to Uringu. The highest HFIAS that can be attained is a score of 27. The higher the score, the more food insecure the household is.

Table 3.15: Household food insecurity access scale score of households in the two divisions in Phase 1

HFIAS score	***Akithii N=240***	***Uringu N=258***	***Both divisions***	***Independent T-test p-value***
Mean	16.2	10.0	13.0	0.0001***
SD	7.01	6.90	6.91	
SE	0.4	0.4	0.4	

Significance ***at p <0.001; HFIAS=0-27; SD= standard deviation

The HFIAP indicator was used to categorize households in the two divisions into the four levels of food insecurity used internationally.[70] Akithii was significantly more food insecure than Uringu as illustrated by the significantly higher score of 16.2 (p<0.0001).

The findings also showed that 8% of the households were food secure while the majority (62%) were categorized as being severely food insecure (Figure 3.4).

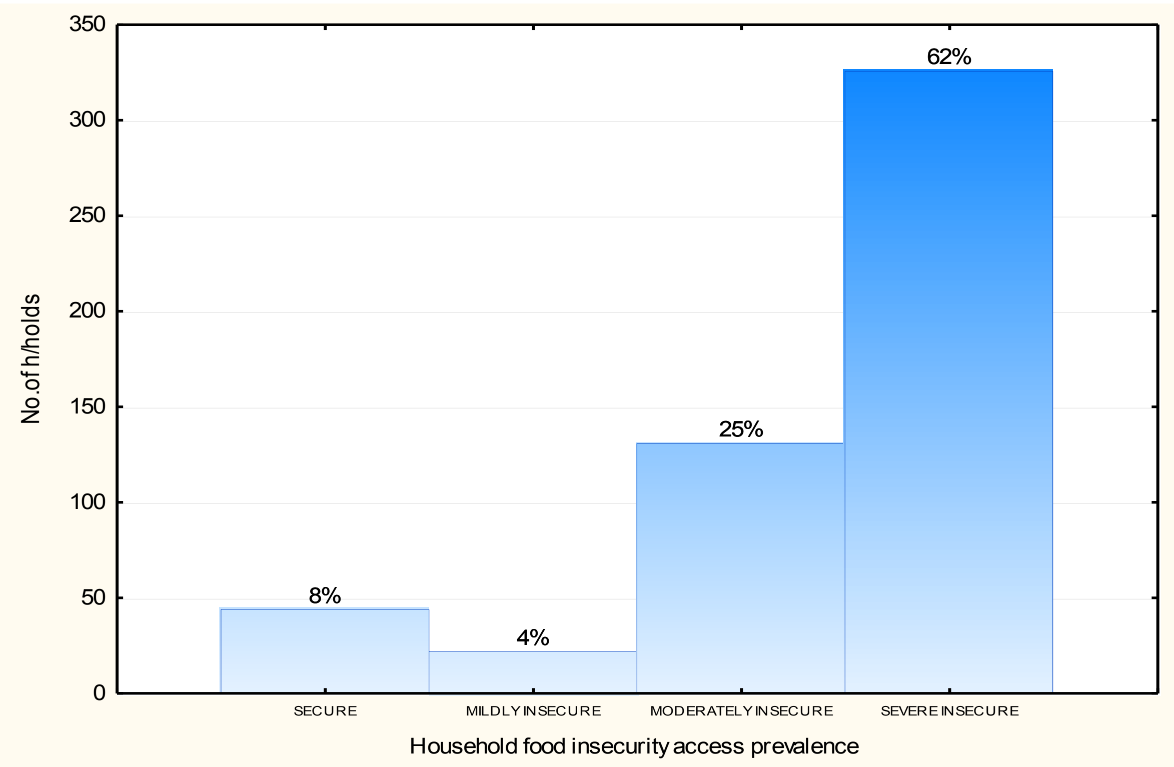

Figure 3.4: Household food insecurity access prevalence categories for the two divisions in Phase 1

In Akithii division, 2% of the households were food secure and 82% severely food insecure (Figure 3.5).

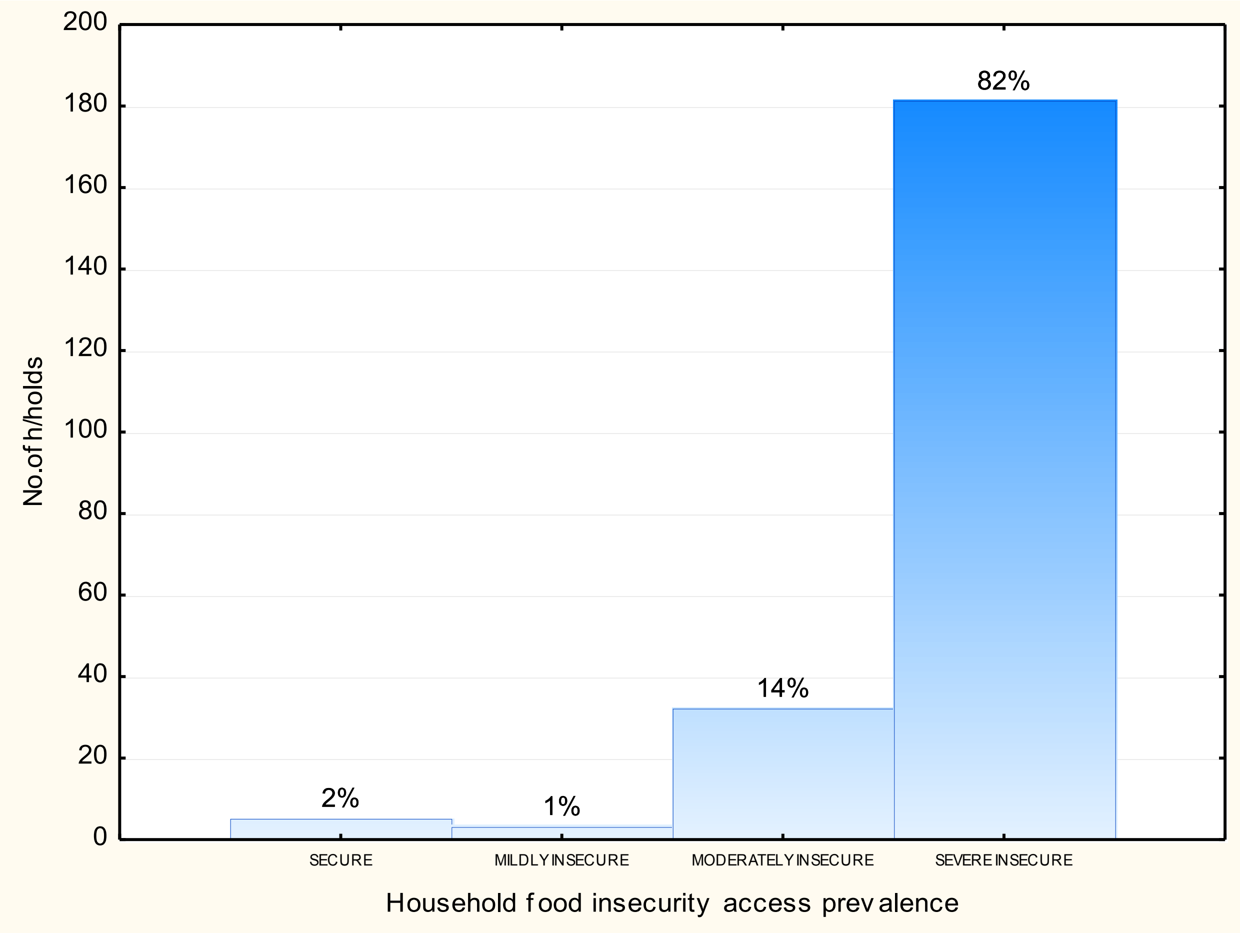

Figure 3.5: Household food insecurity access prevalence categories for Akithii Division in Phase 1

In Uringu division, 12% of the households were food secure and 47% were categorized as being severely food insecure (Figure 3.6).

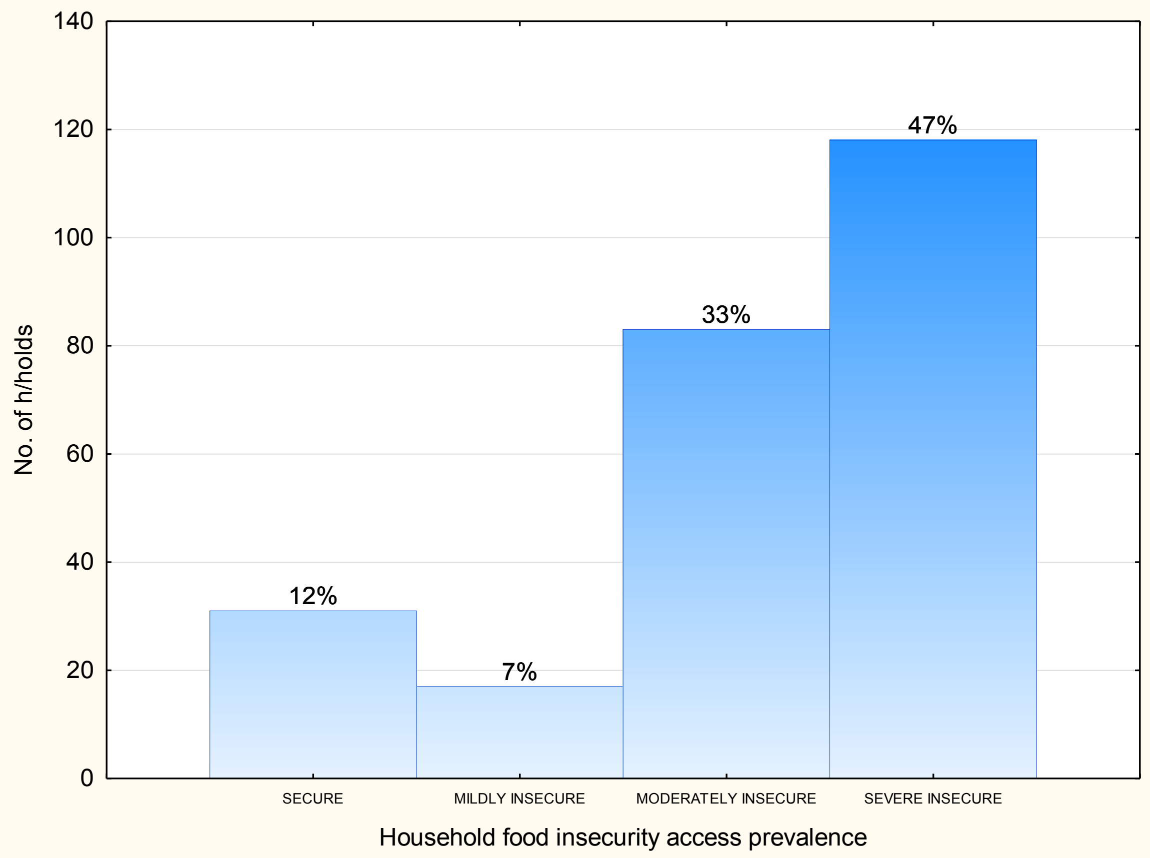

Figure 3.6: Household food insecurity access prevalence categories for Uringu Division in Phase 1

3.5 AGRICULTURAL BIODIVERSITY

Agricultural biodiversity was measured by determining the variety of food plants grown, animals reared for food and food items obtained from natural habitats. The total biodiversity was found to be 26 different food items and categorized into animals, cereals, roots, fruits, vegetables and nuts. The distribution shows that three foods were from the natural habitat while 23 were domesticated or cultivated (Table 3.16).

Table 3.16: Different types of food items (agricultural biodiversity) in the two divisions in Phase 1

Categories	***Types of food items***		
	Domesticated/cultivated	**Natural habitat**	**Total number**
Animals	Goats, pigs, chicken, rabbit, sheep, ducks, cows	antelopes	8
Cereals, pulses and roots	Maize, beans, sorghum, pigeon peas, cowpeas, millet, arrow roots	none	7
Nuts	ground nuts, macadamia nuts	none	2
Fruits	Paw paws, avocadoes, bananas, oranges, mangoes	wild berries	6
Vegetables	Kales and tomatoes	Amaranth sp *Amaranthus blitum*)(*terere*)	3
Total biodiversity	**23**	**3**	**26**

The food category with the highest number of foods was animals with a total number of 8 foods, followed by 8 cereals and roots, 6 fruits and 3 vegetables. Plant species were not classified into varieties in this study; therefore, foods such as maize, beans, sorghum and millet may reflect more than one variety.

3.5.1 Comparison of the Levels of Agricultural Biodiversity in Akithii and Uringu Divisions

Figure 3.7 shows a comparison of the mean of the different types of biodiversity found in Akithii and Uringu. Uringu had consistently higher levels of biodiversity compared to Akithii apart from cereals and roots.

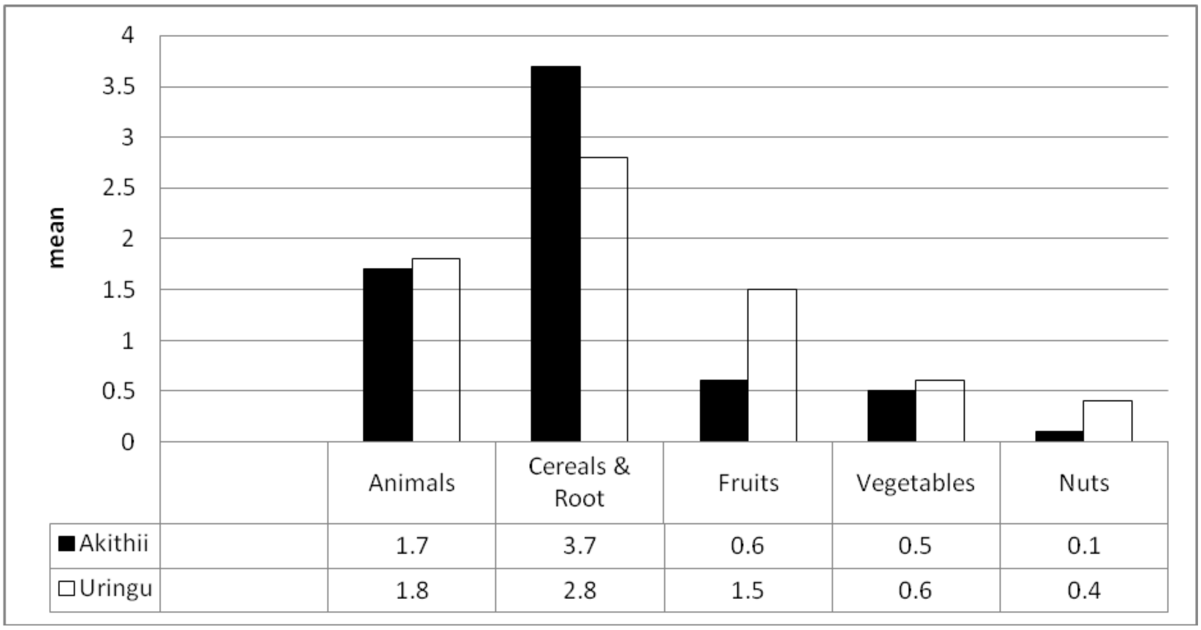

Figure 3.7: Mean number of different types of agricultural biodiversity in Akithii and Uringu in Phase 1

Akithii had a mean of 1.7 ± 1.01 types of animals compared to Uringu with1.8 ± 1.42 types and the nut category had the lowest mean at 0.1 ± 0.32 for Akithii compared to a mean of 0.4 ± 0.52 for Uringu. Akithii division had a mean agricultural biodiversity score of 6.6 ± 2.44 compared to Uringu with 7. 2 ± 4.19.The total mean for all divisions was 6.9 ± 3.47. Further comparison of the means of the two divisions on the basis of the level of agricultural biodiversity (ANOVA) F (1,403) = 4.4468, p=0.035 (Figure 3.8) showed a weak significant difference between Akithii and Uringu. Uringu had a significantly higher mean biodiversity level compared to Akithii.

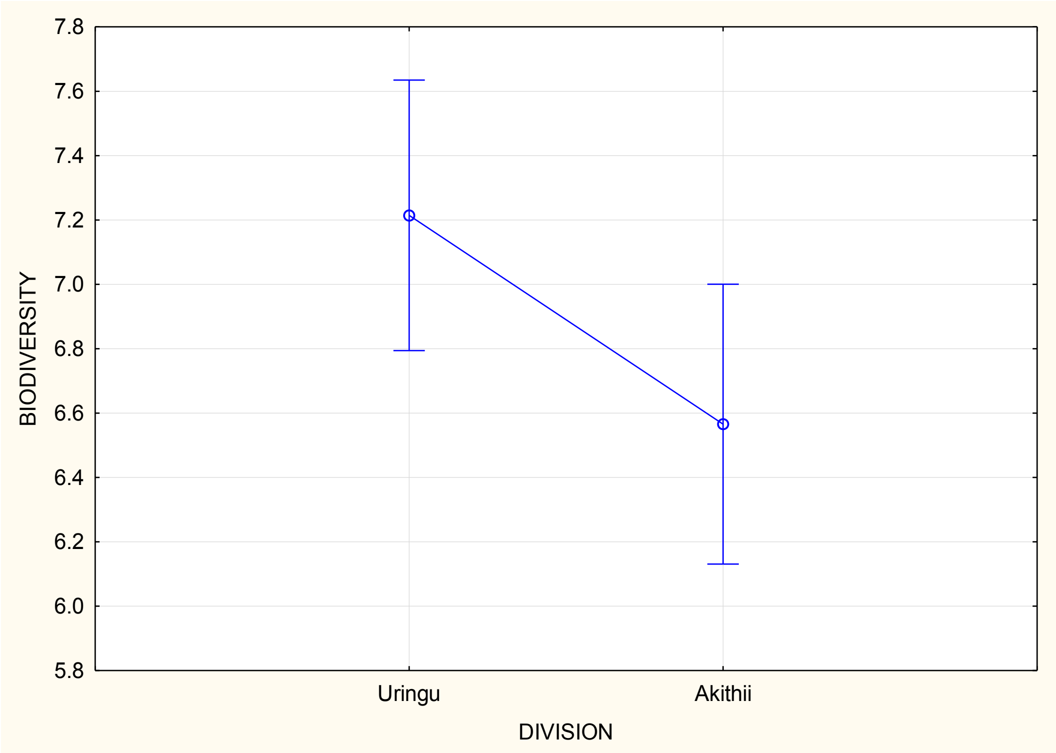

Figure 3.8: Comparison of the levels of agricultural biodiversity in Akithii and Uringu in Phase 1.

Further analysis using Mann-Whitney U test per division showed that households in Akithii utilized a significantly higher number of different cereals compared to Uringu (F (1.503)-40.880, $p<0.01$), while households in Uringu utilized a greater number of different fruits than those in Akithii (F (1.503)-54.839, Mann-Whitney U, $p<0.01$).

3.5.2 Past Agricultural Biodiversity in the Two Study Divisions

Four focus group discussions were held per sub-location with key informants and other select members of the community. The chiefs assisted in identifying the village elders from the two divisions. The chiefs and village elders were included in one focus group. The chiefs also assisted in identifying the community leaders who formed the second focus group. Between 8 and 12 participants were included in each group. The focus group discussions were conducted in the local primary schools. The research assistant recorded the focus group discussions and took supplementary notes during the discussions. The researcher conducted interviews based on the focus group discussion questions with the district agricultural officer and district nutritionist in their offices. The discussions focused on gathering data on the broad theme of food items which were no longer utilized (Table 3.17). Recordings were transcribed in English with simultaneous translation from the focus group language. The transcriptions were read and re-read to identify emerging codes.

Within the broad theme, four codes emerged around the reasons for the change in food utilization and these included 1) legislation; 2 modernization; 3) climate change; 4) other factors. The recurring codes are described below with selected comments.

Change in food utilization due to legislation

Wild animals such as antelope and elephants used to be hunted for food but this is no longer practiced since hunting is prohibited by the government of Kenya.

"The forest cover has reduced and the wild animals are protected in the parks hence it is not possible to do wild hunting anymore."

Change in food utilization due to modernization

Several wild fruits and vegetables have also been neglected because of reliance on "modern" fruits and vegetables that have been introduced by the Ministry of Agriculture. The fruits, roots and vegetables that are now seldom utilized/available include yams, guavas, amaranth species (*Amaranthus blitum*) and *ndarama* (wild berries). Respondents also reported that less millet, finger millet and sorghum were planted due to destruction by birds.

"We stopped planting millet and are not keen to plant sorghum and finger millet because the birds keep destroying the crop. Previously, children used to scare the birds away, now they go to school."

Table 3.17: Different types of food items (past biodiversity) found in the two divisions in Phase 1

Categories	***Types of food items***		
	Domesticated/cultivated	**Natural Habitat**	**Total Number**
Animals	Goats, sheep, cows, chicken	Antelopes, elephants, wild birds	7
Cereals, pulses and roots	Sorghum, pigeon peas, cowpeas (*Vigna unguilata*), millet, arrow roots, yams, finger millet, sorghum	*Mang'ua* (roots)	9
Fruits	Bananas, oranges, mangoes	Wild berries	4
Vegetables	Arrowroot leaves	Amaranth sp (*Amaranthus blitum*) African nightshade (*mathunku*)	3
Total biodiversity	**16**	**7**	**23**

Change in food utilization due to climate change

Participants of the focus groups indicated that climate change had significantly affected levels of agricultural biodiversity. Unpredictable weather changes had led to long periods of drought which made some farmers choose alternate crops that did not take as long to mature as many of the indigenous types. Crops such as the traditional black beans, despite their resistance to drought were abandoned by the farmers.

"Every four years there is drought."

Respondents were asked to comment on the relationship between agricultural biodiversity with food security.

"Since the last el nino in 1997, there is no time that we have had sufficient food".

The participants concurred that the community suffered from food insecurity regularly. When asked what time of the year or season of the year the community had the most difficulties in ensuring food security, one of the community leaders said:

"Almost every year in the months of September to October and early January we are really hungry".

Change in food utilization due to other factors

Other factors reported by the participants to contribute to food insecurity included; post-harvest losses, lack of farm inputs such as certified seeds and fertilizer, reduced agricultural land size due to sub-divisions, observed reduced soil fertility, destruction of crops by pests and unreliable weather patterns. The rest of the members concurred with these sentiments. Pests, disease infestations and reduced soil fertility were given as reasons for abandoning some indigenous crops. Due to the high poverty levels in the area, many farmers were not able to afford farming necessities such as fertilizers and therefore low food production and low biodiversity are the outcomes.

Respondents were asked to discuss the reasons why people stopped preparing the traditional dishes such as millet *ugali.* Various reasons were given by the participants including: lack of time to prepare the food, lack of indigenous foods and change in food preferences.

"It is difficult to get firewood these days and hence we prefer food that will take a short time to cook. The cost of charcoal is very high and it's rarely available because the government forbids us from burning trees to produce it.

The respondents also discussed the measures the community should put in place to ensure food security. Among the measures recommended was irrigation through water harvesting, sinking of boreholes and establishment of dams. Other suggestions made were reduction in post-harvest losses and use of drought resistant crops.

"The government should attach agricultural extension officers like they did in the 1970s and 1980s to teach us on modern agricultural practices".

The other members concurred with this suggestion.

To test the relationship between past and current biodiversity using the Pearson correlation coefficient a significant correlation was found between the two in Akithii and Uringu divisions. In Uringu, Pearson's r was 0.327, ($p<0.001$) and in Akithii it was at $r=0.299$, ($p<0.001$). In both divisions, the levels of biodiversity were currently higher than in the past. However, food items collected from the natural habitat had reduced while the cultivated/domesticated ones had increased.

3.6 CHILD HEALTH CARE PRACTICES

3.6.1 Immunization Coverage

The coverage of various immunizations among children was established based on the mothers/care givers recall or through verification of the child health card. The findings showed that almost all the (98.5%) children below the age of five had received BCG vaccine, which prevents tuberculosis, (Table 3.18). Only 1.5% had not been vaccinated at the time of data collection. The majority of children had received the three OPV vaccines according to WHO guidelines, therefore, were protected against polio.

The majority of children (91.6%) had received three doses of pentavalent vaccine while 8.4% had not been immunized according to WHO guidelines. The majority of the children therefore had been protected against diptheria, whooping cough, tetanus, hepatitis B and influenza. The measles vaccine coverage in both divisions was 95.8% with 4.2% not immunized.

Table 3.18: Immunization coverage for children 24-59 months of age in both divisions in Phase 1

Type of immunization		*Akithii N=*		*Uringu N=*		*Both divisions*		*Chi-square statistic and p-values*
		N	**%**	**N**	**%**	**N**	**%**	
BCG	Immunized	260	98.9	256	98.1	516	98.5	X=0.516,p=0.473
	Not immunized	3	1.1	5	1.9	8	1.5	
OPV1	Immunized	260	98.9	257	98.5	517	98.7	X=0.149,p=0.700
	Not immunized	3	1.1	4	1.5	7	1.3	
OPV2	Immunized	258	98.1	256	98.1	514	98.1	X=0.000,p=0.995
	Not immunized	5	1.9	5	1.9	10	1.9	
OPV3	Immunized	256	97.3	255	97.7	511	97.5	X=0.075,p=0.784
	Not immunized	7	2.7	6	2.3	13	2.5	
DPT1/Pentavalent1	Immunized	261	99.2	259	99.2	520	99.2	X=0.000,p=0.997
	Not immunized	2	0.8	2	0.8	4	0.8	
DPT2/Pentavalent2	Immunized	260	98.9	256	98.1	516	98.5	X=0.516,p=0.473
	Not immunized	3	1.1	5	1.9	8	1.5	
DPT/Pentavalent3	Immunized	258	98.9	256	98.1	514	98.1	X=0.000,p=0.995
	Not immunized	5	1.9	5	1.9	10	1.9	
Measles(≥ 9 months)	Immunized	252	95.8	250	95.8	502	95.8	X=0.000,p=0.993
	Not immunized	11	4.2	11	4.2	22	4.2	
Complete immunizations	Fully immunized	249	94.7	254	97.3	503	96.0	X=2.403,p=0.121
	Not fully immunized	14	5.3	7	2.7	21	4.0	

Significance at*p <0.05: Immunization status was confirmed by card & recall

In general, the majority (96%) of the children were fully immunized for their age in both Akithii and Uringu divisions. Full immunization refers to children having received all the required doses of vaccines in the first year of life. There was no significant difference in the immunization coverage in Akithii and Uringu (Table 3.18).

3.6.2 Morbidity Prevalence in Children of 12-59 Months

Prevalence of illnesses in children was determined based on the mothers'/care giver's recall of a two week period prior to the visit. Overall, prevalence of self-reported morbidity among the children in the two divisions was 41.4%. In Akithii division, the prevalence of morbidity was 42.4% in Akithii and 40.4% in Uringu (Table 3.19). The symptoms varied (Table 3.19) ranging from running nose and cough (17.1%) when both divisions were combined. Vomiting was only reported by 1.5% in Akithii. Akithii had a higher proportion of children with upper respiratory infections (83.3%), compared with Uringu at 79.3%.The upper respiratory infections in this study included running nose, cough or a combination of both running nose and coughing. A significant difference between the two divisions in the types of symptoms reported (chi-square, p=0.027) was established. In general, children in Akithii had a higher prevalence of morbidity symptoms compared to those in Uringu.

Table 3.19: Morbidity prevalence among children 12-59 months old in Phase 1

		Akithii		***Uringu***		***Both divisions***		***Chi-square statistic P-values***
		N	%	N	%	N	%	
Illness reported	Sick	111	42.4	105	40.4	216	41.4	X=1.633,p=0.201
	Not sick	151	57.6	155	59.6	306	58.6	
Symptoms reported (multiple responses)#	Running nose and cough	44	16.8	45	17.3	89	17.1	
	Cough	24	9.2	12	4.6	36	6.9	
	Fever	9	3.4	12	4.6	21	4	
	Running nose	12	4.6	8	3.1	20	3.9	X=9.210,p=0.027*
	Diarrhea	3	1.1	10	3.8	13	2.5	
	Running nose and fever	2	0.8	5	1.9	7	1.4	
	Fever and cough	6	2.3	1	0.4	7	1.4	
	Vomiting	4	1.5	0	0	4	1.5	
	Upper respiratory infections	80	83.3	66	75.0	146	79.3	

#multiple responses allowed for the illnesses. Significance* at p <0.05

3.7 INFANT AND CHILD FEEDING PRACTICES

3.7.1 Breastfeeding Practices

Breastfeeding in Akithii and Uringu divisions as reported was almost universal; with breastfeeding initiated in 99.6% of the children at birth (Table 3.20). Exclusive breastfeeding up to the recommended six months, however, was reported to have been practiced at lower rates namely: 23.4% in both divisions; 13.8% in Akithii and 32.9% in Uringu. There was a significant difference in exclusive breastfeeding rates between the two divisions ($p<0.0001$) (Table 3.20). Three quarters (72.4%) of the children in Akithii were exclusively breastfed for less than the recommended 6months compared with 55.8% in Uringu. The divisions combined had an exclusive breastfeeding rate of 23.4%.

About two thirds (61.7%), of the children in both divisions were still breastfeeding at 12-24 months, 58% in Akithii and 65.4% in Uringu. Thirty six percent of children in Akithii were breastfed for 25 months and above compared with 32% in Uringu.

Table 3.20: Breast feeding practices of mothers of children in the study in Phase 1

Breast feeding practices		***Akithii***		***Uringu***		***Both division***		***Chi-square statistic p-values***
		N	%	N	%	N	%	
Breastfeeding	Breastfed	262	99.6	260	99.6	462	99.6	X=0.000, p=0.996
	Never breastfed	1	0.4	1	0.4	2	0.4	
Exclusive breastfeeding rates	Exclusively breastfed < 6months	189	72.4	144	55.8	333	61.4	X=26.281, p<0.0001***
	Exclusively breastfed up to 6months	36	13.8	85	32.9	121	23.4	
	Exclusively breastfed > 6months	2	0.8	3	1.2	5	1.0	
	Not exclusively breastfed	34	13.0	26	10.1	60	11.6	
Continued breastfeeding	Children breastfed 6-12months	15	6.1	7	2.9	22	4.5	X=4.601, p=0.001**
	Children breastfed 12-24 months	142	58.0	159	65.4	301	61.7	
	Children breastfed 25 months and above	88	36.0	77	32.0	165	34.0	

Significance*at p <0.05; ** p<0.01; ***p<0.001

3.7.2 Complementary Feeding Practices

Table 3.21 shows that 39.3% of mothers in both divisions reported to have introduced complementary foods before 6 months of age. Three out of four (75.7%) mothers in Akithii had introduced complementary foods before 6 months compared to 2.9% in Uringu.

In Akithii, complementary foods had been introduced to 23.6% of children 6-8 months of age compared to 65.4% in Uringu. In Akithii about 0.8% of children were introduced to complementary foods after 8 months as compared to 31.7% in Uringu.

Only 16.8% of children 6-12 months in both divisions had achieved the minimum meal frequency of ≥4 times per day.[142] The percentage of children aged 13-23 months who were fed ≥ 4 times per day was high in both divisions as well as for the divisions combined at 42.5%.

Table 3.21: Complementary feeding practices among children in the study in Phase 1

Complementary feeding practices		***Akithii***		***Uringu***		***Both divisions***		***Chi-square statistic P-values***
		N	%	N	%	N	%	
Age of introduction of complementary feeds	<6 months	96	75.7	7	2.9	203	39.3	χ =27.575, p<0.001***
	6-8 months	61	23.6	159	65.4	220	44.5	
	>8 months	2	0.8	77	31.7	79	16.3	
Minimum meal frequency (MMF) for non-breastfeeding children of 4 times a day	**Children 6-12 months**							
	≥4times/day	38	14.4	49	19.1	87	16.8	X=4.713, p=0.095
	<4times/day	223	85.4	207	80.9	430	83.2	
	Children (13-23 months)							
	≥4times/day	92	35.4	127	49.6	219	42.5	X=13.553, P<0.001***
	<4times/day	168	64.6	129	50.4	297	57.5	

Significance*at p <0.05; ** p<0.01; ***p<0.001

There was a significant difference in the age of introduction of complementary feeds in the two divisions (p<0.001). There was also a significant difference (p=0.001) in the attainment of the minimum meal frequency ratio (MMR) for children aged 13-23 months between the two divisions, while there was no significant difference for children aged 6-12 months (p=0.095). Akithii had a significantly lower proportion of children (35.4%) who had achieved the minimum meal frequency of 4 times per day compared to 64.6% in Uringu.

3.8 ANTHROPOMETRIC STATUS OF CHILDREN 24-59 MONTHS

The anthropometric status of children was determined using the World Health Organization's growth standards.[147] (Table 3.22) Mean values of WHZ, WAZ and HAZ were all well below zero, indicative of overall poor nutritional status. Mean values overall were lower in Akithii than in Uringu. There were no significant mean differences in WHZ, WAZ and HAZ between the two divisions.

Table 3.22: Anthropometric status of children of 24-59 months in Akithii and Uringu in Phase 1

Anthropometric indices		Akithii N=245 Boys % (95%CI)	Akithii Girls % (95%CI)	Akithii All % (95%CI)	Uringu N=232 Boys % (95%CI)	Uringu Girls (95%CI)	Uringu All (95%CI)	ANOVA p value
WASTING	WHZ<-2	10.4 (6.1 - 17.4)	5.8 (2.9 - 10.9)	7.9 (5.2 - 11.8)	6.3 (3.1 - 12.4)	5.2 (2.6 - 10.4)	5.7 (3.4 - 9.4)	
	WHZ-2 to -3	(10.4 (6.1 - 17.4)	4.3 (2.0 - 9.1)	7.1 (4.5 - 10.9)	3.6 (1.4 - 8.9)	3.0 (1.2 - 7.4)	3.3 (1.7 - 6.3)	
	WHZ<-3	0.0 (0.0 - 3.2)	1.4 (0.4 - 5.1)	0.8 (0.2 - 2.8)	2.7 (0.9 - 7.6)	2.2 (0.8 - 6.4)	2.4 (1.1 - 5.2)	
	Mean WHZ 95% CI		-0.52 (-0.7 to -0.4)			-0.45 (-0.6 to -0.3)		0.482
UNDERWEIGHT	WAZ <-2	22.7 15.9 - 31.4	20.7 14.8 - 28.3	21.6 16.9 - 27.2	13.8 8.5 - 21.5	14.5 (9.4 - 21.8	14.2 10.3 - 19.2	
	WAZ<-2 to -3	17.3 11.3 - 25.4	17.0 11.6 - 24.3	17.1 12.9 - 22.4	11.9 7.1 - 19.3	9.7 5.6 - 16.2	10.7 (7.4 - 15.4	
	WAZ<-3	5.5 (2.5 - 11.4	3.7 (1.6 - 8.4)	4.5 (2.5 - 7.9)	1.8 (0.5 - 6.4)	4.8 (2.2 - 10.2	3.4 (1.7 - 6.6)	
	Mean WAZ 95% CI		-1.19 (-1.3 - -1.3)			-1.04 (-1.2- -1.1)		0.119
STUNTING	HAZ <-2	37.3 28.8 – 46.6	32.6 25.3 - 40.9	34.7 29.0 - 40.8	28.7 21.0- 37.9)	24.2 17.5 - 32.4	26.3 21.0 - 32.3	
	HAZ -2 to -3	23.6 16.7 - 32.4	27.4 20.6 - 35.5	25.7 20.6 - 31.5	24.1 17.0 -32.9)	16.9 11.4 - 24.5	20.3 15.6 - 25.9	
	HAZ<-3	13.6 (8.4 - 21.3)	5.2 (2.5 - 10.3	9.0 (6.0 - 13.2)	4.6 (2.0 - 10.4	7.3 (3.9 - 13.2	6.0 (3.6 - 9.9)	0.144
	Mean HAZ 95% CI		-1.46 (-1.6- -1.3)			-1.29 (-1.4- -1.1)		

The nutritional status of the children based on the WHZ revealed that 7.9% of the children from Akithii were wasted (WHZ < 2 z-score) compared to 5.7% in Uringu (Table 3.22). There were a higher percentage of boys who were wasted in both divisions compared to girls. In Akithii, 10.4% boys were wasted compared to 6.3% in Uringu. Severe wasting (WHZ<-3 z-score) in Akithii was 0.8% compared to 2.4% in Uringu. The prevalence of wasting was generally found to be higher in boys than in girls.

Twenty-one point six percent of children in Akithii were underweight (WAZ < -2 z-score), compared to 14.2% in Uringu while 4.5% of the children were severely underweight (WAZ < -3 z-score) in Akithii compared to 3.4% in Uringu. In Akithii, boys had a higher rate of underweight compared to girls. Worth noting is that in Uringu, girls were generally more underweight compared to boys. The findings also revealed that 34.7% of children were stunted (HAZ < -2 z-score) in Akithii compared to 26.3% in Uringu, and 9.0% children were severely stunted in Akithii compared to 6% in Uringu. In both divisions, boys had higher rates of stunting compared to girls, with the highest rate of stunting being 37.3% in Akithii. Figure 3.9 shows the graphic comparison of mean WHZ scores in Akithii and Uringu. The mean WHZ score for Akithii was -0.52 (CI:-0.7 to -0.4), while Uringu had a mean of -0.45 (CI:-0.6 to -0.4).

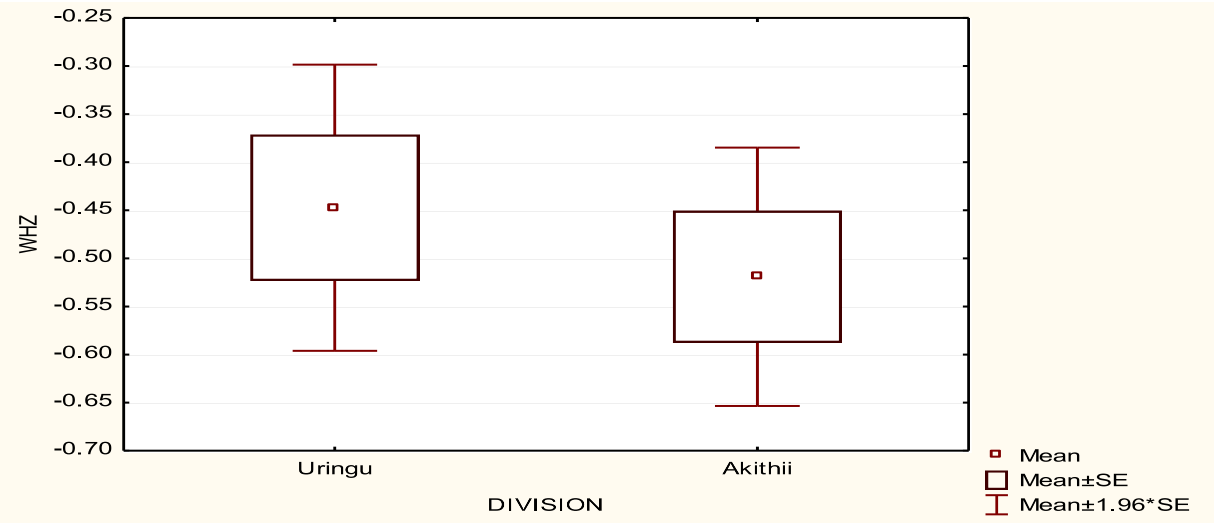

Figure 3.9: Comparison of mean WHZ scores of children in Uringu and Akithii in Phase 1

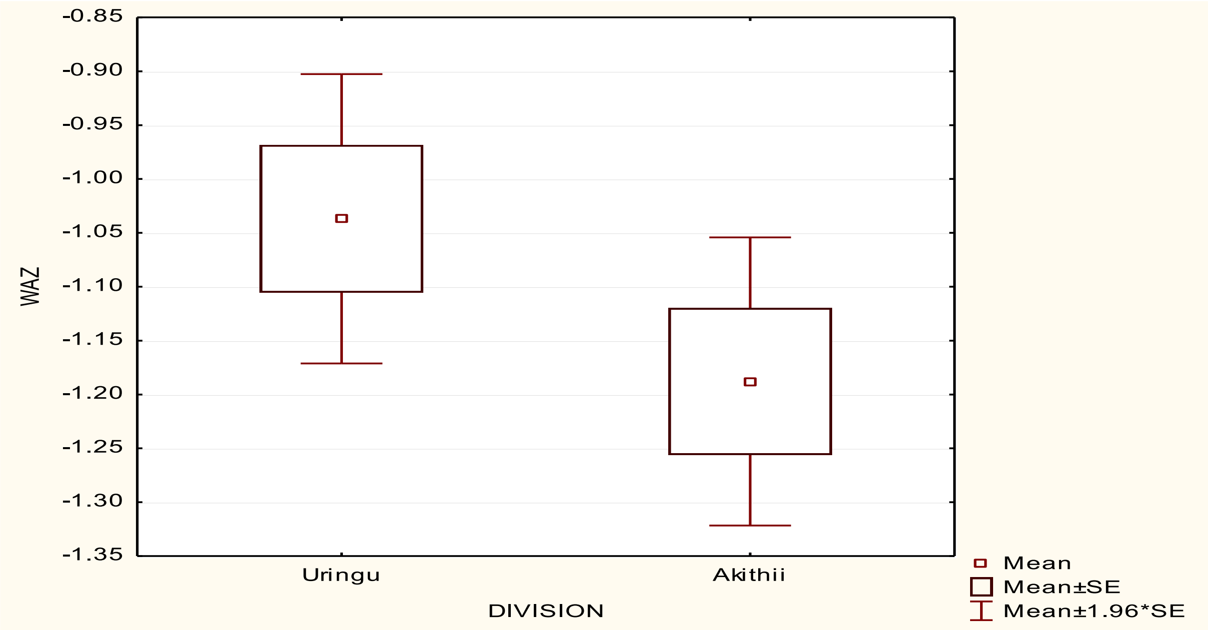

Figure 3.10: Comparison of the mean WAZ scores in Uringu and Akithii in Phase 1

The mean WAZ score for Akithii was -1.19 (CI:-1.3 to -1.3) while Uringu had a mean of -1.04 (CI:-1.2 to -1.0) (Table 3.22). There was no significant difference in WAZ scores between the two divisions (p=0.119). Figure 3.10 shows the graphic comparison of mean WAZ scores in the two divisions.

The mean HAZ score for Akithii was -1.46 (CI:-1.6 to -1.3) while Uringu had a mean of -1.29 (CI:-1.4 to -1.1) (Table 3.22). There was no significant difference in the mean HAZ scores between the two divisions (p=0.144). Figure 3.11 shows the graphic comparison of mean HAZ scores for Akithii and Uringu.

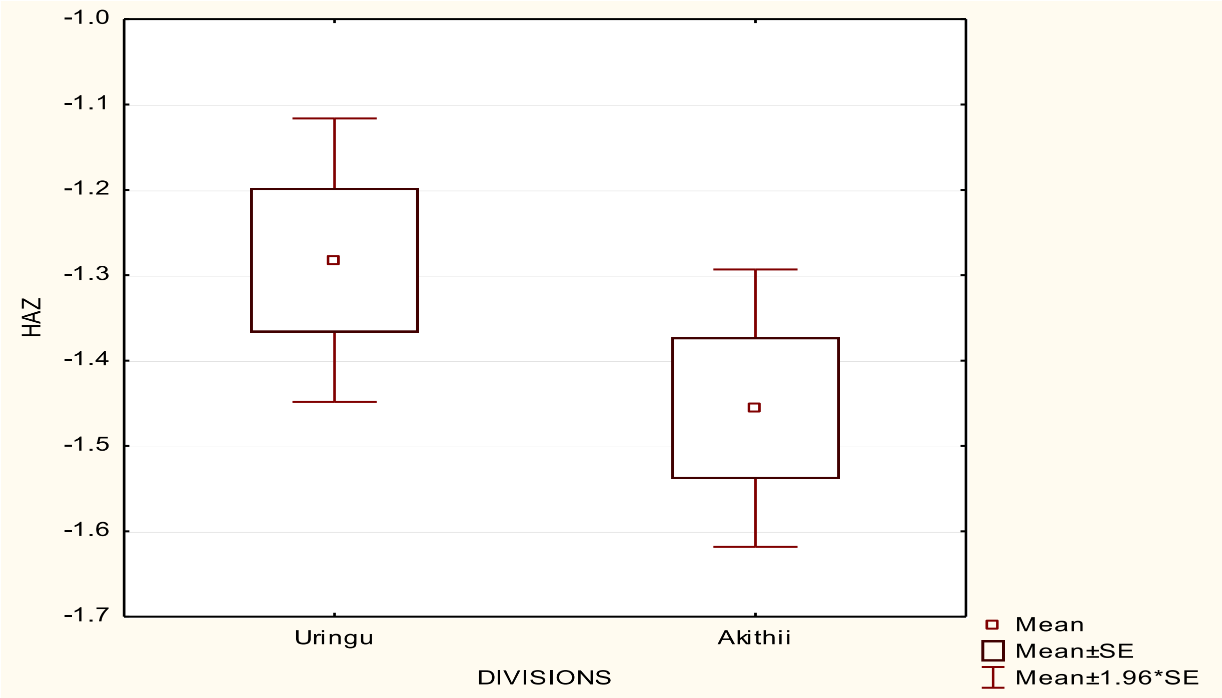

Figure 3.11: Comparison of mean HAZ scores for Uringu and Akithii in Phase 1

3.9. ANTHROPOMETRIC STATUS OF THE MOTHERS/CARE GIVERS

In this study, the anthropometric status of mothers/care givers based on BMI (Table 3.23) revealed that in Akithii and Uringu 17.1% and 14.1% of the sample respectively, had a BMI <18.5, hence being classified as underweight.

The majority (70%) of the mothers/care givers had a BMI of 18.5-24.9 (classified as a normal weight). About one-tenth of the mothers in both Akithii (10.5%) and Uringu (12.4%) were overweight (BMI=25-29.9). Just over 2% of women were classified as being obese (BMI>= 30). Comparison of the mean BMI categories (Table 3.23) of Akithii and Uringu did not show any significant differences between the two divisions (Chi-square, p=0.088).

Table 3.23: Comparison of BMI of mothers/care givers of Akithii and Uringu divisions in Phase 1

	Akithii	*Uringu*	*Both Divisions*	**Pearson. Chi- square p value**
Number (n)	210	234	444	
Mean BMI	21.4	21.8	21.6	p=0.88
(95% CI)	20.9-21.8	21.4-22.3	21.3-21.9	
BMI	%	%	%	
<18.5	17.1	14.1	15.6	
18.5<=24.9	70.0	70.9	70.5	
25<=<29.9	10.5	12.4	11.5	
30<=<34.9	1.0	1.3	1.4	
35 and above	1.4	1.3	1.4	

95% confidence interval

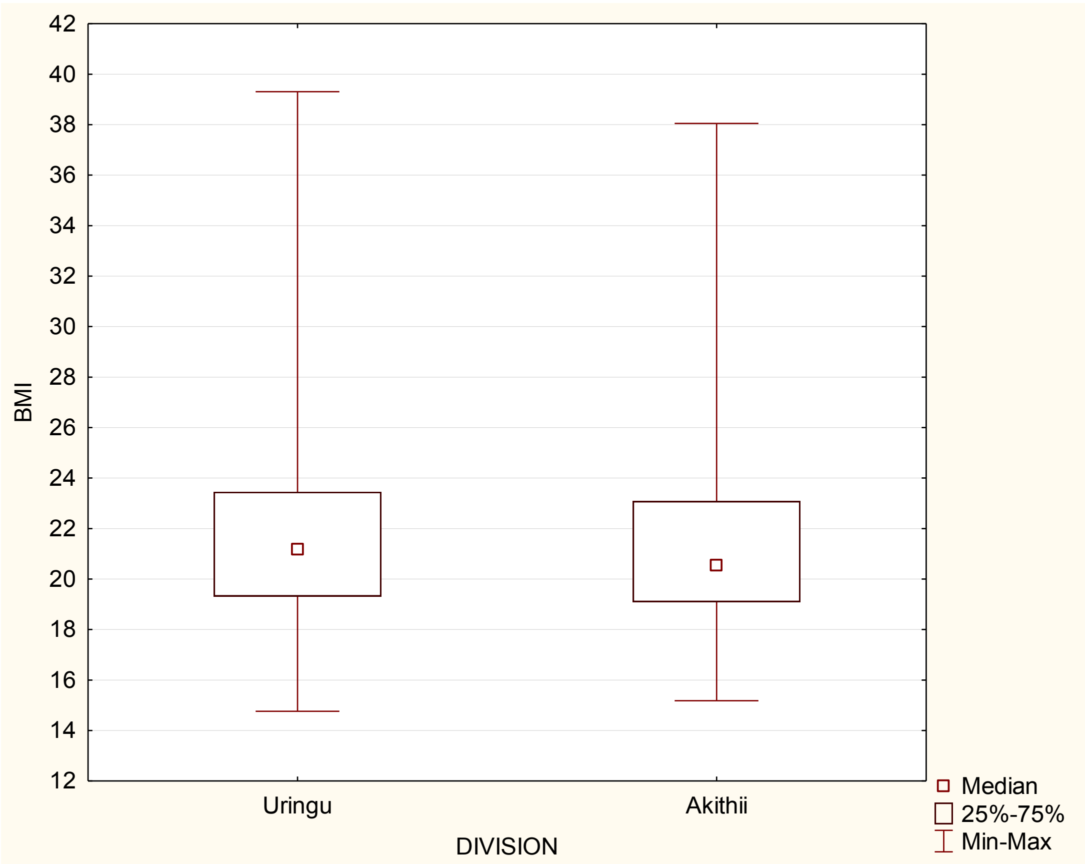

Figure 3.12: Comparison of mean BMI of women in Uringu and Akithii in Phase 1

The mean BMI for Akithii was 21.4 and 21.8 for Uringu. Comparison of the mean BMI categories between Akithii and Uringu did not show any significant differences (Figure 3.12) Mann-Whitney U test, p=0.077.

FINDINGS AT PHASE 2

3.10 DIETARY INTAKE

3.10. 1 Dietary Intake by Repeated 24-Hour Recall (HR)

Dietary data was collected using the repeated 24-hr recall. Comparisons were made between the means of repeated 24-hour recalls using a paired t-test and pooled T-test for comparison between the divisions. Adequacy of nutrient intake was interpreted based on the FAO and WHO [152,156,157,158] recommended dietary intake (RDI) for the study population. RDI do not have a value for carbohydrates, therefore the RDA of the Food and Nutrition Board of the USA was used.[155] Table 3.24 and Table 3.25 shows the findings for macro nutrients in Akithii and Uringu respectively.

Table 3.24: Mean dietary intake of macronutrients of children in the study in Akithii in Phase 2

Nutrient	***24-HR 1***		***24-HR 2***		***Both 24-HRs***		***Paired T-test p value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Energy (kJ)	3755	2144	3853	2411	3808	1914	0.560	4276-5656
Carbohydrate (g)	148	85	150	92	149	74	0.870	130**#**
Added sugar(g)	7.1	14.81	8.1	20.59	7.8	14.54	0.506	No RDI
Total protein (g)	23.3	13.83	24.4	18.19	23.9	13.10	0.384	14-22.2
Animal protein(g)	1.3	3.01	1.6	2.59	1.6	2.40	0.326	No RDI
Vegetable protein(g)	21.5	13.26	22.4	17.28	21.9	12.33	0.524	No RDI
Total fat(g)	14.9	17.18	16.4	21.1	15.9	15.51	0.329	No RDI
Poly-unsaturated fat (g)	4.2	4.99	3.9	5.37	4.1	4.14	0.655	No RDI
Saturated fat (g)	4.9	9.22	6.5	13.81	5.7	9.36	0.066	No RDI
Fiber (g)	16.6	10.71	17.0	13.56	16.9	9.83	0.691	19-25

N= 225; Significance * at p <0.05;p<0.01;***p<0.001; [155,156,157,158]; # RDA; SD=standard deviation**

In Akithii, there were no significant differences between means of 24 hr 1 and 2 in the nutrients in Table 3.24.

Comparison of the mean nutrient intakes of macronutrients with the RDI shows that the respondents consumed inadequate mean energy and fiber intakes. Mean protein intakes appeared to be in the adequate range. Carbohydrate values were above the minimum RDA value of 130g. Mean total fat and animal protein intakes were low.

Table 3.25: Mean dietary intake of macronutrients of children in the study in Uringu in Phase 2

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p, value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Energy (kJ)	4181	1908	4136	2075	4149	1673	0.778	4276-5656
Carbohydrate (g)	154	73	154	75	153	60	0.964	130#
Added sugar(g)	13.2	31.45	12.6	37.52	12.3	24.12	0.854	No RDI
Total protein (g)	25.4	13.14	25.8	14.04	25.5	11.78	0.683	14-22.2
Animal protein (g)	3.2	6.31	2.4	4.83	2.7	4.35	0.093	No RDI
Vegetable protein (g)	21.9	11.02	23.1	12.97	22.5	9.92	0.245	No RDI
Total fat (g)	22.5	20.47	20.7	22.94	22.1	18.39	0.294	No RDI
Poly-unsaturated fat (g)	5.9	5.39	5.9	8.33	6.2	6.40	0.981	No RDI
Saturated fat (g)	5.9	7.62	5.6	7.36	5.7	5.64	0.615	No RDI
Fiber (g)	17.2	8.90	18.6	10.36	17.8	7.97	0.085	19-25

N=221; Significance * at p <0.05;p<0.01;***p<0.001; [155,156,157,158]; # RDA; SD=standard deviation**

There were no significant differences between means of 24-hr 1 and 2 in any of the nutrients in Uringu (Table 3.25). Comparison of the mean nutrient intakes of macronutrients with RDI shows that the respondents consumed an adequate mean protein and carbohydrate intake. Mean energy and fiber intakes were lower than the RDI. Comparisons of the mean intake of micronutrients are shown in Tables 3.26 and 3.27.

Table 3.26: Mean intake of micronutrients of children in Akithii in Phase 2

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Calcium (mg)	140.3	128.42	159.2	171.21	155.22	133.81	0.117	500-600
Iron (mg)	5.4	4.03	5.6	4.92	5.51	3.68	0.541	6.0
Zinc (mg)	3.0	1.82	3.2	2.35	3.11	1.71	0.542	4.1-5.1
Vitamin A (ug)	293.2	480.37	276.6	562.6	287.86	398.71	0.710	400-450
Vitamin C (mg)	36.0	51.41	29.5	48.79	34.01	41.29	0.130	30
Folate (ug)	247.9	190.91	264.6	271.10	257.86	181.87	0.408	160-200
Thiamin (mg)	0.6	0.36	0.6	0.55	0.57	0.36	0.712	0.5-0.6
Riboflavin (mg)	0.3	0.18	0.3	0.49	0.29	0.27	0.181	0.5-0.6
Niacin (mg)	3.1	2.48	3.3	4.72	3.19	2.79	0.438	6-8
Vitamin 6 (mg)	0.5	0.39	0.5	0.52	0.49	0.36	0.901	0.5-0.6
Vitamin B12 (ug)	0.2	0.34	0.2	0.32	0.19	0.29	0.179	0.9-1.2

N=225; Significance* at p <0.05:p<0.01; *** p<0.001; [152]; SD=standard deviation**

There were no significant differences between means of 24-hr 1 and 2 in the micronutrients in Akithii (Table 3.26). Comparison of the mean nutrient intake of micronutrients with RDI show that the respondents consumed less mean calcium, iron, zinc, vitamin A, riboflavin, niacin and vitamin B12, while consumption of vitamin C, folate and other B vitamins appear to be adequate.

Table 3.27: Mean intake of micronutrients of children in Uringu in Phase 2

Nutrient	***24-hr 1***		***24-hr 2***		***Both 24-hrs***		***Paired T-test p value****	***FAO /WHO RDI***
	Mean	SD	Mean	SD	Mean	SD		
Calcium (mg)	206.1	185.3	199.1	159.39	200.4	154.04	0.528	500-600
Iron (mg)	6.06	3.81	6.6	4.09	6.3	3.52	0.037*	6.0
Zinc (mg)	3.5	1.93	3.5	2.15	3.5	1.89	0.625	4.1-5.1
Vitamin A (ug)	363.4	450.6	379.1	631.99	398.2	516.63	0.748	400-450
Vitamin C (mg)	53.7	51.29	60.9	68.46	57.4	47.39	0.162	30
Folate (ug)	246.3	158.13	280.5	185.28	261.3	150.80	0.008**	160-200
Thiamin (mg)	0.6	0.34	0.6	0.31	0.6	0.30	0.555	0.5-0.6
Riboflavin (mg)	0.3	0.26	0.3	0.22	0.3	0.22	0.729	0.5-0.6
Niacin (mg)	4.1	3.10	4.2	3.92	4.2	3.35	0.694	6-8
Vitamin 6 (mg)	0.6	0.52	0.7	0.46	0.6	0.39	0.637	0.5-0.6
VitaminB12 (ug)	0.3	0.52	0.3	0.50	0.3	0.41	0.169	0.9-1.2

N=221; Significance* at p <0.05: *** p<0.001; [152]; SD= standard deviation; SD=significant difference

There were significant differences between means of 24-hr 1 and 2 in iron (p=0.037) and folate (p=0.008) in Uringu (Table 3.27).Comparison of the mean intakes of micronutrients with RDI show that the respondents consumed considerably less calcium, iron, zinc, riboflavin, niacin and vitamin B12, while vitamins A, C, folate, other B vitamins were consumed in adequate amounts.

3.10. 2 Comparison of the Dietary Intake by Repeated 24-hour (hr) Recall of Akithii and Uringu in Divisions

Comparison of the mean nutrient intakes of the macronutrients and micronutrients between the two divisions was done and is shown in Table 3.28.

Table 3.28: Comparison of mean dietary intake of macronutrients of children in the study in Phase 2

Nutrient	*Akithii*		*Uringu*		*Pooled T-test p value**	*FAO/WHO RDI*
	Mean	SD	Mean	SD		
Energy (KJ)	3808	1914	4149	1673	0.038*	4276-5656
CHO (g)	149	74	153	60	0.528	130**#**
Added sugar (g)	7.8	14.54	12.3	24.12	0.013*	No RDI
Total protein (g)	23.9	13.10	25.5	11.78	0.158	14-22.2
Animal protein (g)	1.6	2.40	2.7	4.35	P<0.001***	No RDI
Vegetable protein (g)	21.9	12.33	22.5	9.92	0.586	No RDI
Total fat (g)	15.9	15.51	22.1	18.39	P<0.001***	No RDI
Poly-unsaturated fat (g)	4.1	4.14	6.2	6.40	P<0.001***	No RDI
Saturated fat (g)	5.7	9.36	5.7	5.64	0.977	No RDI
Fiber (g)	16.9	9.83	17.8	7.97	0.287	19-25

Akithii (N=239); Uringu (N=233) Significance* at p <0.05:p <0.01: *** p<0.001; [155, 156, 157,158]; SD= standard deviation**

Comparison between Akithii and Uringu showed that there were significant differences in the mean dietary intakes of energy (p=0.038), added sugar (p=0.013), animal proteins (p<0.001), total fat (p<0.001) and polyunsaturated fat (p<0.001) with Uringu having the higher intakes. Akithii had lower dietary intakes for all the macronutrients. Comparison of the mean nutrient intakes of macronutrients with RDI shows that the respondents in both divisions had low mean energy and fiber intakes. Mean protein intakes were low and vegetable protein intakes were high.

Table 3.29: Mean intake of micronutrients of children in Akithii and Uringu divisions in Phase 2

Nutrient	*Akithii*		*Uringu*		*Pooled T-test p value**	*FAO/WHO RDI*
	Mean	SD	Mean	SD		
Calcium (mg)	155.22	133.81	200.4	154.04	P<0.001***	500-600
Iron (mg)	5.51	3.68	6.3	3.52	0.013*	6.0
Zinc(mg)	3.11	1.71	3.5	1.89	0.015**	4.1-5.1
Vitamin A (ug)	287.86	398.71	398.2	516.63	0.009**	400-450
Vitamin C(mg)	34.01	41.29	57.4	47.39	P<0.001***	30
Folate (ug)	257.86	181.87	261.3	150.80	0.821	160-200
Thiamin (mg)	0.57	0.36	0.6	0.30	0.356	0.5-0.6
Riboflavin (mg)	0.29	0.27	0.3	0.22	0.025*	0.5-0.6
Niacin (mg)	3.19	2.79	4.2	3.35	P<0.001***	6-8
Vitamin B6 (mg)	0.49	0.36	0.6	0.39	P<0.001***	0.5-0.6
Vitamin B12 (ug)	0.19	0.29	0.3	0.41	0.002**	0.9-1.2

Akithii (N=239); Uringu (N=233); Significance* at p <0.05:p <0.01: *** p<0.001; [152;] SD=standard deviation**

Comparison between Akithii and Uringu showed that there were significant differences in the mean dietary intakes of most of the nutrients apart from folate (p=0.821) and Thiamin (p=0.356). Akithii had lower mean dietary intakes of all the micronutrients compared to Uringu. Comparison with the RDI showed that calcium, zinc, vitamin A, riboflavin, niacin and vitamin B12 were lower in both divisions. However vitamin B6 and iron were also lower in Akithii.

3.10. 3 Comparison of the Dietary Intake by Repeated 24-hour (hr) Recall of Akithii and Uringu in both Phases

Comparison of the mean nutrient intakes of the macronutrients and micronutrients between the two divisions in both Phases was done and shown in Tables 3.30 and Table 3.31.

Table 3.30: Comparison of mean intake of macronutrients in both divisions combined in both Phases

Nutrient	***Akithii***		***Uringu***		***Pooled T-Test P value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD		
Energy (KJ)	3599	2002	3908	1650	0.008***	4276-5656
CHO (g)	138	71	143	58	0.209	130#
Added sugar(g)	6.5	15.21	9.1	19.93	0.024*	No RDI
Total protein (g)	22.2	12.81	23.8	11.98	0.048*	14-22.2
Animal protein (g)	1.5	2.78	2.4	10.37	P<0.001***	No RDI
Vegetable protein (g)	20.5	11.99	20.5	10.37	0.936	No RDI
Total fat (g)	16.7	19.60	21.6	18.10	P<0.001***	No RDI
Poly-unsaturated fat (g)	4.5	5.11	6.4	6.03	P<0.001***	No RDI
Saturated fat (g)	4.9	7.69	5.3	5.53	0.303	No RDI
Fiber(g)	15.3	8.95	16.7	7.74	0.009***	19-25

Akithii (N=479); Uringu (N=479); Significance* at p <0.05;p<0.01;***p<0.001; [155, 156, 157,158]; SD=standard deviation**

Comparison between Akithii and Uringu showed that there were significant differences in all the macronutrients with the exception of carbohydrates (p=0.209), plant protein (p<0.936) and saturated fats (p=0.303). Apart from plant proteins, Akithii had lower mean intakes of all the macronutrients. Comparison with the RDI showed that the consumption of energy and fiber were low. Mean protein and carbohydrate intakes were above the minimum requirements.

Table 3.31: Comparison of mean intake of micronutrients in both divisions combined in both Phases

Nutrient	***Akithii***		***Uringu***		***Pooled T-test p value****	***FAO/WHO RDI***
	Mean	SD	Mean	SD		
Calcium (mg)	150.8	121.82	198.5	145.49	P<0.001***	500-600
Iron (mg)	5.07	3.27	5.9	3.19	P<0.001***	6.0
Zinc (mg)	2.9	1.63	3.3	1.86	P<0.001***	4.1-6.1
Vitamin A (ug)	435.4	517.2	496.2	532.78	0.070	400-450
Vitamin C (mg)	35.9	39.96	59.5	49.32	P<0.001***	30
Folate (ug)	222.2	208.82	236.1	170.57	0.252	160-200
Thiamin(mg)	0.6	0.47	0.6	0.38	0.214	0.5-0.6
Riboflavin (mg)	0.3	0.45	0.3	0.38	0.036*	0.5-0.6
Niacin(mg)	3.2	4.24	4.4	4.51	P<0.001***	6-8
Vitamin B6 (mg)	0.5	0.38	0.6	0.41	P<0.001***	0.5-0.6
Vitamin B12 (ug)	0.2	0.61	0.3	0.37	0.072	0.9-1.2

Akithii (N=479); Uringu (N=479; Significance* at p <0.05;p<0.01;***p<0.001; [152;] SD = standard deviation**

Comparison between Akithii and Uringu (Table 3.31) showed that there were significant differences in all the micronutrients between the 2 divisions, with the exception of vitamin A (p=0.07), folate (p<0.252), thiamin (p=0.214) and vitamin B12 (p=0.072). Apart from thiamin and riboflavin, Akithii had lower mean dietary intakes of all the micronutrients compared to Uringu. Comparison with the RDI shows that the consumption of vitamin A, C and folate were above the recommended while the mean of thiamin and vitamin B6 were not. The consumption of all the other micronutrients was below the RDI.

3.10.4 Nutrient Adequacy of the Children's Dietary Intake

Nutrient adequacy is illustrated by means of nutrient adequacy ratios (NARs) with 100% being the ratio that completely meets the RDI (refer to 3.10.2). Children in Uringu consumed consistently higher amounts of macronutrients and micronutrients than those in Akithii (Table 3.32).

The lowest NAR values were found for vitamin B12 and calcium. Vitamin B12 values were less than 25% of the requirement and calcium less than 40%. Energy and protein adequacy ratios were all less than 50% of the RDI. The highest NARs of 70% and above were found in vitamin B6, Thiamin, folate and iron. When combining the 11 micronutrients to give a MAR, it was found that the mean adequacy ratio for all the micronutrients was at 56.3 ± 23.2 for Akithii and 67.4 ± 17.7 for Uringu.

Table 3.32: Comparison of nutrient adequacy ratios (NARs) in Akithii and Uringu in Phase 2

NAR# (%)	*Akithii*		*Uringu*		*Both divisions combined*		*Independent T-test p-value*
	Mean	SD	Mean	SD	Mean	SD	
Energy (kJ)	40.9	20.42	44.5	17.48	42.7	19.00	0.04*
Protein	48.7	26.61	52.0	24.02	49.3	22.33	0.15
Vitamin A	44.8	39.14	61.5	33.70	53.1	37.44	0.001***
Vitamin B6	71.0	30.25	85.5	21.36	78.3	27.11	0.001***
Vitamin B12	18.4	23.41	25.7	28.31	22.0	26.22	0.002***
Vitamin C	55.0	41.60	81.9	31.94	68.4	39.44	0.001***
Calcium	29.2	23.62	36.5	22.93	32.9	23.55	0.001***
Folate	85.4	23.71	92.3	17.42	88.9	21.03	0.001***
Iron	72.0	29.50	83.0	20.13	77.5	24.83	0.001***
Niacin	46.8	28.42	57.8	25.65	52.3	27.67	0.001***
Riboflavin	50.4	26.51	58.4	24.54	54.4	25.85	0.001***
Thiamin	80.7	23.93	87.4	18.73	84.1	21.76	0.001***
Zinc	65.1	27.62	71.8	22.66	68.4	25.48	0.003**
MAR##	**56.3**	**23.23**	**67.4**	**17.76**	**61.8**	**21.39**	0.001***

Akithii (N=239); Uringu (N=239) Significance *at p <0.05; ** p<0.01; ***p<0.001; #= Nutrient adequacy ratio truncated; ##=Mean adequacy ratio; SD=standard deviation

Comparison of the means of the two divisions showed significant differences in all the NARs with the exception of protein (p=0.15).

3.10.5 Foods and Food Groups Commonly Consumed by the Children

Findings of the analysis of foods that were commonly consumed by the children in the two divisions are shown in Table 3.33. The most commonly consumed food and drinks was brewed tea, maize meal (*ugali*) with 80.7% consumers in Akithii and 85.3% in Uringu. Other foods in both divisions that had more than 50% children consuming them were maize and beans (*githeri*), milk, porridge, sugar and tea.

Table 3.33: Foods commonly consumed by children in Akithii and Uringu divisions in Phase 2

Type of food	***Akithii***			***Uringu***		
	% Consumers	Mean portion size consumers (g)	Per capita amount (g)	% Consumers	Mean portion size consumers (g)	Per capita amount (g)
Brewed tea	90.79	454.84	412.97	88.70	407.56	361.52
Maize meal *(ugali)*	80.75	227.28	183.53	85.36	211.73	180.72
Maize & beans (*githeri)*	76.57	317.12	242.82	84.52	61.40	51.90
Milk	75.31	58.86	44.33	84.52	61.40	51.90
Porridge	58.58	437.34	256.18	46.44	338.61	157.26
Sugar	51.05	14.30	7.30	57.32	14.30	8.20
Onions	32.22	29.48	9.50	41.00	44.68	18.32
Mango	23.85	198.89	47.43	33.47	159.80	53.49
Boiled rice with beans	22.18	206.62	45.82	22.59	152.08	34.36
Tomato fried	21.76	62.21	13.54	30.96	63.44	19.64
Spinach & potato	16.32	89.05	14.53	8.79	73.71	6.48
Beans (dry)	15.06	110.68	16.67	14.23	127.32	18.11
Kales	13.39	114.23	15.29	8.79	131.19	11.53
Pigeon pea leaves	13.39	83.91	11.23	22.18	71.43	15.84
Banana	9.21	171.91	15.82	21.76	173.62	37.77

As indicated in Table 3.33, almost all the children were fed some kind of a cereal, root or tuber in the two divisions. A higher percent of children in Uringu consumed milk, githeri, mangoes, tomatoes, pigeon pea leaves and bananas while more children in Akithii consumed porridge, spinach with potatoes and kales. Apart from milk, no other animal products were found on the list of commonly consumed foods.

Findings on food groups consumed are presented in Table 3.34. Uringu had a significantly higher percentage of children consuming vitamin A rich fruits and vegetables (p=0.01); other fruits and vegetables (p=0.02); sugars (p=0.03) and beverages (p=0.04) compared to children in Akithii. A smaller percentage of children in Akithii consistently consumed from all the other food groups compared to those in Uringu.

Table 3.34: Percent of children consuming different food groups in Phase 2

Food group	*Akithii %*	*SE*	*Uringu %*	*SE*	*Both %*	*SE*	*Indep. T-test p-value*
Cereals/roots/tubers	98.9	0.68	98.2	0.9	98.6	0.5	0.62
Vitamin A fruits & vegetables	59.6	0.5	78.0	0.07	68.8	5.3	0.01*
Other fruits & vegetables	23.1	4.9	52.0	1.3	37.5	8.6	0.02*
Sugars/syrup/ sweets	45.3	0.9	56.5	1.4	50.9	3.3	0.03*
Legumes & nuts	28.8	6.3	44.6	4.3	36.7	5.5	0.17
Meat, poultry, fish	0.6	0.2	2.2	1.7	1.4	0.8	0.54
Fats & oils	13.7	0.1	11.7	0.3	12.7	0.6	0.06
Dairy products	61.9	2.1	78.7	0.2	70.3	4.9	0.07
Eggs	0.7	0.2	0.9	0.01	0.8	0.1	0.52
Beverages	1.0	0.3	1.5	0.4	2.5	0.7	0.04*

Significance * at p <0.05; ** p<0.01; SE = standard error

3.10.6 Dietary Diversity Score

Table 3.35 shows that Akithii had a mean DDS of 2.9 ± 1.0 and Uringu had a mean score of 3.7 ± 1.1, while the average for both divisions was 3.3.

Table 3.35: Dietary diversity scores of children in the study in Phase 2

	Akithii	***Uringu***	***Both divisions***	***Independent T-test p-value***
Mean DDS	2.9	3.7	3.3	p=0.0001***
SD	1.0	1.1	1.1	
SE	0.1	0.1	0.1	
Lower 95%	2.7	3.6	3.2	
Upper 95%	3.0	3.8	3.4	

Akithii (N=239); Uringu (N=233); Significance * at p <0.001; SD =standard deviation; SE = standard error**

There was a significant difference in mean DDS between Akithii and Uringu (p<0.001). Children in Akithii consumed a less diversified diet compared to those in Uringu though both divisions did not meet the minimum acceptable dietary diversity score of four. A comparison of children who attained the minimum DDS are shown in Figure 3.12.

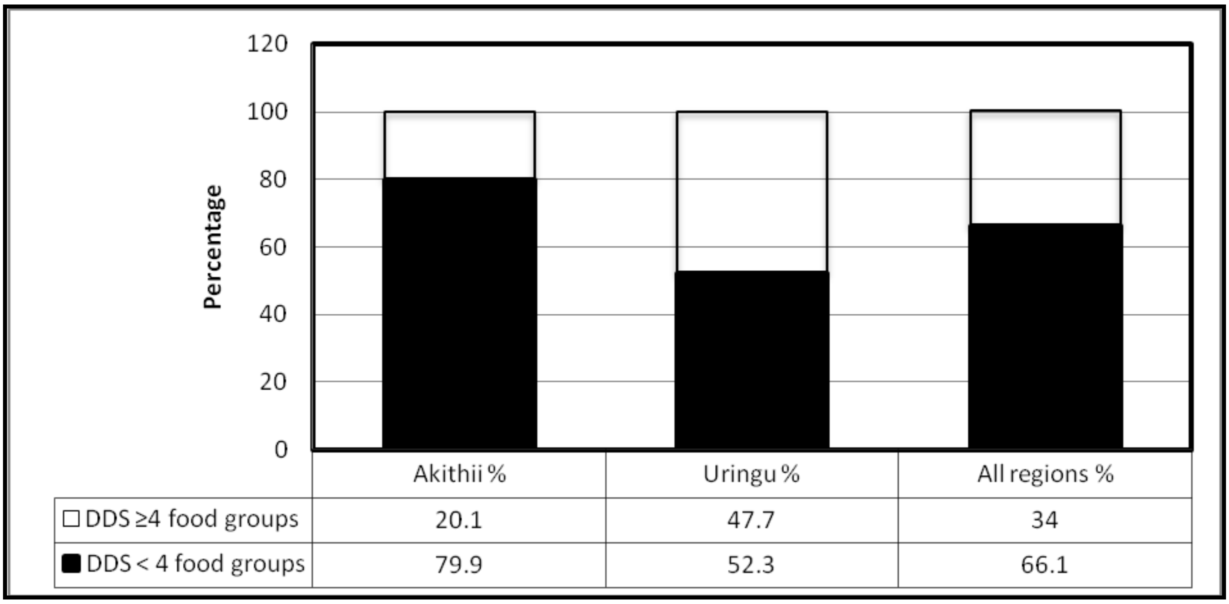

Figure 3.13: Dietary diversity score of children by divisions in Phase 2

About one-third (34%) of children in the two divisions had a minimum DDS equal or greater than 4, whereas 66.1% had a dietary diversity score lower than 4. More than three quarters (79.9%) of the children in Akithii consumed diets with a dietary diversity score of less than four (Figure3.12) compared to Uringu where about half (52.3%) consumed diets with a dietary diversity score of less than four.

A comparison of the dietary diversity in Akithii and Uringu showed that there was a significant difference between the two divisions (chi-square test, $p<0.001$). Children in Akithii consumed a less diversified diet as compared to Uringu.

The DDS was significantly correlated to MAR and NARs for all the nutrients studied (Spearman rank, $p<0.001$) in the divisions in the study. This means that an increase in the DDS led to an increase in NARs and MAR.

3.10.7 Correlating Nutrient Adequacy Ratios with Mean Adequacy Ratio

The MAR was correlated with the NARs of all the nutrients studied using the Spearman rank correlation. There was a significant positive correlation ($p<0.001$) for each correlation (Table 3.36).

Table 3.36: Correlation of nutrient adequacy with the mean adequacy ratios of 11 nutrients in Phase 2

Correlation of each NAR	***Akithii***			***Uringu***		
with MAR	**Spearman R**	**T(n-2)**	**p-value**	**Spearman R**	**T(n-2)**	**p-value**
Energy (kJ)	0.8	24.6	0.001***	0.7	15.2	0.001***
Protein	0.8	22.8	0.001***	0.8	18.8	0.001***
Vitamin 12	0.6	11.3	0.001***	0.5	9.9	0.001***
Vitamin C	0.7	17.4	0.001***	0.6	12.4	0.001***
Calcium	0.9	32.5	0.001***	0.8	23.3	0.001***
Folate	0.7	14.8	0.001***	0.5	7.8	0.001***
Iron	0.9	26.5	0.001***	0.8	19.1	0.001***
Niacin	0.9	38.5	0.001***	0.8	23.6	0.001***
Riboflavin	0.9	34.8	0.001***	0.9	28.5	0.001***
Thiamin	0.8	22.5	0.001***	0.7	14.6	0.001***
Zinc	0.9	29.3	0.001***	0.8	22.8	0.001***

Akithii (N=239); Uringu (N=233); Significance * at p <0.001**

3.11 HOUSEHOLD FOOD SECURITY

Household food security was assessed by the Household Food Insecurity Access Scale (HFIAS) developed by Coates et al.[70]

3.11.1 Measuring Household Food Security in the Two Divisions

Table 3.37 shows the mean HFIAS score of the two divisions; Akithii had a mean HFIAS score of 12.54, while Uringu had a score of 9.25. This shows that Akithii had a higher level of food insecurity compared to Uringu with the higher score indicating a more insecure household food situation. The difference between the divisions was statistically significant (P<0.0001).

Table 3.37: Household food insecurity access scale score of households in the two divisions in Phase 2

HFIAS	***Akithii***	***Uringu***	***Both divisions***	***Independent T-test p-value***
Mean	12.5	9.3	10.9	0.0001***
SD	7.80	7.02	7.42	
SE	0.556	0.442	0.499	

Akithii (N=239); Uringu (N=233); Significance * at p <0.001: HFIAS=0-27; SD = standard deviation, SE= standard error**

The HFIAP indicator was used to categorize the households in the two divisions into the four levels of food insecurity used internationally.[70] The findings showed that 15% of the households were food secure while the majority (50%) were categorized as severely food insecure (Figure 3.14).

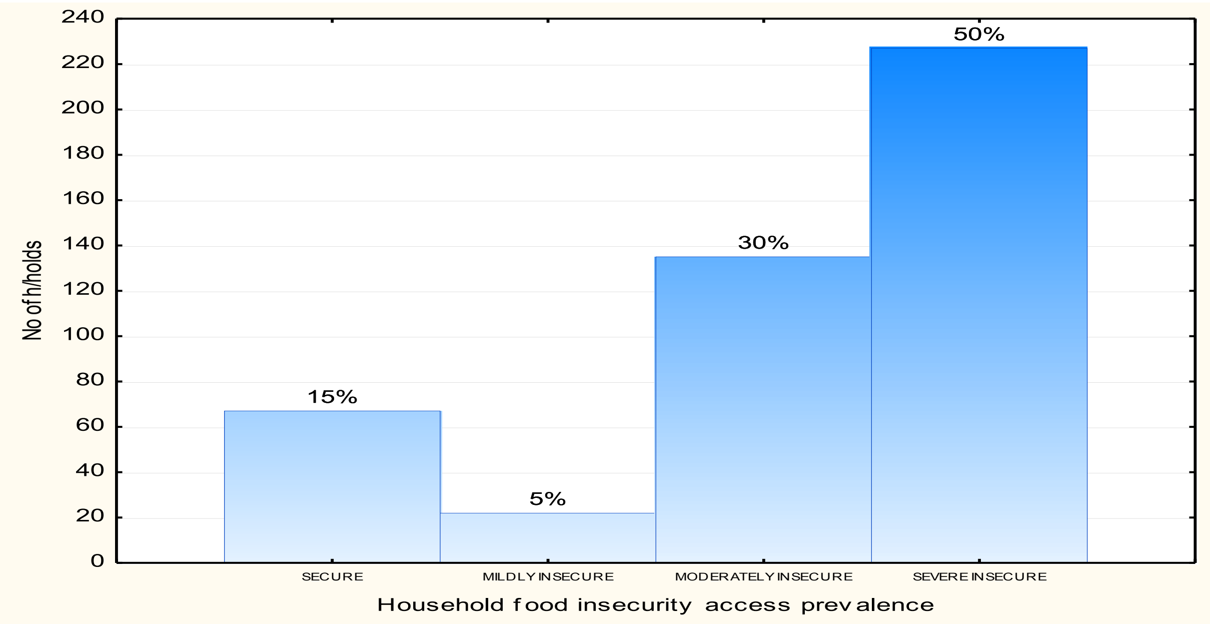

Figure 3.14: Household food insecurity access prevalence categories for the two divisions in Phase 2

In Akithii division, 11% of the households were found to be food secure and 58% severely food insecure (Figure 3.15).

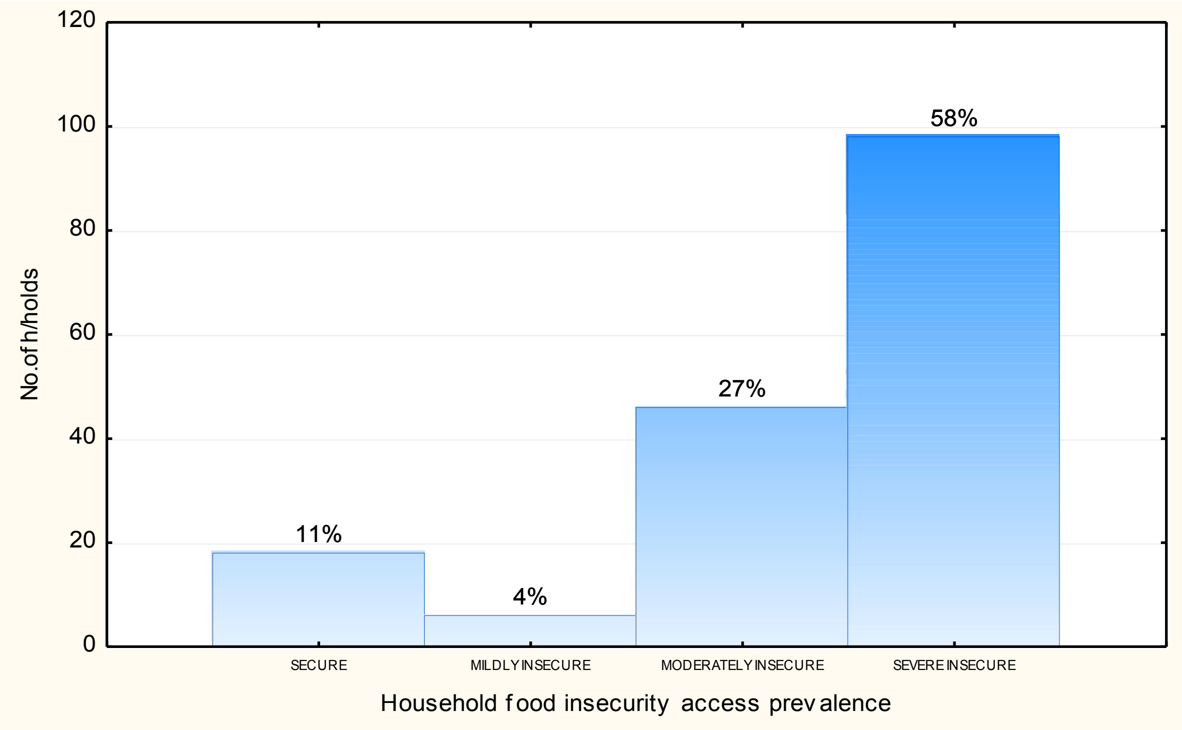

Figure 3.15: Household food insecurity access prevalence categories in Akithii division in Phase 2

In the Uringu division, 18% of the households were found to be food secure and 42% severely food insecure (Figure 3.16).

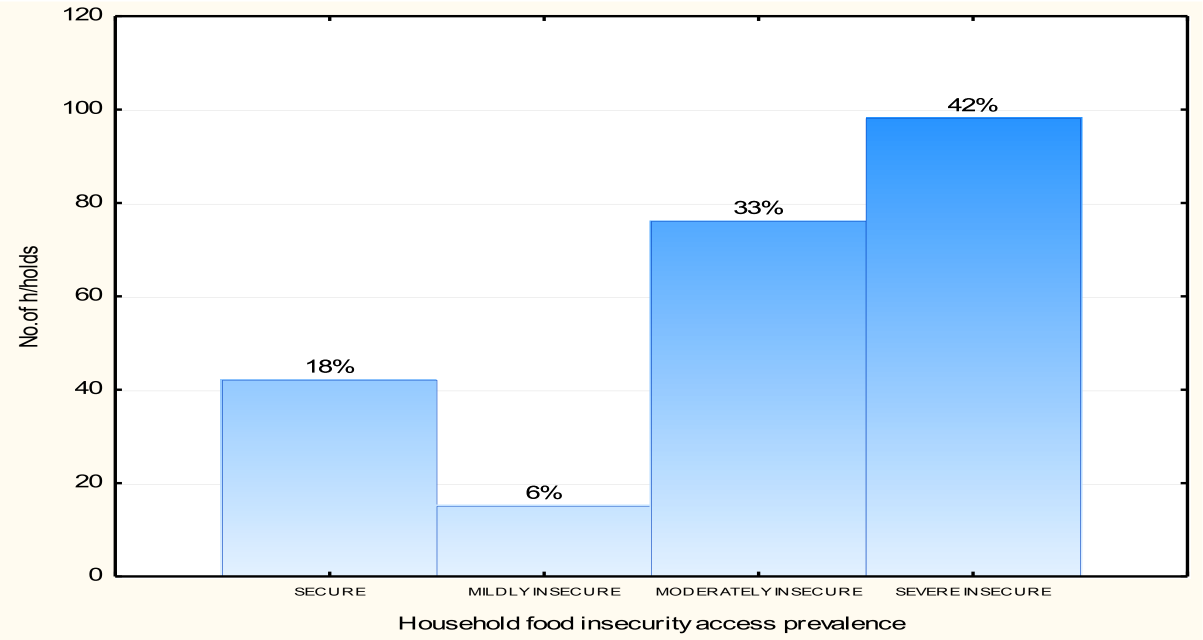

Figure 3.16: Household food insecurity access prevalence categories in Uringu division in Phase 2

3.12 ANTHROPOMETRIC STATUS OF CHILDREN OF 24-59 MONTHS

The anthropometric status of the children based on the WHZ revealed that 4.6% of children from Akithii were wasted (WHZ < 2 z-score) compared with 8.8% of Uringu children (Table 3.38). There was a higher rate of boys who were wasted compared to girls in both divisions. In Akithii, 4.9% boys were wasted compared to 12.8% in Uringu. The prevalence of wasting was generally higher in Uringu compared with Akithii in both boys and girls except in severe wasting. Sixteen point seven percent of the children in Akithii were underweight (WAZ < -2 z-score), compared with 20.2% in Uringu. About 5.4% of children were severely underweight (WAZ < -3) in Akithii compared to 3.4% in Uringu. In Akithii, boys had a higher rate of underweight compared to girls. Worth noting is that apart from severe underweight, Uringu had higher levels of underweight than Akithii. The findings also revealed that 31.9% of the children were stunted (HAZ < -2 z-score) in Akithii compared to 28.2% in Uringu. Approximately 9.6 % children were severely stunted in Akithii compared to 6.7% in Uringu. In Akithii, boys had higher rates of stunting compared to girls while in Uringu girls had higher rates of stunting than boys.

Table 3.38: Anthropometric status of children of 24-59 months in Akithii and Uringu in Phase 2

Anthropometric indices		Akithii N=245 Boys % (95%CI)	Akithii Girls % (95%CI)	Akithii All % (95%CI)	Uringu N=232 Boys % (95%CI)	Uringu Girls (95%CI)	Uringu All (95%CI)	ANOVA p value
WASTING	WHZ<-2	4.9 (2.1 - 11.0)	4.3 (1.4 - 12.6)	4.6 (2.4 - 8.5)	12.8 (7.8 - 20.4)	5.4 (2.6 - 10.7)	8.8 (5.8 - 13.1)	
	WHZ-2 to -3	4.9 (2.1 - 11.0)	3.6 (1.2 - 10.6)	4.2 (2.2 - 7.8)	12.8 (7.8 - 20.4)	5.4 (2.6 - 10.7)	8.8 (5.8 - 13.1)	
	WHZ<-3	0.0 (0.0 - 3.6.)	0.7 (0.2 - 2.2)	0.4 (0.2 - 0.8)	0.0 (0.0 - 3.4)	0.0 (0.0 - 2.9)	0.0 (0.0 - 1.6)	
	Mean WHZ 95% CI	0.43 (-0.6--0.3)			0.53 (-0.7- -0.4)			0.343
UNDERWEIGHT	WAZ <-2	18.6 (12.3 – 27.3)	15.3 (4.6 - 40.3)	16.7 (8.5 - 30.2)	21.3 (14.6 -29.9)	19.2 (13.4 - 6.8)	20.2 (15.6-25.7)	
	WAZ<-2 to -3	10.8 (6.1 - 18.3)	11.7 (3.6 - 31.8)	11.3 (5.8 - 20.7)	15.7 (10.1 - 23.8)	17.7 (12.1 -25.2)	16.8 (12.6-22.1)	
	WAZ<-3	7.8 % (4.0 – 14.7)	3.6 % (1.2 - 10.7)	5.4 % (2.8 - 10.1)	5.6 % (2.6 - 11.6)	1.5 % (0.4 - 5.4)	3.4 (1.7-6.5)	
	Mean WAZ 95% CI	1.13 (-1.3 - -1.0)			-1.09 (-1.2- -1.0)			0.707
STUNTING	HAZ <-2	36.4 (28.0 - 45.7)	28.4 (17.5 - 42.5)	31.9 (23.4 - 41.7)	25.9 (18.6 - 34.9)	30.0 (22.8 - 38.4)	28.2 (22.8 -34.2)	
	HAZ -2 to -3	22.7 (15.9 - 31.4)	22.0 (16.8 -28.3)	22.3 (19.1 - 25.9)	19.4 (13.1 -27.9)	23.1 (16.7 - 31.0)	21.4 (16.7 - 7.1)	
	HAZ<-3	13.6 (8.4 - 21.3)	6.4 (2.1 - 17.8)	9.6 (5.1 - 17.1)	6.5 (3.2 - 12.8)	6.9 (3.7 - 12.6)	6.7 (4.2 - 10.6)	
	Mean HAZ 95% CI	-1.44 (-1.6 - -1.3)			-1.29 (-1.5- -1.1)			0.203

Mean values of WHZ, WAZ and HAZ were all well below zero which is indicative of overall poor nutritional status. Mean values overall were lower in Akithii than in Uringu. There were no significant differences in the means for WHZ, WAZ, and HAZ scores between the two divisions.

Figure 3.17 shows the graphic comparison of mean WHZ scores in Akithii and Uringu. The mean WHZ scores for Akithii was -0.43 (CI:-0.6 to -0.3), while Uringu had a mean of -0.53 (CI: -0.7 to -0.4).

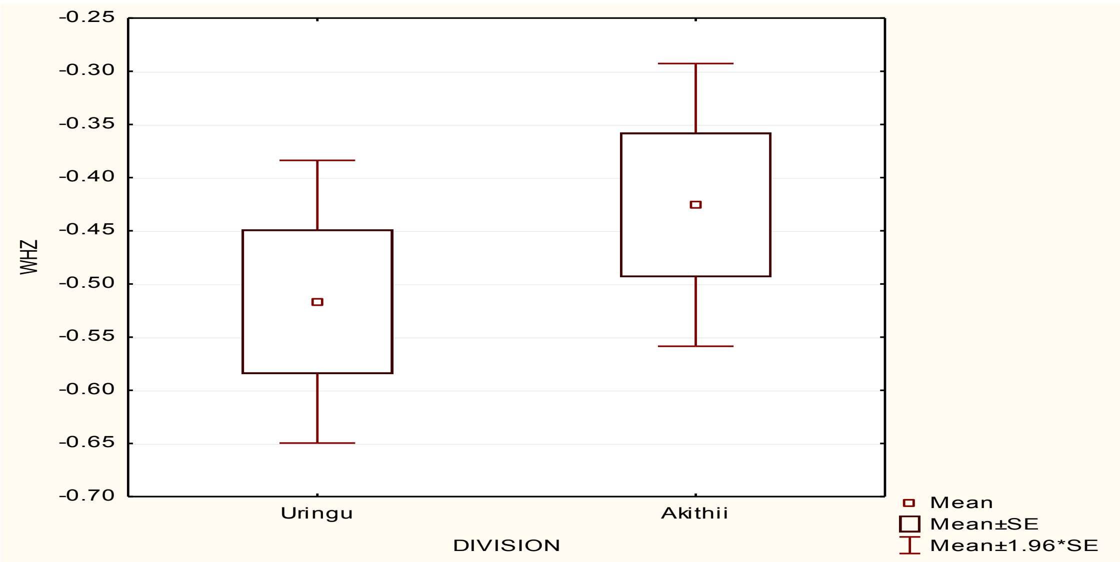

Figure 3.17: Comparison of WHZ scores of children at Uringu and Akithii in Phase 2

The mean WAZ score for Akithii was -1.13 (CI: -1.3 to -1.0) while Uringu had a mean of -1.09 (CI: -1.2 to -1.0) (Table 3.38) There was no significant difference in the mean WAZ scores between the two divisions (p=0.707). Figure 3.18 shows the graphic comparison of WAZ scores for Akithii and Uringu.

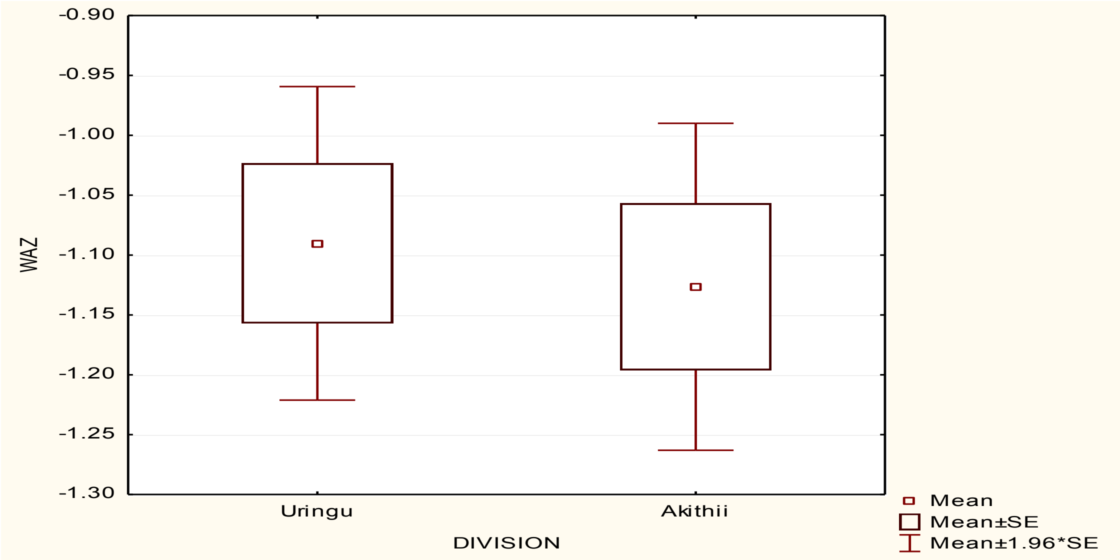

Figure 3.18: Comparison of WAZ scores for children in Uringu and Akithii in Phase 2

The mean HAZ score for Akithii was -1.44 (CI: -1.6 to -1.3) while Uringu had a mean of -1.29 (CI: -1.5 to -1.1) (Table 3.38) There was no significant difference in the mean HAZ scores between the two divisions (p=0.203) Figure 3.19 shows the graphic comparison of WAZ scores for Akithii and Uringu.

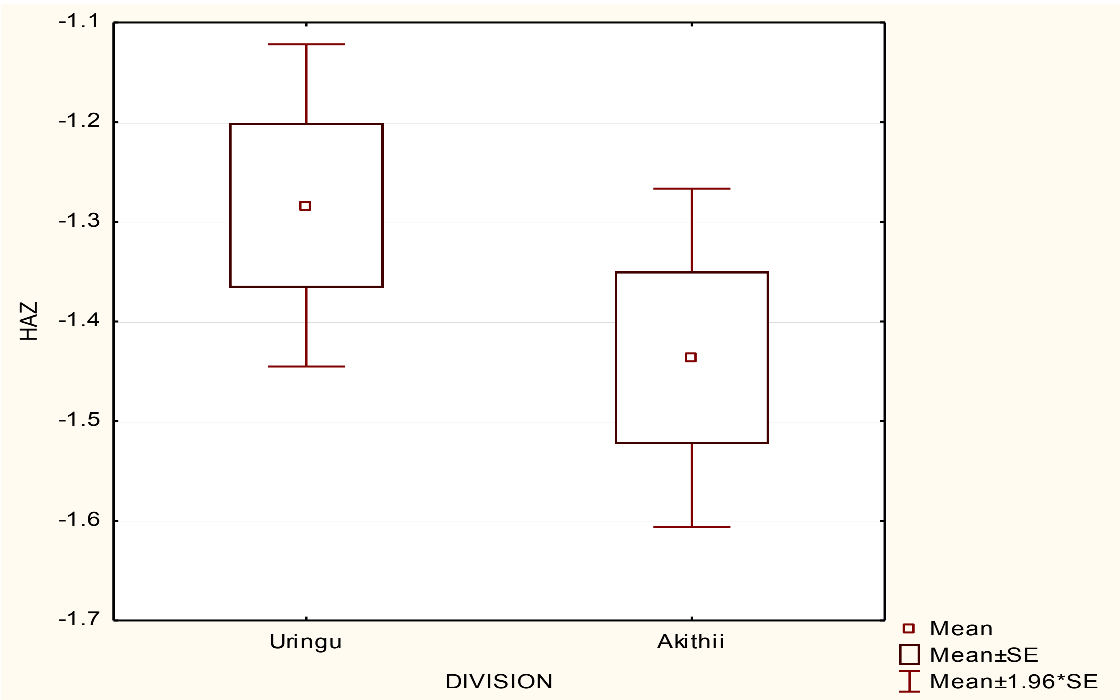

Figure 3.19: Comparison of HAZ scores of children in Akithii and Uringu in Phase 2

3.13 ANTHROPOMETRIC STATUS OF THE MOTHERS/CARE GIVERS

In this study the anthropometric status of mothers/care givers based on BMI (Table 3.39) revealed that 16.1% of women in Akithii and 15 % of women in Uringu had a BMI<18.5, signifying underweight. Akithii had 73.1% and Uringu had 69.5% participants in the normal weight (BMI, 18.5-24.9) category. A small percentage of respondents were classified in the overweight category (BMI, 25-29.9), 9.1% in Akithii and 12.8% in Uringu. Few women were found in the BMI > 30 category. Comparison of the mean BMI (Table 3.39) categories between Akithii and Uringu did not show any significant differences in the two divisions (p=0.22).

Table 3.39: Comparison of BMI for mothers/care givers in Akithii and Uringu in Phase 2

BMI	***Akithii (%)***	***Uringu (%)***	***Both Divisions (%)***	**Pearson. Chi- square p value**
Number (n)	186	226	412	
Mean BMI	21.3	21.7	21.5	p=0.22
95% CI	20.8-21.8	21.2-22.1	21.1-21.8	
BMI				
<18.5	16.1	15.0	15.5	
18.5<= 24.9	73.1	69.5	71.1	
25<=<29.9	9.1	12.8	11.1	
30<=<34.9	0.5	1.8	1.2	
35 and above	1.1	0.9	1.0	

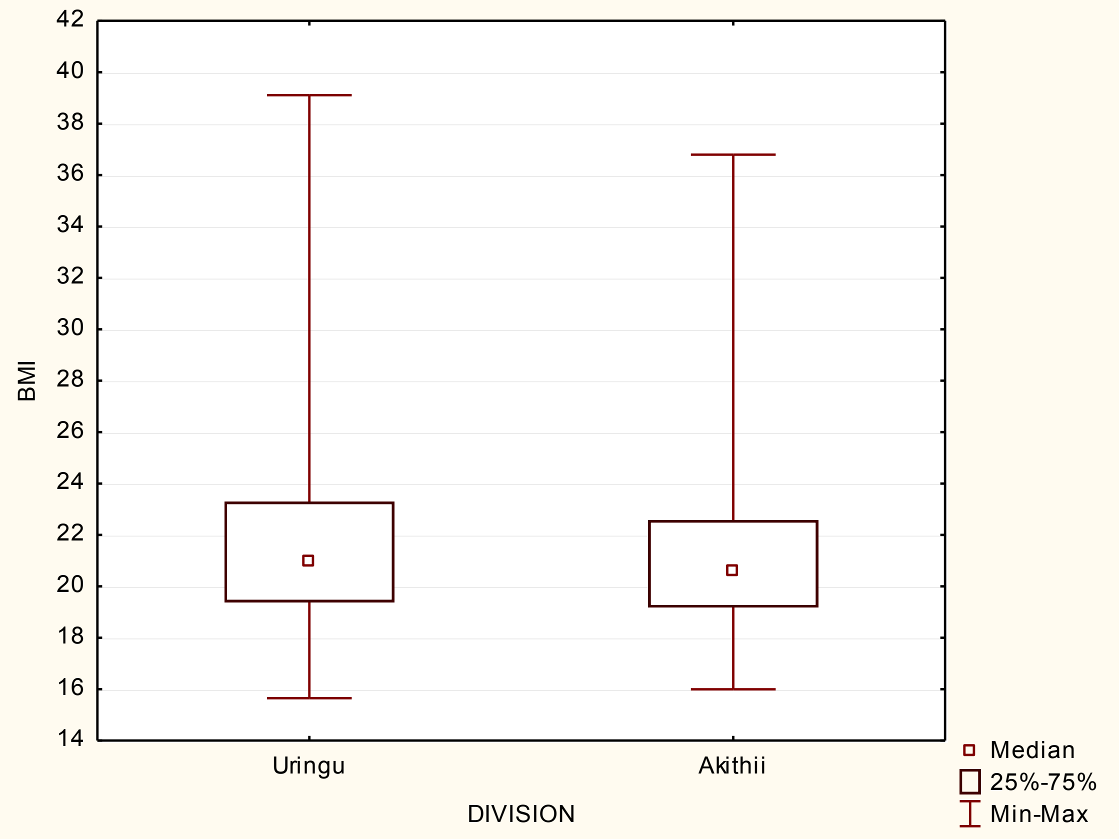

Figure 3.20: Comparison of mean body mass index of Uringu and Akithii women in Phase 2

Comparison of the mean BMI of women in Akithii and Uringu did not show any significant differences in BMI categories between the two divisions (Figure 3.20) (Mann-Whitney U test, p=0.22).

3.14 ASSOCIATIONS BETWEEN THE VARIOUS KEY VARIABLES

3.14.1 Associations of Selected Socio-Demographic Characteristics with Key Variables of the Study

The associations of selected socio-demographic characteristics that may affect vulnerability to food insecurity and nutritional status of the children were explored. No significant association was found between education of the mother/care giver and children with stunted growth (Chi-square, p=0.068), the education of the care giver appeared not to affect the child HAZ index. However various significant associations were found between some socio-demographic characteristics and anthropometric variables (Table 3.40).

Table 3.40: Associations between socio-demographic characteristics with child nutritional status in both Phases

Socio-demographic characteristics	***WHZ***	***WAZ***	**HAZ**
No. of contributors to household income	Kruskal-Wallis p=0.38	Kruskal-Wallis p=0.001***	Kruskal-Wallis p=0.14
Amount of money spent on food per week	Kruskal-Wallis p=0.04*	Kruskal-Wallis p=0.02*	Kruskal-Wallis p=0.55
No. of people eating from the same pot	Spearman r=-0.06, p=0.17	Spearman r=-0.10, p=0.03*	Spearman r=-0.08, p=0.08

Significance* at p <0.05; *** p<0.001; WHZ= weight for height z score; WAZ= weight for age z score; HAZ= height for age z score

Findings in Table 3.40, show there was a significant relationship between the number of contributors to household income and WAZ Kruskal-Wallis (p=0.001). The number of people contributing to household income appeared to significantly correlate to WAZ values. The number of contributors to household income did not correlate to HAZ or WHZ. The amount of money spent on food per week significantly correlated to WAZ values (Kruskal-Wallis, p=0.02) and WHZ (Kruskal-Wallis, p=0.04). The number of people eating from the same pot was significantly inversely correlated with WAZ (Spearman p=0.03).The higher the number of people eating from the same pot, the lower the WAZ values.

The findings also showed that the number of people eating from the same pot was significantly correlated with stunted growth in children (F (1,472) =2.1965, p=0.14, Mann-Whitney U, p=0.04), Figure 3.21.

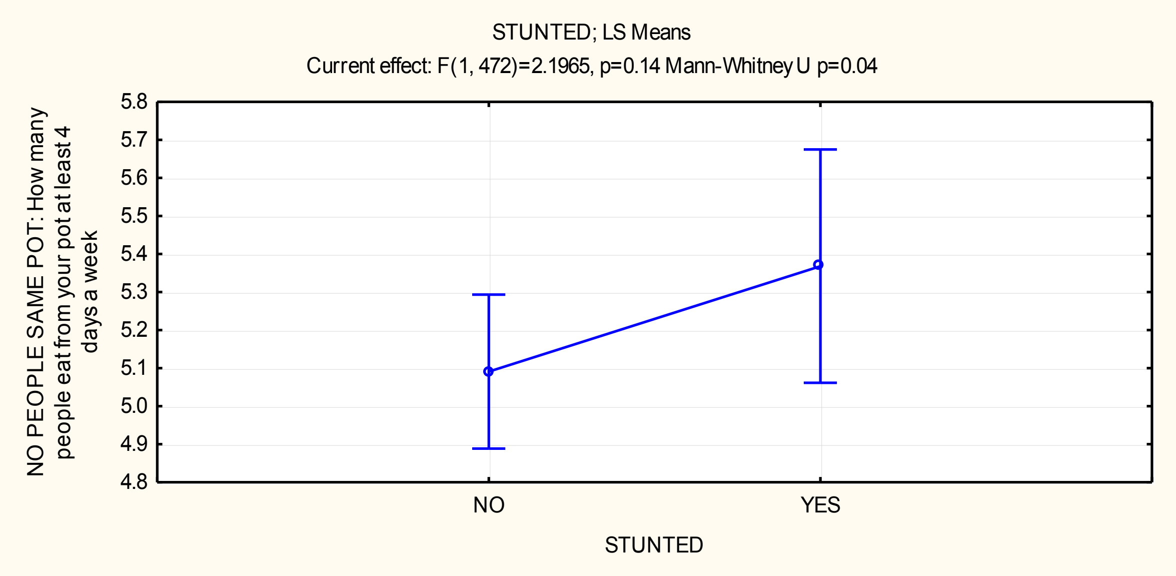

Figure 3.21: Relationship between the numbers eating from the same pot with stunting in both Phases

Figure 3.20 shows that in households with children presenting with stunted growth, the mean number of people feeding from the same pot was significantly higher than those of households with children without stunted growth, namely 5.37 versus 5.09.

When the child nutrition indices (WAZ, WHZ, and HAZ) were explored separately in the two divisions in relation to the three socio-economic indices, there were mixed results.

In Uringu, during Phase 1 of data collection, there was a significant relationship between the amount of money spent per week on food and WAZ (Spearman r=-0.14, p=0.03).The inverse correlation shows that an increase in the amount of money spent on food per week was likely to decrease the WAZ values. Also the number of contributors to household income was significantly correlated to WAZ values (Spearman r=-0.20, p=0.001). The number of contributors to household income was significantly correlated to HAZ (Spearman r=-0.15, p=0.02); as did number of household assets (Spearman r=-0.17, p=0.01).The greater the number of household assets, the higher the HAZ values became.

In Akithii, during Phase 1 of data collection, there was a significant relationship between the number of household assets and WHZ (Spearman r=-0.18, p=0.01).The other socio-demographic indicators did not show any significant correlation with the nutritional indicators (WAZ, HAZ or WHZ).

3.14.2 Comparison of Household Food Security Using HFIAP in Akithii and Uringu Divisions in Phase 1 and 2 of Data Collection

Akithii had a higher number of food insecure households compared to Uringu during Phases 1 and 2 of data collection. Using the HFIAP indicator to categorize the various levels of food security, 2% of the households were found to be food secure in Akithii compared to 12% in Uringu. About 82% of households in Akithii were found to be severely food insecure compared to 47% in Uringu division during Phase 1.The household food security situation however improved in Phase 2 though Akithii consistently had higher levels of food insecurity.

Using the HFIAP indicator to categorize the various levels of food security for Phase 2, 11% of the households were found to be food secure in Akithii compared to 18% in Uringu. About 58% of households in Akithii were found to be severely food insecure compared to 42% in Uringu division. Figure 3.22 shows that Akithii had a significantly higher level of food insecurity compared to Uringu (Chi-square (df=3) =67.75, p<0.001) using HFIAP categories.

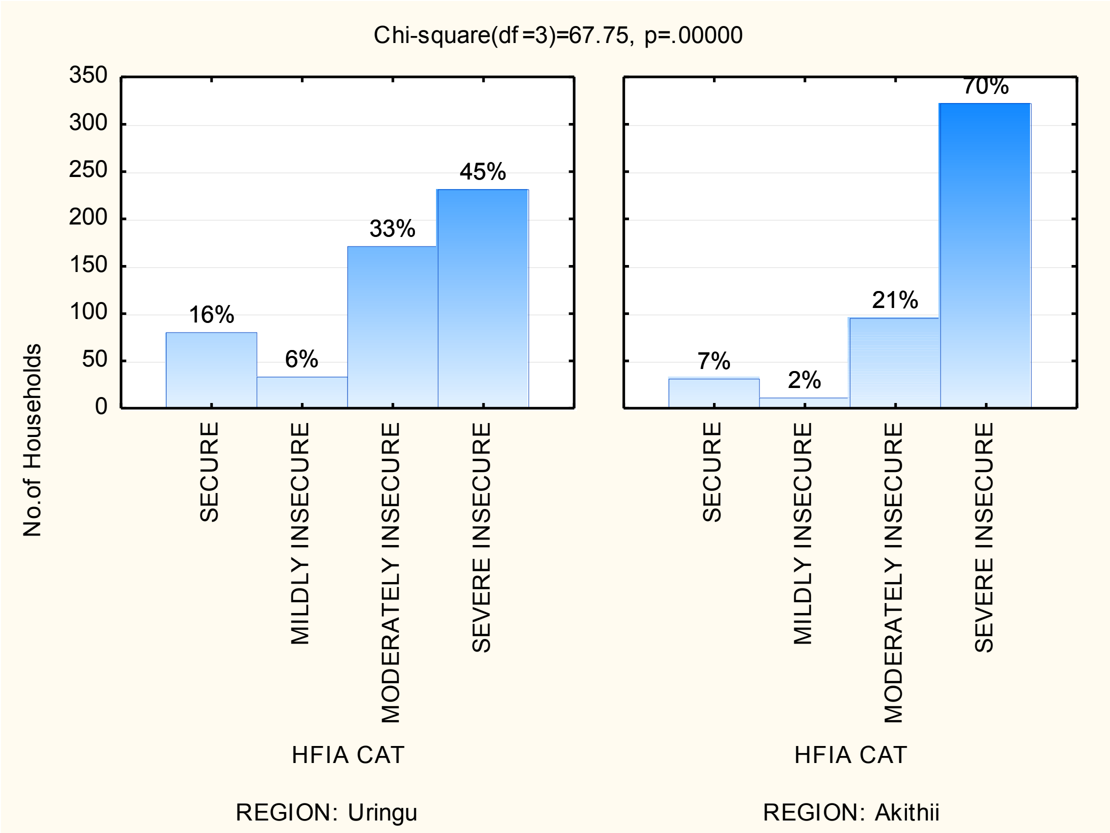

Figure 3.22: Comparison of levels of food security in Akithii and Uringu using household food insecurity access prevalence in Phase 2 of the study

Further analysis was carried out to determine whether there was a significant difference between the two study divisions in household food security using Mann-Whitney U-test. Figure 3.23, shows that there was significant difference between Akithii and Uringu in terms of household food security as assessed using the HFIAS. Akithii had a significantly higher level of food insecurity compared to Uringu ($p<0.001$).

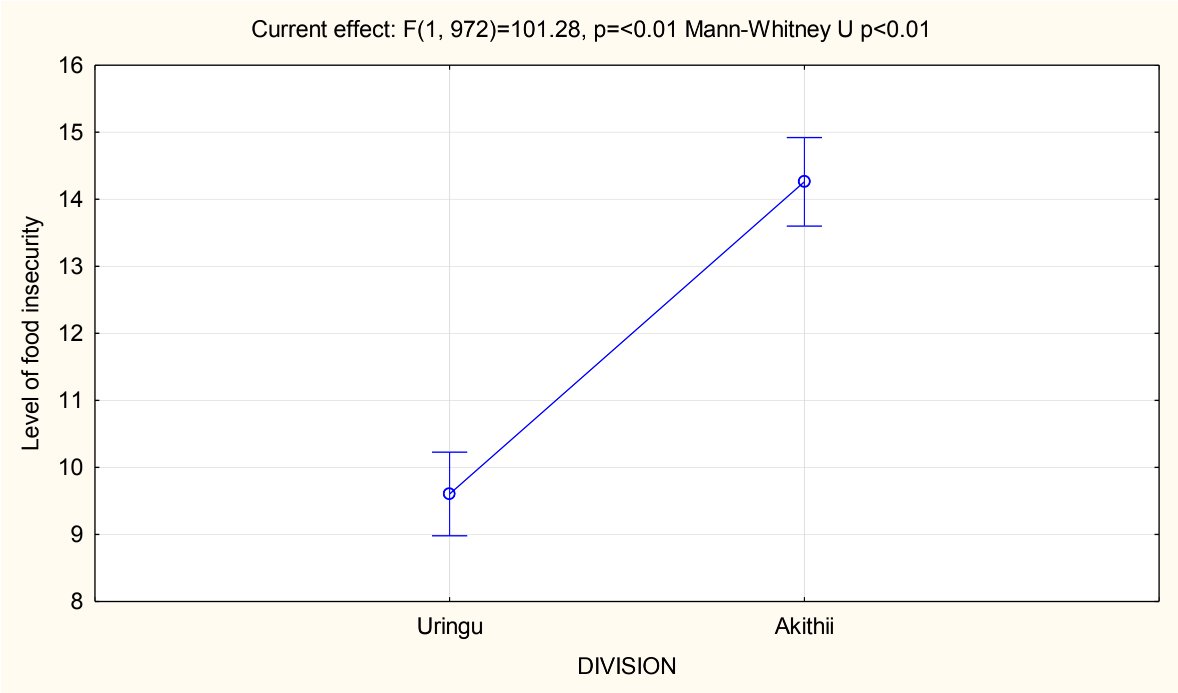

Figure 3.23: Comparison of the levels of food insecurity in Akithii and Uringu divisions in both Phases

Overall, more households in Akithii were highly food insecure than in Uringu in both periods of data collection as measured by the HFIAS and HFIAP.

To assess whether the household food security situation was influenced by the change in seasonality, comparison was done between Phase 1 and Phase 2 of data collection. There were significant differences between Phase 1 and Phase 2 of data collection, Phase 1 (dryer season) had relatively higher levels of food insecurity compared to Phase 2 (wet season) with a mean value of 12.8±7.5 (pooled t-test, $p<0.001$) for Phase 1 and 10.7±7.6 (pooled t-test, $p<0.001$) for Phase 2.The findings therefore show that seasonality affected the levels of food security in this division with better food security during the rainy season (Phase 2).

3.14.3 Relationship between Household Food Security and Anthropometric Variables

Household food security as measured using the HFIAS in both divisions was related with all the three nutritional indices (WAZ, HAZ, and WHZ) to establish whether there was a relationship between household food security and anthropometric status of children in the study. Pearson's correlation coefficient was used to establish whether there was any statistical significance and Table 3.41 shows that there was none.

Table 3.41: Correlating household food security with various anthropometric indices

Phase 1 and 2 combined		WAZ	HAZ	WHZ	HFIAS
WAZ	Pearson Correlation	1	0.708	0.686	-0.048
	Sig. (2-tailed)	.	0.000	0.000	0.156
	N	955	951	950	884
HAZ	Pearson Correlation	0.708	1	-0.024	-0.037
	Sig. (2-tailed)	0.000	.	0.467	0.264
	N	951	966	950	894
WHZ	Pearson Correlation	0.686	-.024	1	-0.031
	Sig. (2-tailed)	0.000	0.467	.	0.352
	N	950	950	978	906
HFIAS-Score	Pearson Correlation	-0.048	-0.037	-0.031	1
	Sig. (2-tailed)	0.156	0.264	0.352	.
	N	884	894	906	974

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

The results of the analysis (Table 3.41) show that in this study, household food security as measured by HFIAS did not significantly reflect the anthropometric status of children in the study population.

3.14.4 Relationship between Agricultural Biodiversity with Household Food Security

Figure 3.24 shows that there was a significant relationship between the HFIAS score with agricultural biodiversity (Spearman r=-0.10, p=0.02). As the agricultural biodiversity score increased, the HFIAS score decreased. This means that increase in the agricultural biodiversity influences household food security (access).

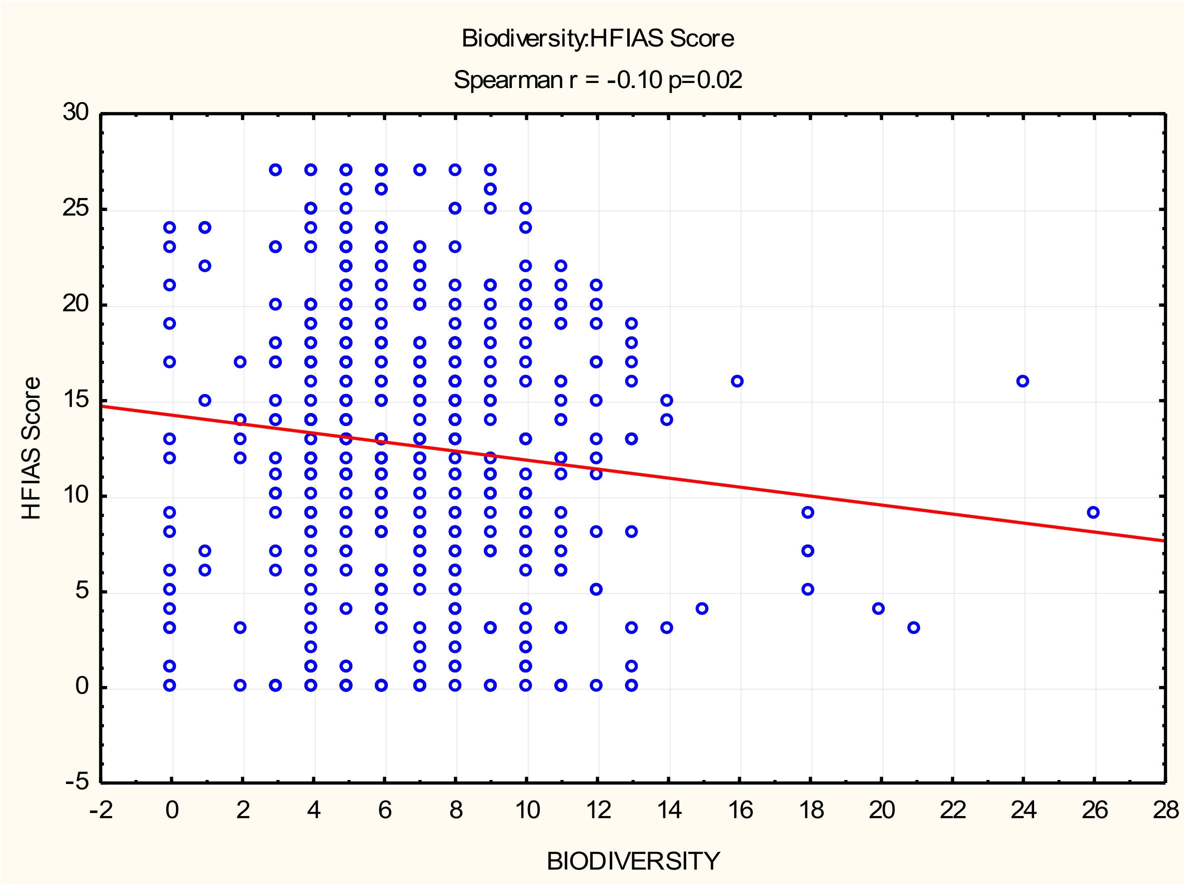

Figure 3.24: Relationship between agricultural biodiversity and household food insecurity

3.14.5 Relationship between Agricultural Biodiversity and Anthropometric Variables

Agricultural biodiversity was correlated with anthropometric indices to establish whether there were any significant relationships. No significant relationship was found to exist between agricultural biodiversity with WAZ, HAZ or WHZ scores (Table 3.42).

Table 3.42: Relationship between agricultural biodiversity and anthropometric variables

Variables	Spearman R	T (n-1)	P value
Both divisions, Phase 1&2 combined			
Agricultural Biodiversity & WAZ	0.047	1.009	0.313
Agricultural Biodiversity & HAZ	-0.005	-0.114	0.909
Agricultural Biodiversity &WHZ	0.079	1.726	0.085
Akithii: Phase 1&2 combined			
Agricultural Biodiversity & WAZ	-0.036	-0.544	0.586
Agricultural Biodiversity & HAZ	-0.087	-1.311	0.191
Agricultural Biodiversity & WHZ	0.088	1.359	0.175
Uringu: Phase 1&2 combined			
Agricultural Biodiversity & WAZ	0.097	1.473	0.142
Agricultural Biodiversity & HAZ	0.043	0.650	0.516
Agricultural Biodiversity &WHZ	0.065	1.014	0.312

Correlations significant * at p <0.05

Agricultural biodiversity (using agricultural biodiversity score) was also correlated with stunted growth, (HAZ<-2SD) in children in the study population. No significant difference was found (fig 3.25 (F (1,457) =0.48636, p=0.49 Mann-Whitney U-test, p=0.51) when the two divisions were combined in both Phases.

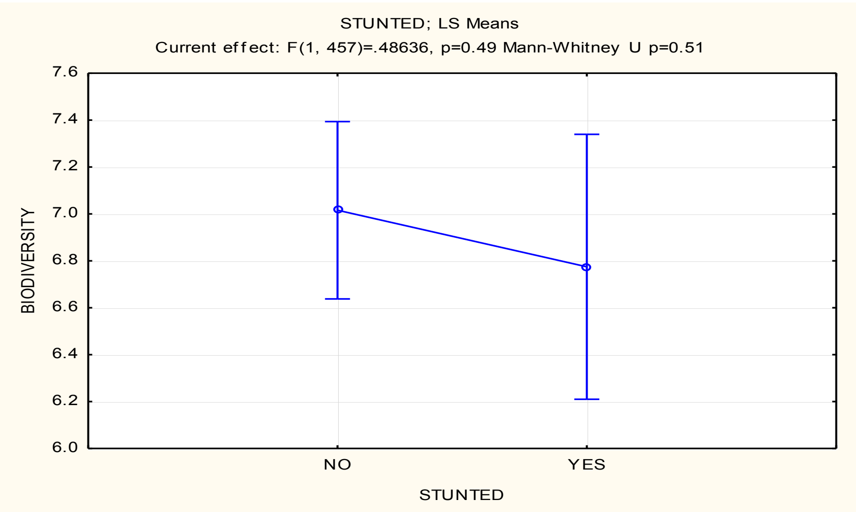

Figure 3.25: Relating agricultural biodiversity to stunting in children

3.14.6 Correlating the Anthropometric Status of the Mother/Care Giver with Children's Anthropometric Status

The BMI of the mothers/care givers was explored in relation to the anthropometric status of the children in the sample. The BMI was compared with all the indices of anthropometric status of children (WAZ, WHZ, and HAZ). Figure 3.26 shows that there was a significant but weak correlation between the BMI of the mother/care giver and the WAZ scores of the children (r=0.1410, p<0.001). For every one unit increase in WAZ, the BMI increased by 0.0418 while the relationship line (r=0.1410) accounted for 14.10 % of the variation in the two data sets. This implies that there was a significant likelihood that mothers of underweight children would have a lower BMI.

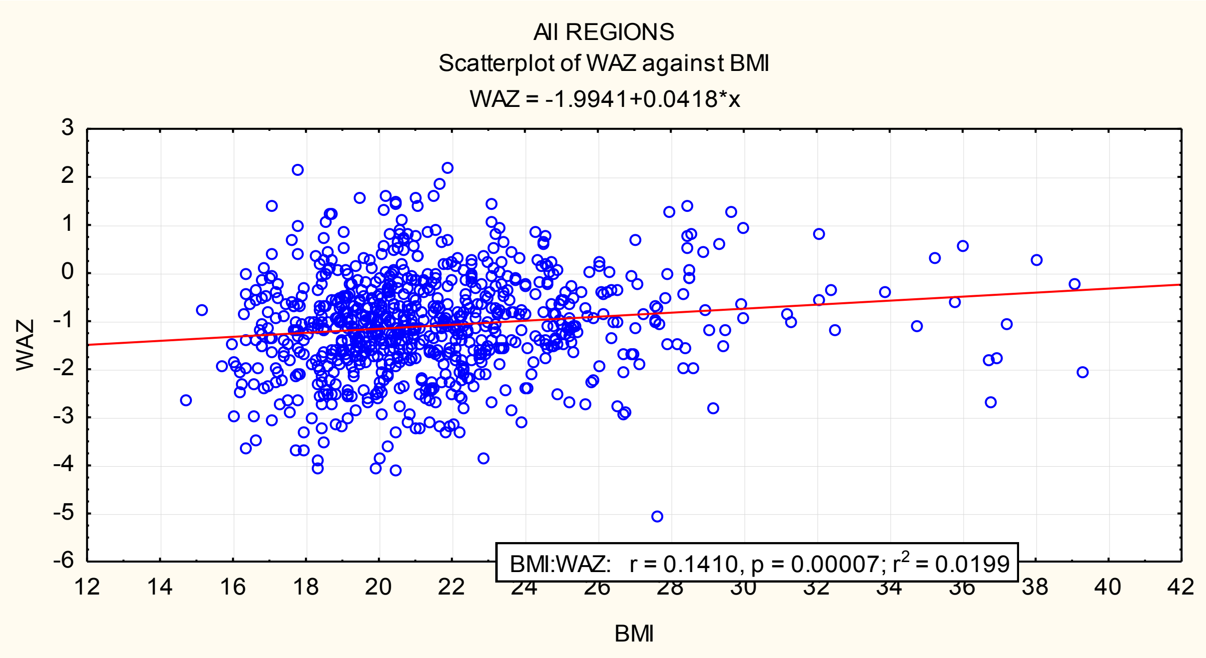

Figure 3.26: Correlation between body mass index of mothers and weight for age of children

A comparison between HAZ scores of children and BMI of mothers/care givers (Figure 3.27) showed that there was a significant weak correlation between BMI and HAZ scores of the children (p<0.001). Children with stunted growth were likely to have a mother/care giver with a lower BMI than those children who were not stunted.

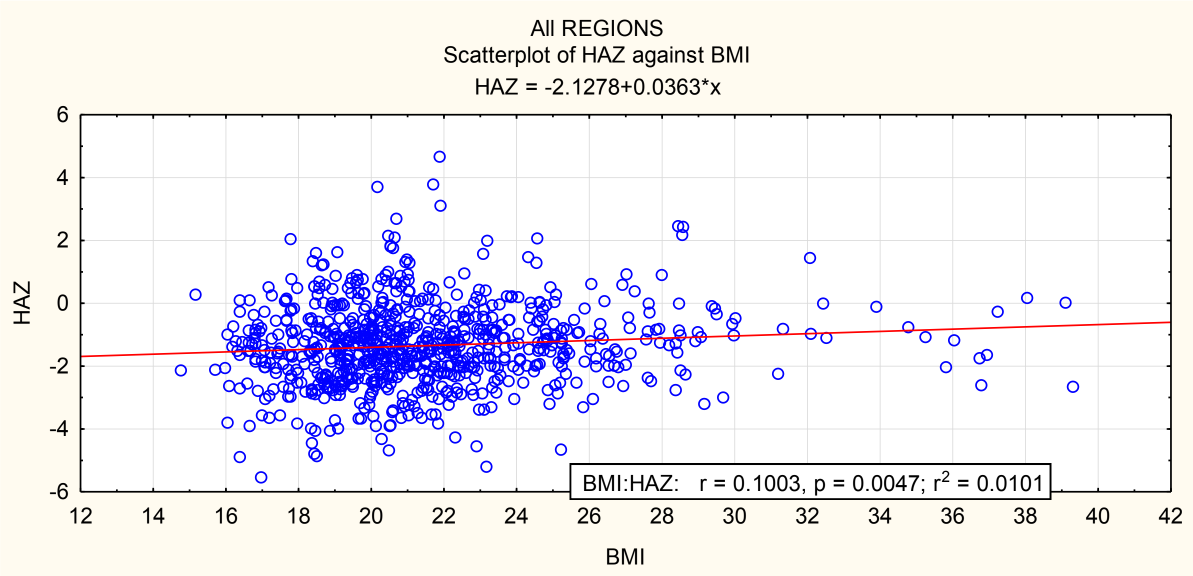

Figure 3.27: Correlation between body mass index of mothers and height for age of children

For every one unit increase in HAZ, the BMI increased by 0.0363 while the relationship line (r=0.1003) accounted for 10.03 % of the variation in the two data sets. Further analysis revealed that there was a significant weak correlation between BMI and WHZ scores (r=0.0875, p=0.0130) (Figure 3.28).Children who were wasted were likely to have a mother/care giver with a lower BMI than those who were not wasted. For every one unit increase in WHZ, the BMI increased by 0.0274 while the relationship line (r=0.0875) accounted for 8.75 % of the variation in the two data sets.

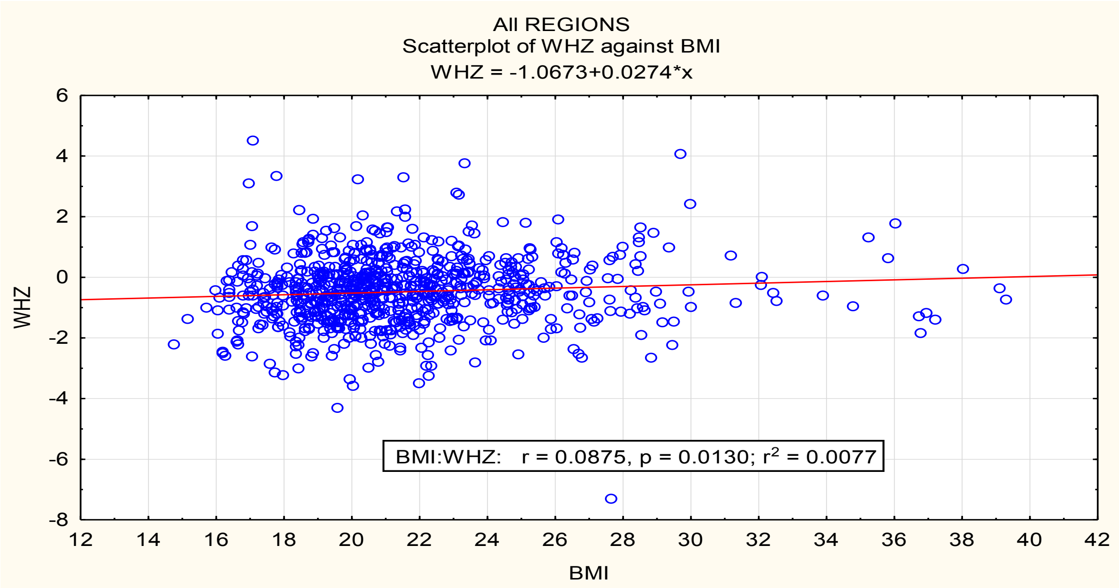

Figure 3.28: Correlation between body mass index of mothers and weight for height of children

The analysis presented in Figures 3.26, 3.27 and 3.28 shows that there is a significant relationship between the BMI of the mother/care giver and the anthropometric status of their children.

In an effort to understand whether there was a relationship between mothers/care givers BMI with stunted growth in children, further analysis was done. Figure 3.29 revealed that children without stunted growth had mothers who had a higher mean BMI while children with a stunted growth had mothers/care givers with a lower mean BMI. This shows that there is a significant relationship between BMI and stunted growth in children ($F(1,790) = 5.4467$, $p=0.01986$).

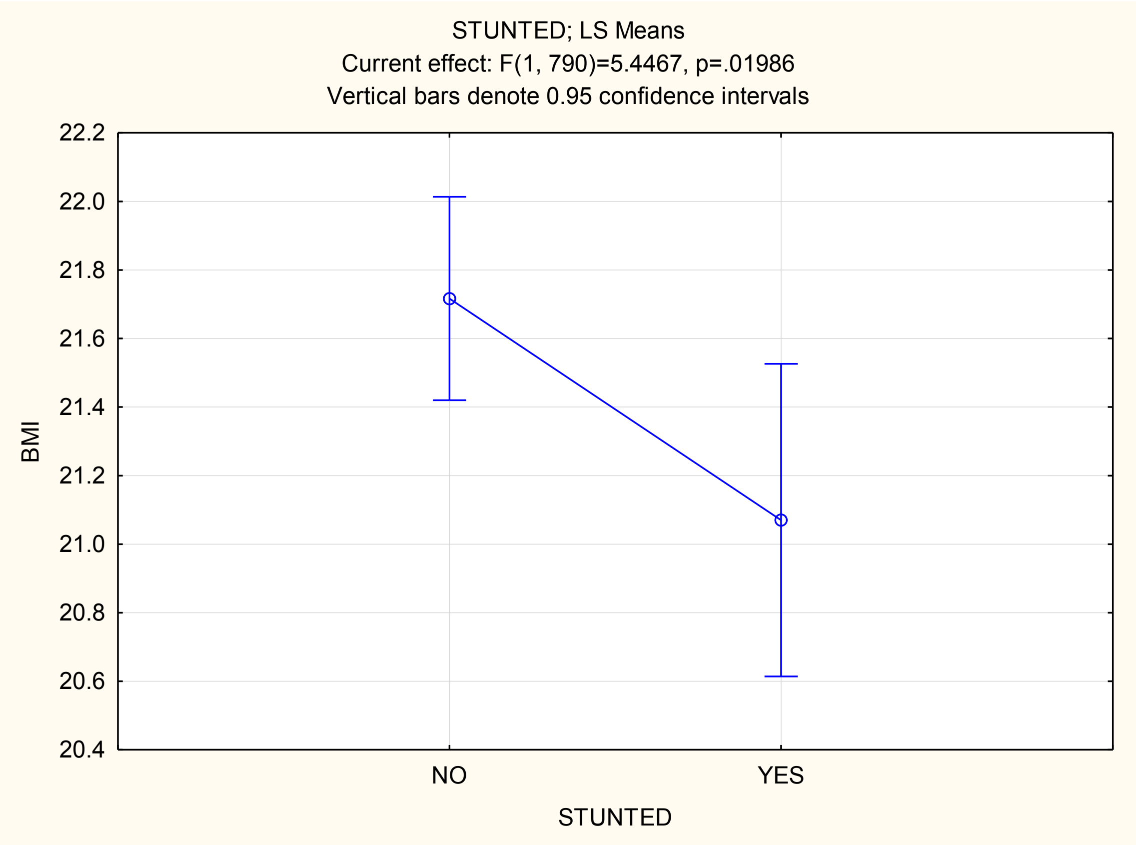

Figure 3.29: Correlating body mass index of care givers with stunted growth in children

3.14.7 Relationship between Dietary Diversity and Child Anthropometric Status

Child anthropometric indices (WAZ, HAZ, and WHZ) were correlated with DDS to determine the relationships between these variables. No significant correlation was found to exist between WAZ and WHZ with DDS. There was, however, a significant relationship between stunting in children (HAZ<-2SD) and dietary diversity in Phase 2 data (Table 3.43). An increase in DDS appeared to reflect a decrease in stunting in children. This finding should however be interpreted with caution because stunted growth in children is a marker of chronic malnutrition and hence significant change may not occur over a short period of six months.

Table 3.43: Correlations between dietary diversity and child anthropometric status

Variables	Spearman R	T (n-1)	P value
Phase 1			
DDS & WAZ	-0.015	-0.335	0.73
DDS & HAZ	-0.005	-0.120	0.90
DDS & WHZ	-0.009	-0.202	0.83
Phase 2			
DDS & WAZ	0.068	1.439	0.150
DDS & HAZ	0.114	2.455	0.014*
DDS & WHZ	0.021	0.454	0.649

Correlation significant * at p <0.05

3.14.8 Relationship between Dietary Diversity and Household Food Security

Findings showed that DDS was consistently, significantly and inversely correlated to HFIAP in Phase 1 and Phase 2 data (refer to Figure 3.29) and when the two divisions were combined. During Phase 1, the correlation using Spearman R was (R =-0.158, t (N-2)-3.565), p=0.0003) while during Phase 2 the correlation was (R =-0.185, t (N-2)-3.889), p=0.0001). This correlation shows that an increase in dietary diversity inversely affected HFIAS. This means that an increase in household food security influenced DDS.

Further correlation of DDS with HFIAP using ANOVA showed significant relationships in all Phases, divisions and both divisions combined. Phase 1 (F (3,494) =4.9204, p=0.002), Phase 2 (F (3,423) =6.77, p<0.0001).

A significant relationship was found between DDS and HFIAP for all Phases and divisions combined F (3,921) =9.6178, P<0.01; Kruskal-Wallis p<0.01) Figure 3.29.

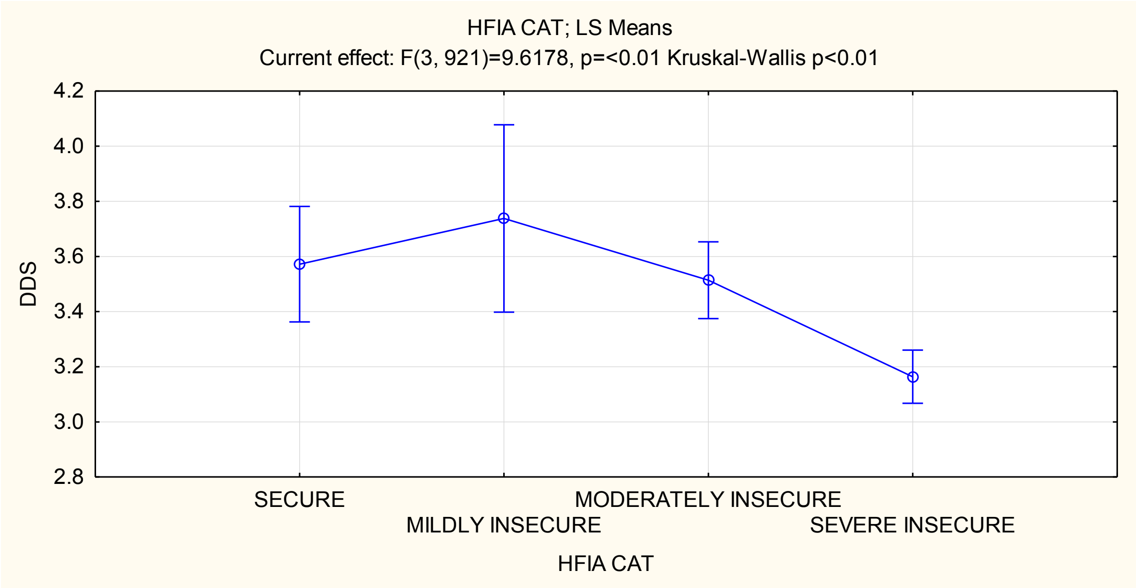

Figure 3.29: Correlating Household Food Insecurity Access Prevalence with DDS

Fig 3.29 also shows that respondents in households that were moderately and severely food insecure had a lower DDS compared to those being food secure and mildly insecure.

3.14.9 Relating the Micronutrient Adequacy Ratio (MAR) with Household Food Security

The mean adequacy ratio (MAR) was correlated with HFIAP. During Phase 1, findings showed a current effect (3,494) =2.9815, p=0.03102) and in Phase 2, there was a current effect: F (3,423), =2.5778, p=0.05329).This Indicates that in Phase 1 with both divisions combined, there was a significant relationship between MAR and HFIAP while during Phase 2,the relationship was not significant yet bordering on significance. However, when the two Phases were combined, a significant relationship was found (ANOVA) F (3,921) =4.7592, p=0.00268). Figure 3.30 shows that households that were food secure were likely to have children with a higher MAR.

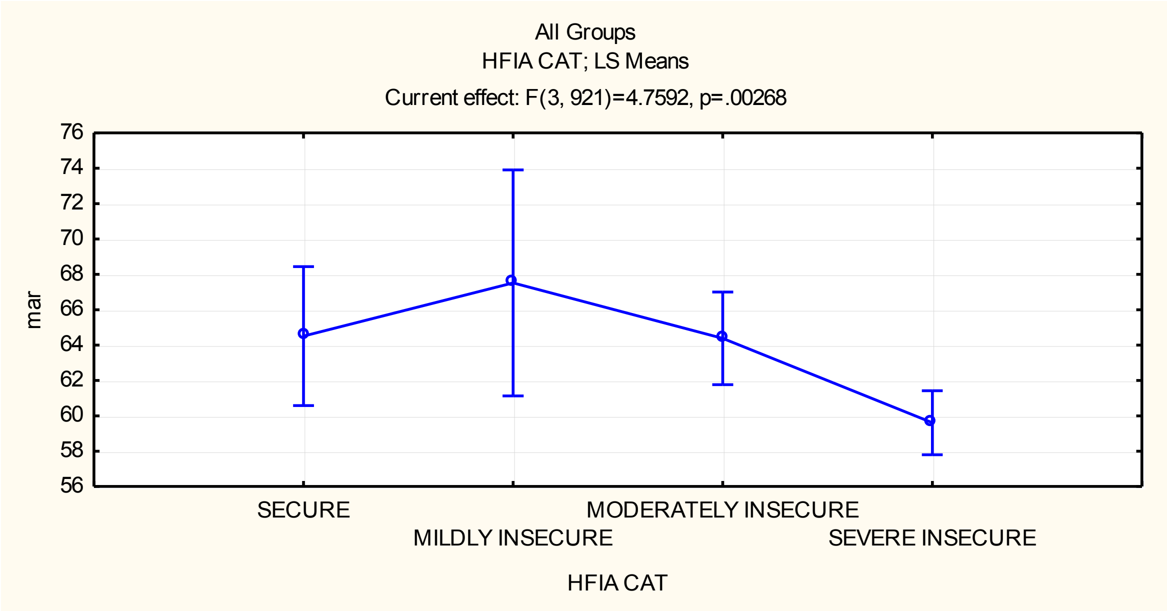

Figure 3.30: Comparing Food Insecurity Access Prevalence with Micronutrient Adequacy Ratio

Fig 3.30 shows that the households that were food secure had a lower MAR (=65%) compared to those that were mildly food insecure (=68%). The respondents in households that were moderately and severely food insecure however had a lower MAR compared to those food secure and mildly insecure.

3.14.10 Relationship between Agricultural Biodiversity and Dietary Diversity

Agricultural biodiversity was related to DDS to ascertain whether there was a relationship between the two variables. Dietary diversity was categorized in two ways; those respondents with a DDS greater than four food groups (DD>4) and those respondents with a dietary score of less than four food groups (DD<4); with 4 representing the cut=off value for poor DDS.

Findings established that there was a significant relationship between agricultural biodiversity and dietary diversity. A univariate test for significance (ANOVA) showed there was a significant relationship (current effect (1,496) =14.791, p=0.00014) in both divisions combined. Households with a higher agricultural biodiversity score had a DDS>4 showing that agricultural biodiversity positively affected dietary diversity (Figure 3.31).

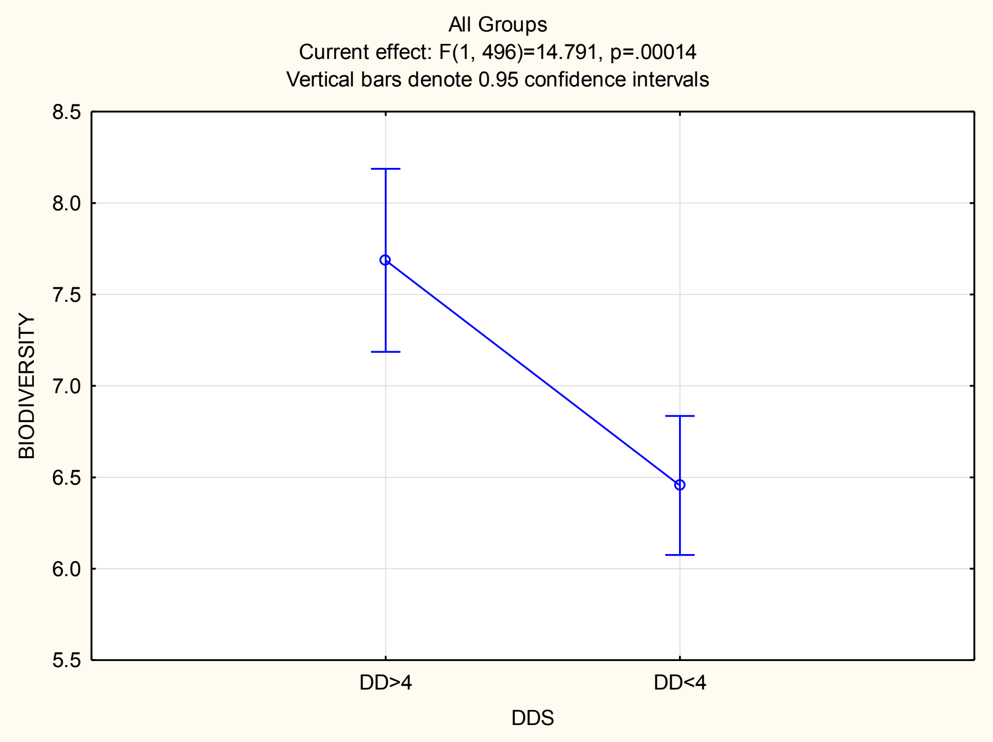

Figure 3.31: Correlating Agricultural Biodiversity to Dietary Diversity Score

Further analysis using Spearman rank order correlation was done between agricultural biodiversity and DDS which confirmed that there was a significant relationship between the two variables in both Phases and divisions combined ($p<0.0001$) and also when the divisions were separated (Akithii, $p=0.0002$, Uringu, $p=0.002$).

3.14.11 Relationship between Agricultural Biodiversity and Nutrient Adequacy

The correlation between agricultural biodiversity and NARs was explored. A significant relationship was found to exist between agricultural biodiversity with all the nutrients investigated in the study with the exception of energy (kilojoules). Table 3.44 shows the significant correlations between agricultural biodiversity and different NARs.

Table 3.44: Correlations between agricultural biodiversity and nutrient adequacy ratios

Spearman Rank Order Correlations			
Variables	**Spearman - R**	**t(N-2)**	**p-value**
Biodiversity& Energy	0.085259	1.905757	0.057260
Biodiversity & Protein	0.092733	2.074202	0.038576*
Biodiversity & Iron	0.152744	3.442158	0.000626*
Biodiversity & Zinc	0.130081	2.921870	0.003638*
Biodiversity & Vitamin B12	0.118747	2.663477	0.007985*
Biodiversity & Vitamin B6	0.193014	4.381010	0.000014*
Biodiversity & Vitamin C	0.176918	4.003289	0.000072*
Biodiversity & Folate	0.091869	2.054719	0.040429*
Biodiversity & Riboflavin	0.184129	4.172091	0.000036*
Biodiversity & MAR	0.194045	4.405322	0.000013*

Correlations are significant *at p <0.05; ** p<0.01; ***p<0.001

3.14.12 Relating Dietary Diversity, Agricultural Biodiversity and Household Food Security in Households With and Without Children with Stunted Growth

DDS, agricultural biodiversity score and HFIAS were related with households with and without children with stunted growth to determine the relationships between these variables.

Table 3.45: Relating dietary diversity, agricultural biodiversity and household food security in households with and without children with stunted growth in both Phases and divisions

Variables	*Divisions*		*Households with children without Stunted growth*	*Households with children with Stunted growth*	*ANOVA, p-value*
DDS	**Akithii &Uringu**	Mean	3.3(SD,1.41)	3.3 (SD,1.22)	p=0.651
	Phase 1	N	314	139	
	Akithii &Uringu	Mean	3.3(SD,1.12)	3.1 (SD,1.13)	p=0.047*
	Phase 2	N	317	136	
	All groups	Mean	3.3 (SD, 1.13)	3.2 (SD,1.18)	p=0.090
	(Phase 1& 2)	N	N=631	N=275	
HFIAS	**Akithii &Uringu**	Mean	12.4(SD,7.38)	14.3(SD,7.17)	p=0.009*
	Phase 1	N	331	145	
	Akithii &Uringu	Mean	11.1	10.1	p=0.232
	Phase 2	N	291	127	
	All groups	Mean	11.8(SD,7.61)	12.4(SD,7.45)	p=0.310
	(Phase 1& 2)	N	N=622	N=272	
Agricultural Biodiversity	**All groups**	Mean	7.0 (SD, 3.14)	6.8(SD,3.45)	p=0.486
	(Phase 1)	N	N=317	N=142	

Significance*at p <0.05

During Phase 1, there was a significant difference between households with and without children with stunted growth for the variable DDS (p=0.047) and also for the variable HFIAS. (p=0.009) (Table, 3.45). Agricultural biodiversity did not show any significant differences between the two groups of households. The means for households with children presenting with stunted growth were however lower at 6.8, as compared to 7.0 of those with normal growth. This implies that households with children with stunted growth and those without were significantly different in DDS and HFIAS but not with agricultural biodiversity in this study.

3.14.13 Summary of Key Findings and Relationships between Variables in the Study

Tables 3.46 and 3.47 respectively show the summaries of the key findings between the Phases and the relationships between key variables

Table 3.46: Summary of the key findings of the study

	Phase 1			Phase 2			Both Phases	Significance
Variables	**Akithii**	**Uringu**	**Test result**	**Akithii**	**Uringu**	**Test result**	**Total for Akithii and Uringu**	
Agricultural Biodiversity (mean)	6.6 ±2.44	7.2 ± 4.19	ANOVA p=0.035	No data collected in Phase 2	No data collected in Phase 2		No data collected in Phase 2	This mean is only for Phase 1 6.9 ± 3.47
Child DDS (mean)	2.9±1.1	3.7±1.1	T-test p<0.001	2.9±1.0	3.7±1.1	T-test p<0.001	3.3±1.1	There were no significant differences in the DDS between the 2 Phases T-test p=0.432
% with DDS<4 food groups for children	79.7%	51.6%	Chi-square p<0.001	79.9%	52.3%	Chi-square p<0.001	65.9%	There were no significant differences in the DDS between the 2 Phases
% with DDS ≥4 food groups for children	20.3%	48.4%		20.1%	47.7%			Chi-square p=0.398
MAR %	55.3± 3.56	66.8±17.06	T-test P<0.001	56.3±23.18	67.4±17.68	T-test P<0.001	61.6+21.3	There were no significant differences in the MAR between the 2 Phases T-test p=0.070
HFIAS Score	16.2±7.01	10.0±6.90	T-test P<0.0001	12.5±7.80	9.3±7.02	T-test P=0.001	11.8±7.57	Mann-Whitney U, p=0.01;Akithii had a higher level of food insecurity in both Phases
WHZ (Mean)	-0.52 (-0.7 to -0.4)	-0.45 (-0.6 to -0.3)	ANOVA P=0.482	-0.43 (-0.6 to -0.3)	-0.53 (-0.7to -0.4)	ANOVA P=0.343	-0.49 (-0.6 to -0.4)	No significance differences in WHZ and WAZ.
WAZ (Mean	-1.19 (-1.3 to -1.1)	-1.04 (-1.2 to -1.1)	P=0.119	-1.13 (-1.3 to -1.0)	-1.09 (-1.2 to -1.0)	P=0.707	-1.11 (1.2 to -1.0)	
HAZ(Mean	-1.46 (-1.6 to -1.3)	-1.29 (-0.4 to -1.1)	P=0.144	-1.44 (-1.6 to -1.3)	-1.29 (-1.5 to -1.1)	P=0.203	-1.37 (-1.5 to -1.2)	In HAZ however Akithii had higher stunting levels ANOVA, p=0.010
Mother/ care giver BMI (mean)	21.4 CI (20.9-21.8)	21.8 CI (21.4-22.3)	Chi – square P=0.088	21.3 CI (20.8-21.8)	21.7 CI (21.1-21.8)	Chi-square P=0.220	21.05 CI (20.9-21.8)	No significant difference Chi-square P=0.20

Table 3.47: Summary of relationships between key variables

	Variables	*Significance*
1.	Association of DDS with anthropometric indices (WAZ,HAZ,WHZ)	Children who had a high DDS were more likely not to have stunted growth (Uringu Phase 2)-HAZ Spearman r= 0.114, p=0.014).
2.	Relationship between DDS and HFIAS	Households with children who had high DDS were more likely to be food secure Significant positive relationship established for all Phases and divisions combined F (3,921)=9.6178,P<0.01; Kruskal-Wallis p<0.01.
3.	Relationship between MAR and household food security	Children with a high MAR were more likely to be in households that were food secure (ANOVA) F (3,921) =4.7592, p=0.00268).
4.	Relationship between HFIAS and anthropometric indices (WAZ,HAZ,WHZ)	No relationships established
5.	Differences in agricultural biodiversity score and (HFIAS)	Households with higher biodiversity more likely to be food secure ; Spearman r=- 0.1,p=0.002
6.	Relationship between agricultural biodiversity score and DDS	Households with a high agricultural biodiversity were likely to have children with a high DD; ANOVA (current effect (1,496) =14.791, p=0.00014).
7.	Relating agricultural biodiversity score with NAR	Households with a high agricultural biodiversity score were likely to have children with a higher NAR for all the nutrients with the exception of energy (kilojoules)
8.	Relating DDS, agricultural biodiversity and HFIAS in households with and without children with stunted growth	Households that were food secure and had children with a high DDS were less likely to have children with stunted growth DDS (p=0.047) HFIAS. (p=0.009) (Phase 1)
9.	Differences in mother/care givers' BMI and anthropometric indices for children(WAZ,HAZ,WHZ)	Households with mothers with a normal BMI have a higher chance of having children with normal WAZ,HAZ,WHZ indices WAZ=r=0.1410, p<0.001 WHZ= r=0.08, p=0.013 HAZ= r=0.1003, p=0.004
10.	Relating seasonal variations (rainfall) to dietary diversity, household food security, and/or anthropometric status in children	Seasonal variations did not appear to affect children's' DDS (Chi-square p=0.398), WHZ and WAZ. HAZ was significantly different in Akithii ANOVA, p=0.010. Households were more food secure in Phase 2 (HFIAS) 10.7±7.6 (p<0.001) as compared to Phase 1 at 12.8 ±7.5 (p<0.001) (pooled t-test)

CHAPTER 4: DISCUSSION

4.0 INTRODUCTION

There is scarcity of scientific data exploring the relationships between agricultural biodiversity, dietary diversity, household food security and nutritional status of children (24 to 59 months old) in resource poor households in rural Kenya. Two independent cross-sectional surveys were conducted in which Phase one data collection took place in September to October 2011 (the dry season) while Phase 2 took place in March 2012 (the rainy season) to establish whether seasonality had any influence on the variables. Two areas of study were selected for this study based on the difference in demographic characteristics as well as levels of agricultural biodiversity.

The results will be discussed in the following section according to the main objectives and stated hypotheses in Chapter 2.

Socio-demographic Characteristics

The majority of mothers/care givers had attained a primary level of education, addressing MDG 2, on achievement of universal primary education.[10] Slightly less than half of the households obtained their drinking water from communal taps while the rest of the households consumed water from other sources where the water was not treated. Water sources and general hygiene needs attention since this has an impact on health and nutrition. The majority of the households used wood as the fuel for cooking which means that the environment is likely to be affected because of felling of trees. This could lead to climate change and eventually impact on the agricultural biodiversity. For a basic need such as of shelter, housing was not optimal with about half of the households having houses that had less than four rooms.

4.1 AGRICULTURAL BIODIVERSITY

Kenya has been described as a country rich in agricultural biodiversity with an estimated 35,000 known species of animals, plants and micro-organisms.[159] The country's agricultural biodiversity is, however, under serious threat due to among others increasing deforestation, climate change, pollution and soil degradation.[38] The level of agricultural biodiversity(n=26) in Tigania west in the Eastern part of Kenya, the area of study in the current research project, was found to be low and far less than the number described in an earlier study conducted in western Kenya which found 41 different species of food cultivated, animals reared and those foods from the natural habitat.[35]

Agricultural biodiversity has steadily declined in Kenya, with a corresponding increase in dependence on a small number of food crops.[82] According to Frison et al.[21] and FAO, [1]only three plant species (maize, wheat and rice) currently supply the bulk of protein and energy needed for both developing and developed country populations. Furthermore, a study by Cromwell[160] revealed that 75% of the world's food is generated from 12 plants and five animal species. Approximately 250,000 to 300,000 plant species are known of these, only 4% (10,000) are edible and only 1.5%-2% (150 to 200) is consumed by humans. Similar results were found in the current study with nine starchy crops dominating the food supply. Monotonous diets based on starchy staples lack essential micronutrients and contribute to the burden of malnutrition and micronutrient deficiencies.

A study by Emile[122] indicated that, in Kenya, rice, maize and wheat contribute about 60% of calories and proteins from plants. The magnitude of agricultural effort applied to the three principal crops has led to a decline in the production and consumption of more diverse grains. This concurs with the findings of the present study which revealed that the production of cereals such as indigenous millet and finger millet has declined and the number of foods which can be obtained from the natural habitat have been significantly reduced. This further corresponds with a study by John, [81] which indicated that cultivation of traditional foods like: millet, sorghum, cassava, sweet potatoes, traditional vegetables and indigenous wild fruits are now associated with being poor. This association results in changes in agricultural practices, which leads to disruption of dietary patterns and loss of dietary diversity.

This study established that the current level of agricultural biodiversity had improved (=26) compared to past biodiversity (=23). This is an interesting finding considering the decrease in the level of agricultural biodiversity[82] observed in other parts of the world with FAO[161] indicating that the world is dependent on just 12 crops and 14 animal species. However the findings from the present study show that the increase in biodiversity has been in domesticated species and not on species from the natural habitat. The adoption of domesticated species with less attention to the species from the natural habitat supports the findings by Penafiel et al.[34] who indicated that worldwide, biological diversity from wild and agricultural ecosystems is declining and negatively affects livelihoods especially of the rural poor who subsist from foods supplied by the local biodiversity. Frison et al. [162] also indicated that traditional foods have been replaced by convenience foods. Locally available indigenous and traditional foods that require some form of processing, usually tedious and time consuming before their final use in food preparation have been replaced in the diet by crops such as maize, wheat, rice, and potatoes that are easier to prepare. This and commercialization of agriculture could partly be the reasons why the respondents in this study area have adopted domesticated species as compared to indigenous species.

The improvement of agricultural biodiversity is key in ensuring diverse diets and cushioning households from climatic shocks caused by changing weather patterns in developing countries where most households depend on rain-fed agriculture. Food-based strategies have been recommended as the first priority to meet micronutrient needs.[163] A more diverse diet holds the potential to provide a more abundant supply of both macro- and micronutrients and could therefore be one of the approaches to ensure greater food and nutrition security in Kenya.

4.2 ANTHROPOMETRIC STATUS OF THE CHILDREN

In general, the prevalence of undernutrition in the study area can be classified as medium to high according to WHO standards.[148] There were marked differences in the prevalence of undernutrition in the two study areas across the two Phases of data collection with Akithii being classified as an area with a high level while Uringu was classified as presenting with a medium level of. Uringu had a higher level of assets and agricultural biodiversity as compared to Akithii so this could be the reason for lower malnutrition levels in the region.

Akithii had higher percentages of children who presented with underweight and wasting compared to the national levels in 2008. The level of stunting was the same as the national level of 35%.[57, 164] Uringu, however, had a lower level (27.4%) compared to the national rate. During Phase 2 of data collection, the percentages of children who presented with wasting, underweight, and stunting were overall lower than in Phase 1. This may be attributed to the effect of seasonality. During Phase 2 of data collection, household food security and dietary diversity were better because it was during the rainy reason unlike in Phase 1 when data collection took place during the dry season.

A higher percentage of boys presented with wasting, underweight and stunting in both divisions compared to girls in both Phases of data collection. This concurs with results documented by Nungo et al.[165] where a higher percentage of boys were underweight and wasted than girls (7.8%, 6.1%; 5.1%, 5.0% respectively). The Kenya national anthropometric status data[57] also show that a higher percentage of boys than girls had stunted growth (37%, 33%), wasting (7.8%, 5.6%) and underweight (16.8%, 15.4%) respectively.

The level of stunting in this study was lower than the rate of 40% for Sub-Saharan Africa in 2008[9] which is considered very high, based on WHO criteria.[148] Uringu had stunting rates between 20% and 29%, considered to be medium prevalence and Akithii had rates of 30% to 39% classified as a high prevalence.[148]

According to Black et al.[15] "*Nutrition has profound effects on health throughout the human life course and is inextricably linked with mental and social development, especially in early childhood".* In settings with insufficient resources, children are not able to achieve their full growth and developmental potential. Stunted growth affects a child's chances for survival, body measurements, development and consequences ranging from poorer school performance to increased susceptibility to infectious disease. Based on evidence from numerous previous studies, [166, 26, 15,167-169] the severity of stunted growth in children has far reaching effects and hence the need for appropriate steps taken to address the high levels of stunting observed in this study.

4.3 ASSOCIATIONS OF SELECTED DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS WITH KEY VARIABLES OF THE STUDY

Various socio-demographic characteristics that may affect vulnerability to food insecurity and anthropometric status in children were explored. There was no significant relationship found between the education of the mother/care giver and children presenting with stunted growth. This corresponds with a study by Kamiya, [170] in Lao People's Democratic Republic; the finding on mother's education seems very limited in contrast to numerous past studies. Mother's secondary education had a minimum association with WAZ although it approached statistical significance (p=0.071).This finding was contrary to numerous other studies that show that maternal education has been associated with nutrition outcomes among children in studies in various settings including Jamaica[171] and Kenya.[172-173] However, the study in Kenya found that children born of mothers with no education are likely to be 0.12 HAZ scores lower than children born to mothers with primary education and 0.31 scores lower than children born to mothers with post primary education. The lack of association in the present study may be attributed to the fact that the mother/care givers' levels of education in the study area were low with less than 5% having completed secondary education.

In the present study, a significant positive relationship was found between the number of contributors to household income and WAZ scores of children. The number of contributors to household income did not, however, correlate HAZ or WHZ scores. The amount of money spent on food per week significantly affected WAZ and WHZ but not HAZ values. A significant relationship was found to exist between the number of people eating from the same pot namely; the higher the number of people eating from the same pot, the lower the WAZ values. The number of assets owned by a household also significantly influenced HAZ, scores; the higher the numbers of household assets, the higher the HAZ values were. It is important to note that the households in Akithii which is a semi-arid region, [135,138] spent more money on food on a weekly basis compared to Uringu which has a high agricultural productivity.[135, 138]

There was a significant difference in exclusive breastfeeding rates between the two divisions as reported. Akithii had a smaller percentage of respondents who exclusively breastfed their children for the recommended 6 months compared with Uringu. The divisions combined had an exclusive breastfeeding rate of 23.4% which was lower than the national rate of 32%[164] and 33% for eastern and central Africa.[18] This was a very low rate considering the importance of exclusive breastfeeding as indicated by other research.[26]

Evidence from other researchers has reported that partial breastfeeding (breast milk plus other milks or foods) increases child mortality by 2.8 times, as compared to exclusive breastfeeding. The relative risk for prevalence of diarrhoea is 1.26 and 3.04 for predominant and partial breastfeeding, as compared to exclusive breastfeeding. The relative risk for pneumonia is 1.79 and 2.49 for predominant and partial breastfeeding, as compared to exclusive breastfeeding.[174] A report from Philippines, shows a strong positive association between the intake of formula and/or non-breast milk supplements and the risk of hospitalization for infections like pneumonia and diarrhoea[175] underscoring the importance of exclusive breastfeeding.

A significant percentage of children were introduced to complementary feeding before 6 months in both study areas. Akithii had higher numbers of children who were introduced to complementary feeding before 6 months compared to Uringu. A significant percentage of children did not meet the minimum meal frequency as per their age in both study areas. Akithii had higher numbers of children who did not achieve the minimum meal frequency as compared to Uringu.

Complementary feeding practices were assessed using the key indicators recommended by the World Health Organization,[142,175,176] defined as follows: **1.** Timely introduction of solid, semi-solid or soft foods: the proportion of infants 6–8 months of age who received solid, semi-solid or soft foods. **2.** Minimum dietary diversity: the proportion of children 6–23 months of age who received foods from four or more food groups (see Table 2 for the seven classifications of the food groups). **3.** Minimum meal frequency: proportion of breastfed and non-breastfed children 6–23 months of age, who receive solid, semi-solid, or soft foods (but also including milk feeds for non-breastfed children) the minimum number of times or more. Minimum is defined as two times for breastfed infants 6–8 months, three times for breastfed children 9–23 months and four times for non-breastfed children 6–23 months. **4.** Minimum acceptable diet: the proportion of children 6–23 months of age who received a minimum acceptable diet apart from breast milk.

Complementary feeding of children less than 2 years of age is particularly important because they experience rapid growth and development and are vulnerable to illnesses such as acute respiratory infections and diarrhoea diseases. There is evidence that appropriate feeding during this 'critical window' will reduce undernutrition, childhood illness and mortality, especially in the resource-poor settings.[174] It has been found that interventions that occur after this critical 2-year window will not have much impact on the growth of the child.[17] Further investigations for IYCF indicators were not carried out since they were not the focus of this study.

In summary, the findings showed that the select household socioeconomic factors had an influence on child anthropometric status. These factors should be borne in mind in intervention planning to address the nutrition and agriculture interface[177] for the rural areas of Kenya.

4.4 RELATIONSHIP BETWEEN AGRICULTURAL BIODIVERSITY AND HOUSEHOLD FOOD SECURITY

According to the Director-General of FAO, biodiversity is vital to the productive use of the world's marginal land. For many rural families, the sustainable use of local biodiversity is their key to survival since it allows them to exploit marginal land and ensure a minimum level of food production even when faced with extremely harsh conditions.[161]

Recognition of the value of maintaining and using agricultural biodiversity is not new.[178, 179,180] A significant relationship was found to exist between the HFIAS with agricultural biodiversity in this study. As the agricultural biodiversity score increased, the HFIAS score decreased showing that an increase in agricultural biodiversity improved household food security (access).There is limited evidence in SSA of studies linking agricultural biodiversity with household food security and nutritional status. This study showed a significant relationship between agricultural biodiversity and household food security concurring with the recommendation by Frison et al.[21] that, in order to improve nutritional status, it is crucial to study the role of biodiversity as a factor which impacts on household food security. Kenya plans to reduce food insecurity by 30% by 2015.[139] Maintaining and improving agricultural biodiversity should therefore form part of the interventions to enable the achievement of this target, especially in rural areas.

4.5 RELATIONSHIP BETWEEN AGRICULTURAL BIODIVERSITY AND DIETARY DIVERSITY

To understand the contribution of agricultural biodiversity to child nutrition,[35] measurements of both agricultural diversity and dietary diversity were done by Ekesa et al. Their study showed that agricultural biodiversity of a household positively influenced the children's dietary diversity. Numerous studies have shown that the consumption of different species and cultivars within a species may have an impact on nutritional status due to considerable differences in nutrient composition within and between food species.[80-91] Findings from the present study are aligned with the finding that dietary diversity is positively influenced by agricultural biodiversity[129] since households with a higher agricultural biodiversity score had a higher DDS.

In summary, based on findings of the present study, higher agricultural biodiversity was associated with higher dietary diversity suggesting that dietary diversity in rural Kenya can be improved through agricultural biodiversity.

4.6 RELATIONSHIP BETWEEN AGRICULTURAL BIODIVERSITY AND NUTRIENT ADEQUACY

The relationship between agricultural biodiversity and nutrient adequacy ratios (NARs) of all nutrients was explored. Significant positive correlations between agricultural biodiversity and NARs of calcium, iron, zinc, protein, vitamin A, B6, C, folate, riboflavin were found.

The findings were in agreement with those of other studies which show a strong relationship between agricultural biodiversity and nutrient adequacy.[119, 87] The findings of this study therefore show that nutrient adequacy for specific nutrients in the diet of children can be improved by increasing agricultural biodiversity in rural Kenya.

4.7 RELATIONSHIP BETWEEN DIETARY DIVERSITY AND ANTHROPOMETRIC STATUS OF CHILDREN

Child anthropometric indices (WAZ, HAZ, and WHZ) were correlated with DDS to determine the relationships between these variables. Despite evidence from other studies showing associations between WAZ and WHZ with DDS[113, 181, 35] few significant relationships were found in this study. Another recent study in Kenya also found no significant relationship between DDS, WAZ and WHZ (Nungo et al. [165]

There was, however, a significant positive relationship in the present study between stunting in children (HAZ) with dietary diversity of the child in Phase 2 of the study. A higher DDS appeared to correlate with lower stunting levels. These findings concur with a study in rural Bangladesh which found that reduced dietary diversity was a strong predictor of stunting in children aged 6-59 months. High dietary diversity was associated with a 31% reduced odds of being stunted among children 24–59 months, after adjusting for all potential confounders.[182] Findings of other studies suggest that there is an association between child dietary diversity and nutritional status that is independent of socio-economic factors and that dietary diversity may indeed reflect diet quality.[113,128]

Findings in this study therefore showed that children with higher levels of dietary diversity had lower levels of stunting and vice versa. This implies that increasing children's dietary diversity may be an important strategy in reducing high levels of stunting in rural Kenya.

4.8 RELATIONSHIP BETWEEN DIETARY DIVERSITY AND HOUSEHOLD FOOD SECURITY

Previous research has indicated that food security correlates with dietary quality and the intake of a micronutrient rich diet.[183] Findings from this study showed that the child's DDS was significantly inversely correlated with HFIAP. Findings of the present study are similar to those of a study done in Mozambique by FAO in 2006-2007, which compared two regions, Chibabava and Gondola, during two different seasons (pre-harvest and post-harvest).The study correlated HFIAS categories with DDS score and found a significant inverse relationship (p=0.026) where households with a high HFIAS score had a low DDS.[184]

In summary it appears that individuals with a high dietary diversity are likely to be more food secure. This implies that increasing dietary diversity is an important strategy for reducing household food insecurity in rural Kenya.

4.9 RELATIONSHIP BETWEEN HOUSEHOLD FOOD SECURITY AND ANTHROPOMETRIC STATUS IN CHILDREN

No statistical significance was found in the present study between household food security and child nutritional status based on anthropometric measurements. This implies that the food security situation of the households did not correlate with the nutritional status of the children.

While some studies have reported a positive association between household food insecurity and childhood growth indicators[185, 186] others have found no relationship.[187, 188, 189] The lack of association between nutritional status indicators and food security indicator is difficult to explain but suggests that the relationships are more complex than we may think or understand. Although exclusive breastfeeding was low, continued breastfeeding was quite high, so this could in part explain this relationship.

Due to the multifaceted nature of malnutrition, Ruel et al. [44] argues that food security is necessary but not sufficient to ensure nutrition and prevent malnutrition in children because also needed are care givers to provide them with appropriate feeding, care giving, hygiene, and health-seeking practices in order to grow, develop and stay healthy. Pinstrup-Andersen[41] also emphasizes that even if household food security is achieved, malnutrition may flourish due to intra-household distribution, which may not correspond to individual needs or because non-food factors that are important for nutrition such as unclean water, poor sanitation and hygiene and inappropriate care are the most binding constraints to good nutrition. This could probably explain the lack of association in the present study though an association between DD of children and HAZ was established (ref. 4.7).

4.10 RELATIONSHIP BETWEEN DIETARY DIVERSITY AND NUTRIENT ADEQUACY AND MEAN ADEQUACY RATIO

DDS was significantly correlated to MAR and NARs for the all nutrients studied in this study. This means that children who had a higher DDS also had higher NARs and MAR. This finding concurs with those of several studies that have shown DDS to be positively associated with overall dietary quality, micronutrient intake of young children and household food security.[123, 30, 31,190]

A study carried out in Mali on 13-58 months old children showed that NARs had a correlation coefficient of 0.39 ($p<0.01$) although only 3 NARs were positively associated with dietary diversity scores at the $p<0.05$ level.[123] Another study in Iran found that the DDS was correlated with the MAR for 12 nutrients ($r = 0.42$, $p<0.001$) and that there was a statistically significant correlation between the nutrient adequacy ratios of most nutrients with the dietary diversity score.[124]

Another study carried out in Kenya on children aged 1 to 3 years based on 24-hour recalls showed that nutrient intakes were significantly higher ($p = 0.05$) among children consuming >5 foods, compared to those consuming ≤ 5 foods for all the nutrients considered (energy, protein, vitamin A and C, thiamin, riboflavin, niacin, calcium) except iron (p=0.06) which was not significant.[191]

Dietary diversity is therefore important in improving nutrient adequacy and reducing micronutrient deficiencies in the study area. The findings show that a high proportion of children in the study consumed inadequate nutrients therefore improving the level of dietary diversity as a goal for improving diet quality would address this problem. The dietary diversity could be improved by encouraging the households to improve their nutrient intake by propagating the many food varieties being promoted by the Kenya Agricultural Research Institute.

4.11 RELATIONSHIP BETWEEN ANTHROPOMETRIC STATUS OF THE MOTHERS/ CARE GIVERS AND ANTHROPOMETRIC STATUS OF THEIR CHILDREN

There was a significant weak correlation between the BMI of the mothers/care givers and WAZ, WHZ and HAZ scores of the children. Mothers with a lower BMI tended to have children presenting with underweight, wasting and stunted growth .This concurs with findings from several studies that revealed that mothers with a low Body Mass Index (BMI) tend to have children presenting with underweight and higher stunting and wasting levels.[184, 164]

4.12 EFFECT OF SEASONALITY ON AGRICULTURAL BIODIVERSITY, HOUSEHOLD FOOD SECURITY, DIETARY DIVERSITY AND CHILD ANTHROPOMETRIC STATUS

To assess whether household food security was influenced by the change in seasonality, a comparison was done between Phase 1 (dry season) and Phase 2 (wet season) data. There were significant differences between Phase 1 and Phase 2 results, with Phase 1 showing relatively higher levels of food insecurity compared to Phase 2.These findings are similar to those of a study conducted in

Mozambique that found that change in seasonality affected household food security as measured by HFIAS.[184]

Data from Phase 1 in the present study showed higher levels of stunting compared to data from Phase 2. Furthermore, Akithii, the poorer division, had a higher percentage of stunted children compared to Uringu. These findings illustrated that season and biodiversity play a role in nutritional status as well as socio-economic factors. This finding should however be interpreted with caution considering that stunted growth in children is a marker for chronic malnutrition which may not change due to a change of a season. In order to reduce stunted growth in children, all the aforementioned factors have to be addressed. This underscores the complex nature of household food security as indicated by a study in Uganda by Kikafunda[192] who concluded that household food security does not automatically guarantee nutrition security.

CHAPTER 5: ACCEPTING or REJECTING NULL HYPOTHESIS, LIMITATIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 ACCEPTING or REJECTING NULL HYPOTHESES

The study sought to test the following hypotheses:-

1. There are no differences in dietary diversity, agricultural biodiversity and food security of households with and without children with stunted growth.

   A significant difference was found to exist between households with children with stunted growth and those without stunted growth in relation to DDS and HFIAS but not with regard to agricultural biodiversity in this study. *The null hypothesis is rejected for DDS and HFIAS but not for agricultural biodiversity.*

2. There is no relationship between dietary diversity and anthropometric status in children.

   A positive relationship was established between dietary diversity and HAZ (linear growth/chronic malnutrition) but not with WAZ and WHZ scores in children. *This null hypothesis is therefore rejected for HAZ but not for WAZ and WHZ.*

3. There is no relationship between dietary diversity and household food security.

   A positive relationship was established between dietary diversity and household food security. *This null hypothesis is rejected.*

4. There is no relationship between household food security and anthropometric status in children.

   No relationship was established between household food security and anthropometric status in children. *This null hypothesis is accepted.*

5. There is no relationship between agricultural biodiversity and household food security.

   A positive relationship was established between agricultural biodiversity and household food security. *This null hypothesis is rejected.*

6. There is no relationship between agricultural biodiversity and dietary diversity.

   A positive relationship was established between agricultural biodiversity and dietary diversity.

   This null hypothesis is rejected.

7. There is no relationship between the anthropometric status of the mothers/care givers and the anthropometric status of their children. A positive relationship was established between anthropometric status of the mothers/care givers and anthropometric status of their children.

   This null hypothesis is rejected.

8. Seasonal variation does not influence dietary diversity, household food security, and anthropometric status of mothers/care givers and anthropometric status of their children.

   A positive relationship was established in household food security and HAZ but not with DD and WAZ, WHZ of children and BMI of mothers/care givers. This shows that seasonal variations are correlated to household food security and HAZ but not DD and WAZ, WHZ of children and BMI of mothers/care givers

   This null hypothesis is therefore rejected for household food security and HAZ but not for DD, WAZ, and WHZ of children and BMI of mothers/care givers.

5.2 LIMITATIONS OF THE STUDY

1. Due to limitation of resources, this study adopted a cross sectional design. Ideally, a cohort study may have shown greater strengths of association and outcomes of season on the anthropometric status of the children.

2. There was no existing, pre-tested and validated data collection instrument for measuring agricultural biodiversity at the time of commencement of this study. Subsequently, an instrument was developed by Bioversity International.[77] Plant species were not classified into

varieties in this study; therefore the true reflection of agricultural biodiversity could not be measured.

3. The socio-demographic part of the questionnaire was not repeated in Phase 2, because the researcher carried out Phase 2 for the purpose of comparing the effect of seasonality on DDS, HFIAS, BMI and child nutrition as measured by anthropometric indices. A number of variables have been correlated with socio-demographic indicators and hence the interpretation of these correlations should be done with caution.

4. Possible confounding factors such as socio-economic ones were not controlled for in this study and therefore may have influenced the associations between some of the variables.

5.3 CONCLUSIONS

Agricultural biodiversity was low in the study areas. Exclusive breastfeeding levels were low in the study area with Akithii having lower levels compared to Uringu. A significant percentage of children were introduced to complementary feeding before 6 months in both study areas. Akithii had higher numbers of children who were introduced to complementary feeding before 6 months compared to Uringu. A significant percentage of children did not meet the minimum meal frequency as per their age in both study areas. Akithii had higher numbers of children who did not achieve the minimum meal frequency as compared to Uringu.

The dietary intakes of macronutrients and micronutrients were low in the study with most not meeting the recommended dietary intake. Animal protein intake was very low, indicating a shortfall of essential amino acids in the diets of children despite the availability of chicken and cows in the study areas. In the two study areas, all the NARs of the children were poor, with percentages below the recommended 100%. The MARs were also below the recommended levels. The DDS was significantly correlated to MAR and NARs of all the nutrients studied in this study. This means that higher DDS led to higher NARs and MAR.

The BMI of the mothers/care givers significantly influenced WAZ, WHZ and HAZ of children in the study areas. This implies that a mother with a normal BMI was likely to have children who were underweight, wasted or had stunted growth. Stunting rates were high among children in the study areas; this could be partly attributable to: poor infant feeding practices; inadequate food intake and poor dietary diversity; and social and economic factors, resulting in household food insecurity. Prevalence of stunting was lower among households in Uringu where there is a higher agricultural biodiversity compared to Akithii. Increased dietary diversity was associated with lower rates of stunting in children of 24-59 months old. Higher dietary diversity was associated with higher NARs and MAR which implies that dietary diversity affected diet quality and micronutrient adequacy.

Dietary diversity was positively significantly related to household food security. A higher level of child DDS was associated with households with high household food security levels. A significant positive relationship was found between agricultural biodiversity and household food security. A higher level of agricultural biodiversity was associated with greater household food security. Household food security was not significantly associated with anthropometric status in children. This implies that due to the multi-faceted nature of household food security, increasing food access alone may not be the main solution to nutrition security.

Agricultural biodiversity was positively associated with increased dietary diversity. Dietary diversity was found to be higher in children from households with greater agricultural diversity. Households with children presenting with stunted growth were associated with lower dietary diversity, lower agricultural biodiversity and food insecurity compared to households with children presenting with normal growth. The anthropometric status of the mother/care giver was related to the anthropometric status of her child.

5.4 RECOMMENDATIONS

1. The study unearthed the dependence on a few domesticated food items, mostly cereals, for a living. The study findings suggest the necessity of promoting a greater variety of crops to improve both dietary diversity and household food security. Such interventions need to be initiated at a government level mainly by the Ministry of Agriculture in collaboration with the Ministry of Health. With concerted efforts, the suggested interventions can improve the livelihoods of communities in rural areas of Kenya and consequently the nutritional status of their children.

2. Future studies should explore ways of improving agricultural biodiversity as a means of improving dietary diversity and nutrient adequacy to include experimentation with robust cultivars which are better able to withstand drought than the few staples currently being cultivated.

3. Due to the complexity of the interactions of the variables identified in this study and other confounding factors that were not isolated in the study in the measurement of agricultural biodiversity, it is recommended that a similar study be repeated using the manual developed by Bioversity International.[87]

4. Nutrition sensitive interventions that will address the underlying causes of undernutrition in this area are recommended since household food security and agricultural biodiversity did not appear to significantly affect child anthropometry. The Kenya Food Security Information Steering Group which is an inter-sectorial group (ref 2.2.2) could be lobbied on the development and implementation of targeted agricultural programmes and social safety nets in the area of study and other needy areas to support food security, improve diet quality, empower mothers/caregivers, and reaching nutritionally at-risk children. *Nutrition sensitive*

interventions can be leveraged to serve as delivery platforms for nutrition-specific interventions to address the immediate causes of malnutrition as suggested by Ruel et al.[44]

5.5 ANALYSIS OF THE CONCEPTUAL FRAMEWORK

This study established the following significant relationships:

- Between agricultural biodiversity and household food security
- Between agricultural biodiversity and individual DD
- Between individual DD and HAZ
- Between MAR and household food security
- Households with and without children with stunted growth were significantly different in household food security and individual DD

The study did however not establish any significant relationships in the following:

- Between agricultural biodiversity and anthropometric indices
- Between household food security and anthropometric indices

These findings suggest that agricultural biodiversity plays an important role in household food security and in diversification of the diet in these communities. However it may not be possible to measure the effects of agricultural biodiversity by means of anthropometry. Likewise the effects of household food security may not be translated into anthropometric outcomes. There are two reasons for this, namely the fact that the instruments used to measure biodiversity and household food security may not be sensitive enough to distinguish between children who are well nourished from those malnourished. Secondly, confounding of factors which may also have impacted on anthropometric outcomes could not always be controlled for.

The findings of this study have established and provided empirical evidence (ref 1.3.1) that agricultural biodiversity contributes to household food security by maintaining a diverse diet.[87] This ensures a high nutrient adequacy ratio and a high mean adequacy ratio especially of the micronutrients. Based on these findings, it is evident that better nutrition can be achieved through improved agricultural biodiversity among other inputs as explained in earlier texts. Households with children with stunted growth were significantly different from those without in terms of household food security and individual dietary diversity. This shows that food security at the household level and individual dietary diversity are critical aspects of child nutrition though not sufficient. These findings emphasize the need for careful targeting of the poor in nutrition interventions to ensure that the nutrition objectives are achieved. It also demonstrates that agricultural biodiversity is an important pathway to ensuring household food security, dietary diversity and better nutrition for children.

The conceptual framework was able to establish significant relationships between agricultural biodiversity with household food security and dietary diversity. Significant relationships were also established between household food security and individual dietary diversity and dietary diversity with child nutrition.

The conceptual framework failed to establish significant relationship between agricultural biodiversity with child nutrition and household food security with child nutrition as measured by anthropometric indices. This was a weakness of the framework considering that Ruel et al., [42, 44] indicated that food security is necessary but not sufficient to ensure nutrition security and prevent child malnutrition. The conceptual framework needed to take into cognizance and controlled possible confounding factors such as socioeconomic and child care which could have an impact on child nutrition.

It can however be concluded that this study has been able to shed light on the relationships between agricultural biodiversity, household food security and dietary diversity in households with and without children with stunted growth in rural households. The lack of significant relationships between a few variables demonstrates the multifaceted challenge of achieving food and nutrition security. The findings of this study contribute to the arena of agricultural biodiversity, food security and links to child nutrition. The findings show that food systems play a critical role in protecting food security and child nutrition as suggested by Ruel et al.[42]

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ADDENDA

Addendum 1: Socio-Demographic and Health Questionnaire

(Adapted from Steyn et al. [141] *and modified from the Kenyan adult women study)*

DIVISION:…………………………………..VILLAGE:……………………………………………………………

INTERVIEWER NAMES & CODE: …………………………………………………… | | |

Household number: | E | A | | | H | H | | **Interview Date:** | D | D | M | M | 2 | 0 | 1 | 1 |

NAME OF THE PARTICIPANT &CODE

Child …………………………………… | | | | **Birth Date:** | D | D | M | M | 2 | 0 | Y | Y |

Mother …………………………………… | | | | **Birth Date:** | D | D | M | M | | | Y | Y |

Inclusion criteria:

1. Mothers/ Care givers
2. Household with children between 24 and 59 months (only one child from each household (*Ballot to get the index child*)

Exclusion criteria:

1. Household without children between 24 and 59 months
2. Children who are ill for **at least one month continuously** before and including the time of the study will not be included in the sample since a chronic condition may also lead to stunting e.g. malaria

SECTION A: Socio-demographic characteristics

1. **What is your marital status?** (**Circle one number only**):

1	2	3	4	5	6
Single	Married	Divorced	Separated	Widowed	Other Specify…

Circle one number only for every question:

	1	2	3	4	5	6	7	8	9	10	11	12
2 Who decides on what types of food are bought for this household?	Father /in law	Mother/ in law	Husband/partner	Grandmother	Grandfather	Aunt	Uncle	Brother/nephew	Sister/niece	Friend	Self	Other
	1	2	3	4	5	6	7	8	9	10	11	12
3. Who decides how much money is spent on food for this household?	Father /in law	Mother/ in law	Husband/partner	Grandmother	Grandfather	Aunt	Uncle	Brother/nephew	Sister/niece	Friend	Self	Other

4How many people eat from your pot at least 4 days a week **(Insert number in box)**					
5. How many rooms does this house have under one roof? (excluding bathroom/ toilet) **(Insert number in box)**					
6. Where do you get **drinking water most** of the time? **(Circle one number)**	1	2	3	4	5

	Own Tap	Communal Tap	River, Dam, Lake	Well, Borehole	Other (Specify)	
7. What type of toilet does this household have? **(Circle as many numbers as necessary)**	1	2	3	4	5	
	Flush	Pit	VIP	None	Other (Specify)	
8. What **fuel** is used for cooking **most** of the time? **(You can circle not more than two numbers)**	1	2	3	4	5	6
	Electric	Gas	Paraffin	Wood	charcoal	Other (Specify)

9. What is your highest formal education level? **(Circle one number only)**	1	2	3	4	5
	None	Primary School	Some Secondary School	Completed Secondary School	Tertiary

10. What is your employment status? **(Circle one number only)**	1	2	3	4	5	6	7	8
	Unemployed	Homemaker	Self-Employed	Wage-Earner (salaried)	Self-employed Professional	Casual laborer	Petty trade	Other (Specify

11. How many people contribute to the total income (money) in this household? (Circle one number only)	**1**	**2**	**3**	**4**	**5**
	1 person	2 persons	3-4 persons	5-6 persons	More than 6

12. How much money is spent on food weekly (KES?) (Circle one number only)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	0–500	500-800	800-1100	1100-1400	1400-1700	1700-2000	2000-2300	2300-2600	Over 2600	Don't know

13. Please answer the following questions about which items you possess in/at your home (Mark every line)

ITEM	YES	NUMBER (IF YES)	NO
Own home	1		2
Television set	1		2
Radio	1		2
Video cassette machine	1		2
Cattle	1		2
Goat	1		2
Sheep	1		2
Chicken, ducks	1		2
Camel	1		2

Rabbit	1		2
Pigs	1		2
Donkey	1		2
Vehicle	1		2
Motor cycle	1		2
Bicycle	1		2
Wheelbarrow	1		2
Vegetable garden	1		2
Fruit trees	1		2
Sofa set	1		2
Cell phone	1		2

Now decide on the following (considering the main house where this family lives):

14) Type of dwelling:						
a. Roof **You can circle more than one number, if necessary**	1	2	3	4		
	Tiles	Grass thatched	Tin / Mabati	other Specify:		
b. Floor **You can circle more than one number, if necessary**	1	2	3	4	5	
	Brick, Concrete	Traditional Mud	Plank, Wood	Tiles	Other Specify	
c. Walls **You can circle more than one number, if necessary**	1	2	3	4	5	
	Brick, Concrete	Traditional Mud	Tin / Mabati	Plank, Wood	Other Specify:	

15) Do you own any land? Yes (1) N0 (0)

b) If yes, how much is put for food production? Give approximate acreage-----------------

c) Do you have store? Yes (1) N0 (0)

SECTION B: HEALTH STATUS OF CHILD

CIRCLE THE RESPONSES

16) a) Is the child fully immunized for his/her age? Yes = 1 No = 0

Verify the vaccinations by CHECKING ON THE CARD OR asking the questions below:

Question No	Question	Responses
	Circle the immunizations that have been given if the child has a health card. Then go to question NO 16B.	**Mother's Report: If there is no health card or no vaccination recorded, ask the mother the following questions:**
1.	BCG YES	Has (NAME OF CHILD) ever been given an injection

	NO	in the arm that left a scar? YES=1 NO=0
2.	OPV1 YES NO	Has (NAME OF CHILD) ever been given immunization drops in the mouth to prevent him/her from getting disease? YES NO If YES, how many times had he/she been given the drops? ____________Number of times
3.	OPV2 YES NO	
4.	OPV3 YES NO	
5.	DPT1/PENTAVALENT1 YES NO	Has (NAME OF CHILD) been given an injection in the thigh to prevent him/her from getting disease? YES NO If YES, how many times had he/she been given the injection? ____________Number of times
6.	DPT2 /PENTAVALENT2 YES NO	
7.	DPT3/PENTAVALENT3 YES NO	
8.	Measles YES NO	Has (NAME OF CHILD) ever been given an injection in the upper right arm at the age of 9 months or older, to prevent him/her from getting disease? YES NO If YES, how many times has the he/she been given the injection?................Number of times

b) During the last two weeks, did your child (NAME OF CHILD) suffer from any disease symptoms?
Yes = 1 No = 0

c) If Yes, which disease symptoms?
1 = Diarrhoea 2 = Fever 3 = Running nose 4 = Cough 5 = Vomiting

6= Others (Specify)………………………………………………………………………………………….

SECTION C: BREASTFEEDING AND COMPLEMENTARY FEEDING

17) a) Did you ever breastfeed (NAME OF CHILD) child? Yes (1) No (0)

b) If YES, how long did you exclusively breastfeed [NAME OF CHILD] (BREASTMILK ONLY WITHOUT EVEN WATER)?

i) Never

ii) …….weeks

iii)…….months

c) How long did you breastfeed (NAME OF CHILD? Give Number of weeks/months
WEEKS_________________________________
MONTHS________________________________

18) a) At what age did you start complementary feeding?

i) …….weeks

ii) ……..months

19) a)Which were the first 5 foods introduced to the diet of this child (indicate ingredients)
i)………………………
ii)…………………………
iii)…………………………
iv)…………………………
v)…………………………

b) In the first 23 months, how many times did you feed this child during the day and night?

Indicate the number of times
6 to 12 Months_____________________
13 to 23 Months____________________

Addendum 2: Household Food Insecurity Access Scale (Coates et al.[70])

In answering each of the following questions, please respond according to your situation in the past 30 days			
No.	QUESTION	RESPONSE OPTION	CODE
1.	Did you worry that your household would not have enough food?	0 = No (skip to Q2) 1 = Yes	
1.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
2.	Were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1 = Yes	
2.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
3	Did you or any household member eat limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	
3.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
4	Did you or any household member eat food that you preferred not to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	
4.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
5.	Did you or any household member eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	
5.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in	

		the past 30 days) 3 = Often (more than ten times in the past 30 days)	
6.	Did you or any member eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	
6.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
7.	Was there ever no food at all in your household because there were not resources to get more?	0 = No (skip to Q8) 1 = Yes	
7.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
8.	Did you or any household member go to sleep without food at night because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	
8.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	
9.	Did you or any household member go a whole day without eating anything because there was not enough food?	0 = No (skip to Q5) 1 = Yes	
9.a	How often did this happen?	1 = Rarely (once or twice in the past 30 days 2 = Sometimes (three to ten times in the past 30 days) 3 = Often (more than ten times in the past 30 days)	

Addendum 3: 24-Hour Recall Questionnaire

NAME OF THE PARTICIPANT (CHILD)... ☐☐☐☐

CODE OF PARTICIPANT*:* ☐☐☐☐

INTERVIEWER NAME AND CODE:.. ....

Tick the day of the week, which you are recalling**?** **Monday** ☐ **Tuesday** ☐

Wednesday ☐ ***Thursday*** ☐ ***Friday*** ☐ ***Saturday*** ☐ ***Sunday*** ☐

Steps for the Interviewer to follow when interviewing each participant

Step 1: *The interviewer can start the interview as follows:* "I want you to think back to when you woke up yesterday morning. What time was it? Now I want you to try and remember what the child ate and drank yesterday from the moment that you got up until you went to sleep again last night. Run through the whole day in your mind and try to remember everything that you ate or drank." *The interviewer must then give the subject a little time to do what he/she was asked to do- during this time the interviewer must be quiet. Then the interviewer can carry on:* "Now I would like you to tell me what you child ate and drank starting in the morning after you got up." *After the subject mentioned an item, the interviewer should prompt him/her by saying* "and then?" *It is important that the interviewer does not try to ask any specific detail at this point.* ***Enter the information on Form 1 (Column 1).***

Form 1

STEP 1: Food/drink eaten/drank during the day	**STEP 2:** Forgotten foods (PROMPTED)

Step 2: To check whether the subject forgot anything, the interviewer asks the following:

- *"Did your child have any drinks yesterday?"*
- *"Did your child any sweets and or chocolate yesterday?"*
- *"Did your child any cake yesterday?"*
- *"Did your child any cookies yesterday?"*
- *"Did your child any savoury snacks like chips/pop corn/salty biscuits yesterday?"*
- *"Did your child have any (other) fruit yesterday?"*
- *"Did you have any (other) vegetables yesterday?"*
- *"Did you have any bread or rolls yesterday?"*

Enter this information on Form 1 (Column 2).
At this point you need to ask the subject whether what he/she has ate/drank the previous day is the same as usual, more than usual or less than usual. The answer must be entered at the bottom of Form 1. You must also ask the subject what type of butter/margarine and milk are usually used in their home and enter it in the given space at the bottom of Form 2.

Step 3: To find out more detail about each item that was eaten or drunk, the following can be said and asked: *"Now I am going to ask you more about each food or drink that your child ate/drank yesterday. Let us start with the first item on the list. At what time did you eat…(= item 1 on the list)".* **Enter item 1 on Form 2 (column 3) and then enter the time when this item was eaten also on Form 2 (column 1).** Do not spend a lot of time trying to find out the exact time. Any comments about the time can be **entered on Form 2 (column 2).***Now I want you to tell me more about this food item…."* This will include a description of the food as well as the preparation. **Enter this information on Form 2 (column 4).** *"Now we are going to find out how much of this item you ate/drank."* The fieldworker now uses the different aids to help the subject to identify the portion size. A description of the portion size in terms of cups, spoons, bowls, glasses, matchboxes, Manual Picture size or centimeters (using the ruler) is then **entered on Form 2 (column 5).**If the food code and the portion size in gram of this particular item is easy to find, it can be **entered on Form (columns 6 an 7).** If it is not clear or easy, the code and gram weight can be left out to be completed after the interview. This process is repeated for each food item that was entered on Form 1.

Step 4: To help the subject to make sure that he/she has not forgotten any food item, the interviewer can ask him/her to think back very carefully to make sure that he/she has not forgotten anything. If time allows, the subject can page through the photo cards to see whether he/she sees anything that he/she might have forgotten.
Step 5: Ask the subject the primary source of each of the food items.

FORM 2: DATA SHEET FOR INFORMATION COLLECTED IN THE 24-HOUR RECALL INTERVIEW

Time of day	Food item	Detailed description of the item as well as preparation	Detailed description of the portion size	Code	Weight (g)	*Primary source of the food

*B= Bought; H= Homegrown; FA= Food Aid; D=Donation

Time of day	**Food item**	**Detailed description of the item as well as preparation**	**Detailed description of the portion size**	**Code**	**Weight (g)**	***Primary source of the food**

*B= Bought; H= Homegrown; FA= Food Aid; D=Donation

2 (a) what was eaten/drank by members of your child: was it same as, more than or less than usual? (Circle one)

i. Same
ii. More
iii. Less

b) If more or less than usual, explain why (circle one)

i. Celebration
ii. Religious activity
iii. Little food in household
iv. Other (specify)

Addendum 4: Agricultural Biodiversity

1). Ask the respondent to tell you all the animals reared, hunted and food and food items obtained from natural habitats in the past one year. Probe for all possible answers

Domestic Animals	Domestic cereals	Domestic vegetables &Fruits	Wild animals hunted for food	Wild vegetables, fruits& roots collected for food

2). Ask the respondent to tell you all the animals reared, hunted and food items obtained from natural habitats which were used in the past and are no longer being used. Probe for all possible answers

Domestic Animals	Domestic cereals	Domestic vegetables &Fruits	Wild animals hunted for food	Wild vegetables, fruits& roots collected for food

3). what are the reasons for not using these food items anymore? INDICATE THE FOOD AND THE REASON.

Addendum 5: Nutritional Assessment (Anthropometry)

Identification number I__I__I__I__I__I__I__I__I Date of measurement I__I__I__I

Child birth order	Childs Name	Sex	If birth card or birth certificate are available copy the date of birth	If birth card or birth certificate are not available assist the mother/ care giver to estimate the age in months	Oedema (Bilateral) 1=Yes 2=No	Weight (10gms) (1st)	Weight (10gms) (2nd)	average	Height (0.1cm) (1st)	Height (0.1cm) (2nd)	Average
			Dd/mm/yyyy	mm							

22) Measurement of mother/ care giver body dimensions

Respondents Name	Date of birth	Weight (10gms) (1st)	Weight (10gms) (2nd)	Average	Height (0.1cm) (1st)	Height (0.1cm) (2nd)	Average

Expectant Mothers

Respondents Name	Date of birth	MUAC (0.1mm) (1st)	MUAC (0.1mm) (2nd)	Average

Addendum 6: Focus Group Discussion Conversation Guide

Community Leaders Guide
Be certain to speak into the recorder, both group and the facilitator to ensure recording.

1. Introduction
   a) Welcome
   b) Introduce yourself and team
   c) Summarize the purpose of visit
      a. To investigate the agricultural biodiversity and its relationship with household food security and dietary diversity-past and present experience.
   d) Refreshments
   e) Turn off cell phones

3. Have group members introduce themselves

4. Turn on recorder

Questions

1. a) What food crops have been grown in your community in the past one year?
   b) What cereals are grown?
   c) What vegetables are grown?
   d) What root and tubers are grown?
   e) What fruits are grown?

2. a) What animals have been reared in your community in the past one year?
   b) What animals does the community hunt for food?
   c) What foods are collected from the natural habitat?

3. a) What food crops were grown in your community in the past are not being grown now?
   b) What cereals were grown?
   c) What vegetables were grown?
   d) What root and tubers were grown?
   e) What fruits were grown?

4. What do you think are the reasons the community stopped growing them?

5. a)What animals were reared in your community at past and are not being reared at present?
   b) What animals were hunted for food?
   c) What foods were collected from the natural habitat?

6. What do you think are the reasons the community is not using these sources for food?

7. Considering the changes in the foods being grown now and in the past,
   a) What is the impact in food production?
   b) What is the impact on the food availability?
   c) What is the impact on the food access?

d) What is the impact on the food diversity?

8. Mention some of the traditional dishes that are no longer being prepared presently? What could be the reasons be for people not preparing these dishes today?

9. Do you think the community has a problem with ensuring food security?
   - What do you think are the reasons why the community could be food insecure?
   - What time or season of year does the community have the difficulties in ensuring food security?
   - What measure would the community put in place to ensure food security considering the present circumstances?

Addendum 7: Ethics Approval

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

25 July 2011

MAILED

Ms F M'Kaibi
Department of Human Nutrition
3rd Floor
Clinical Building

Dear Ms M'Kaibi

The role of agricultural biodiversity, dietary diversity and household food security in households with and without stunted children in rural Kenya.

ETHICS REFERENCE NO: N11/02/037

RE : APPROVAL

At a meeting of the Health Research Ethics Committee that was held on 2 March 2011, the above project was approved on condition that further information is submitted.

This information was supplied and the project was finally approved on 22 July 2011 for a period of one year from this date. This project is therefore now registered and you can proceed with the work.

Please quote the above-mentioned project number in ALL future correspondence.

Please note that a progress report (obtainable on the website of our Division: www.sun.ac.za/rds should be submitted to the Committee before the year has expired. The Committee will then consider the continuation of the project for a further year (if necessary). Annually a number of projects may be selected randomly and subjected to an external audit.
Translations of the consent document in the languages applicable to the study participants should be submitted.

Federal Wide Assurance Number: 00001372
Institutional Review Board (IRB) Number: IRB0005239
The Health Research Ethics Committee complies with the SA National Health Act No.61 2003 as it pertains to health research and the United States Code of Federal Regulations Title 45 Part 46. This committee abides by the ethical norms and principles for research, established by the Declaration of Helsinki, the South African Medical Research Council Guidelines as well as the Guidelines for Ethical Research: Principles Structures and Processes 2004 (Department of Health).

Please note that for research at a primary or secondary healthcare facility permission must still be obtained from the relevant authorities (Western Cape Department of Health and/or City Health) to conduct the research as stated in the protocol. Contact persons are Ms Claudette Abrahams at Western Cape Department of Health (healthres@pgwc.gov.za Tel: +27 21 483 9907) and Dr Hélène Visser at City Health (Helene.Visser@capetown.gov.za Tel: +27 21 400 3981). Research that will be conducted at any tertiary academic institution requires approval from the relevant hospital manager. Ethics approval is required BEFORE approval can be obtained from these health authorities.

Approval Date: 22 July 2011 Expiry Date: 22 July 2012

25 July 2011 12:31

Page 1 of 2

Fakulteit Gesondheidswetenskappe · Faculty of Health Sciences

Verbind tot Optimale Gesondheid · Committed to Optimal Health
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Addendum 8: Consent Form

PARTICIPANT INFORMATION LEAFLET AND CONSENT FORM

TITLE OF THE RESEARCH PROJECT:

THE ROLE OF AGRICULTURAL BIODIVERSITY, DIETARY DIVERSITY AND HOUSEHOLD FOOD SECURITY IN HOUSEHOLDS WITH AND WITHOUT CHILDREN WITH STUNTED GROWTH IN RURAL KENYA

REFERENCE NUMBER: N11/02/037

PRINCIPAL INVESTIGATOR:

ADDRESS: BOX 44600-00100, NAIROBI

CONTACT NUMBER:

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the Health Research Ethics Committee (HREC) at Stellenbosch University **and will be conducted according to the ethical guidelines and principles of the international Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.**

What is this research study all about?

- *Where will the study be conducted; are there other sites; total number of participants to be recruited at your site and altogether.*

1. The study will be carried out in Akithii and Uringu divisions of Tigania West District in the Eastern part of Kenya.

2. A sample of 500 participants will be selected; 250 respondents in each of the divisions. This sample will be drawn with a method where everyone in the area has an equal chance to be included in the study.

Explain in participant friendly language what your project aims to do and why you are doing it?

This study aims to look at information about the nutritional health status of children (24 – 59 months) and their mothers in the two mentioned areas. The information will help the researchers understand what the factors are that influence you and your children's nutritional health.
One part of the study will look at the different things that influence whether there is at all times enough healthy food for everyone in the household, as well as the eating patterns of the child and his / her mother. If you agree to participate, the fieldworkers will complete some questionnaires with your help. These questionnaires will focus on:

- information of the household and its members,
- food items in the house, when and where it was gathered / sourced or bought;
- food items and dishes eaten by the child and mother

The fieldworkers will also weigh you and your child and measure your heights and arm thicknesses.

The other part of the study will look at the variety and variability of plants and animals that are used for food in the two areas. Discussions will be held with the chiefs and elders to get this information.

All this information will help the researchers to find ways with the local chiefs and service providers to improve the food and nutrition situation in your area and can eventually help to improve the nutritional health of children and the residents in future.

Why have you been invited to participate?

- *Explain this question clearly.*

You have been invited to participate because you have been selected from the list of households given by the local chief. Your household also has children aged 2-5years. We have used a way to choose addresses of houses in this area so that all houses had the same chance of being chosen.

What will your responsibilities be?

- *Explain this question clearly.*

Your responsibility will be to answer the questions as truthfully and objectively as possible. You will also allow us to take the measurements of your children

Will you benefit from taking part in this research?

- Explain all benefits objectively. If there are no personal benefits then indicate who is likely to benefit from this research e.g. future patients.

You will benefit indirectly if you take part in this study. You will get an opportunity to have your child's measurements taken which will help you know whether your child is growing well. The study will help us gather information regarding the nutritional status of children and their mothers and dietary habits in households in these communities as well as plants and animals that are used for food. This information will help us to work with leaders and organizations in the communities to develop and implement plans to improve the food situation and therefore the nutritional status of the children and residents in these communities in future.

Are there any risks involved in your taking part in this research?

- Identify any risks objectively.

There are no risks associated with taking part in this study

If you do not agree to take part, what alternatives do you have?

- *Clearly indicate in broad terms what alternative treatment is available and where it can be accessed, if applicable.*

If you do not agree to take part in this study you are free to decline. If you need more information about nutrition and healthy eating, you are welcome to get information at the local clinic or any other health care facility.

Who will have access to your medical records?

- *Explain that the information collected will be treated as confidential and protected. If it is used in a publication or thesis, the identity of the participant will remain anonymous. Clearly indicate who will have access to the information.*

All information provided by you will be private. You will get a study number that will be placed on your completed question form. Nobody other than the researchers will see the individual, personal information.

What will happen in the unlikely event of some form of injury occurring as a direct result of your taking part in this research study?

If any injury occurs as a direct result of this study, the researcher will ensure that treatment is sought from the government hospital in the area.

Will you be paid to take part in this study and are there any costs involved?

No, you will not be paid to take part in the study but your transport and meal costs will be covered for each study visit. There will be no costs involved for you, if you do take part**.**

Is there anything else that you should know or do?

- You can contact the Health Research Ethics Committee at +2721-938 9207 if you have any concerns or complaints that have not been adequately addressed by your study doctor.
- You will receive a copy of this information and consent form for your own records.

Declaration by participant

By signing below, I ………………………………..…………. agree to take part in a research study entitled; The Role of Agricultural Biodiversity, Dietary Diversity, And Household Food Security In Households With and Without Children with Stunted growth in Rural Kenya

I declare that:

- I have read or had read to me this information and consent form and it is written in a language with which I am fluent and comfortable.
- I have had a chance to ask questions and all my questions have been adequately answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurized to take part.
- I may choose to leave the study at any time and will not be penalized or prejudiced in any way.
- I may be asked to leave the study before it has finished, if the study doctor or researcher feels it is in my best interests, or if I do not follow the study plan, as agreed to.

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 2011.

....

Signature/thumb print of participant Signature of witness

Declaration by investigator

I *(name)* ……………..……… declare that:

- I explained the information in this document to …………………………………..
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above
- I did/did not use a interpreter. (*If an interpreter is used then the interpreter must sign the declaration below.*

Signed at (*place*) ....…........…………….. on (*date*) …………....……….. 2011.

Signature of investigator Signature of witness

Declaration by interpreter

I *(name)* …………………………………………..……… declare that:

- I assisted the investigator (*name*) ……………………………………… to explain the information in this document to (*name of participant*) ……………..…………………………….. using the language medium of Kiswahili/Kimeru.
- We encouraged him/her to ask questions and took adequate time to answer them.
- I conveyed a factually correct version of what was relayed to me.
- I am satisfied that the participant fully understands the content of this informed consent document and has had all his/her question satisfactorily answered.

Signed at (*place*) ....…........…………….. on (*date*) …………....………………..

....

Signature of interpreter

Addendum 9: TRAINING MANUAL FOR RESEARCH WORKERS

SOCIODEMOGRAPHIC AND HEALTH QUESTIONARE

The first part of the questionnaire comprises questions which you ask to the mother or the care giver. The care giver must be a person who takes care of the child for example a grandmother or an aunt. The respondent must be **preferably** the mother to the child. After completing the questionnaire you should take the weight and height measurements of the child and the mother. If the mother is pregnant take the Mid Arm Circumference (MUAC) as indicated on the nutritional assessment form.

HOW TO COMPLETE THE QUESTIONNAIRE

First greet the Eg, Good morning. Then introduce yourselfwith the help of the village elder; eg, I am Mary Karimi form the Stellenbosch university-South Africa. I would want to ask you questions regarding food security and the children of 24 to 59 months, explain the purpose of the interview. I will ask a number of questions, but feel free to express your opinion. The information I am asking will be confidential. Are you willing to go on with the interview? If they are willing, proceed. Fill in the consent form. Illiterate respondents will express their willingness to participate in the interview by making a cross on the consent form and a witness will sign the consent form. If they are not willing, please thank them for the time and proceed to the next selected household.

Write the address of the participant in the note book e.g. Mary Karimi, Kailimba village, house number 5.Fill in the top of page 1 eg Interviewer no 01.Your interview codes are as follows: Kathure-KH, Joyce-JC, and Mary-MR. This must be done first in each questionnaire. Write the names of the child and the mother/caretaker in full. Fill in the household number, starting with AK- for Akithii Division and UR-for Uringu division eg AK-002 or UR-008.Ask and fill in the birth date of the child, confirm with the immunization card or birth notification card. Fill in the date of the interview, starting with day and the month which you conducted the interview.

NB. The households to be included in the interview are those with children between 24 and 59 months (only one child from each household will participate in the survey but if there is more than one child in this age bracket, randomly select one child).

Now fill in the rest of the questionnaire. Ask all the questions. Note the following when you complete the questionnaire:

- Use a black pen
- Make a (X) or circle in the required space.
- If you make a mistake use a red pen to cross out and re-enter the item in the correct place with a black pen.

A short exercise: *Child X lives in Household Akithii and was born in 2007.Household No. AK008. Fill in the questionnaire*.

Q1: Inquires about the marital status of the mother/ care giver. Ask the question as stated in the questionnaire. Mark only one answer.

Q2: Inquires who makes decisions on the type of foods consumed in the household. Ask the question as stated in the questionnaire. Mark only one answer

Q3: Inquires who makes decisions on amount of money to be spent on food for the household. Ask the question as stated in the questionnaire. Mark only one answer

Q4: Inquires about the number of people who eat from the same pot at least 4 days a week. Ask the question as stated in the questionnaire. Write the number on the space provided.

Q5: Inquires about the number of rooms in the main house (excluding bathroom/ toilet). Ask the question as stated in the questionnaire. Write the number on the space provided.

Q6: Inquires about the sources of drinking water. Ask the question as stated in the questionnaire. Mark only one answer

Q7: Inquires about the type of toilet the household uses. Ask the question as stated in the questionnaire. Mark only one answer

Q8: Inquires about the types of fuel used in the household for cooking most of the time. Ask the question as stated in the questionnaire. You can mark more than one answer

Q9: Inquires about the mothers/ care givers level of education. Ask the question as stated in the questionnaire. Mark only one answer

Q10: Inquires about the mothers/ care givers employment status. Ask the question as stated in the questionnaire. Mark only one answer

Q11: Inquires about the number of people who contribute to the total income used in the household. Ask the question as stated in the questionnaire. Mark only one answer

Q12: Inquires about the amount of money spent on food-help do the calculations if necessary. Ask the question as stated in the questionnaire. Mark only one answer

Q13: Inquires about the household possessions. Ask the question as stated in the questionnaire. Mark only one answers either yes or no and if yes give the numbers.

Q14: Inquires about land ownership and the size under food production. Ask the question as stated in the questionnaire. Mark only one answer and give the size of land where relevant.

Q15: Inquires about whether the child has been fully immunized for his/her. Ask the questions as stated in the questionnaire. The field worker to check the immunization card for verification Mark only one answer

Q16: Inquires about whether the child has been suffered for either of the listed symptoms during the last two weeks. Ask the questions as stated in the questionnaire. Mark only one answer

Q17: Inquires about whether the child was ever breast fed. Ask the questions as stated in the questionnaire. Mark only one answer

Q18 Inquires about whether the child was ever breast fed. Ask the questions as stated in the questionnaire. Mark only one answer, insert the week/months on the space provided and make any comments on the space provided.

Q19 Inquires about complementary feeding and breast feeding. Ask the questions as stated in the questionnaire. Insert the answers on the spaces provided and make any comments on the space provided

Q20. Requires you to record the five foods introduced to the diet of the child. Ask the questions as stated in the questionnaire. Answer on the space provided.

Q 21 NUTRITION STATUS

First obtain the participants permission. Fill in the identification details and the date the measurements are taken. This must be done with full privacy, inside the house.

ANTHROPOMETRIC ASSESSMENT FOR THE CHILD

Weigh the child with light clothing, ie no jackets, sweater, shoes

Record the weight to the nearest 10gms.

Measure the height without shoes or hat. Let the child stand straight up, facing you.

Record measurement to the nearest 0.1cm.

Record all the measurement in the spaces provided

ANTHROPOMETRIC ASSESSMENT FOR THE MOTHER/ CARE GIVER

Weigh the mother/ care giver with light clothing, ie no jackets, sweater, shoes

Record the weight to the nearest 10gms.

Measure the height without shoes or hat. Let the mother/ care giver stand straight up, facing you.

Record measurement to the nearest 0.1cm

NB. Incase the mother/care giver is pregnant measure the Mid arm circumference (MUAC) to the nearest 0.1mm

Record all the measurement in the spaces provided

Q23. Observe record on the space provided the type of dwelling the mother/ care giver and child lives

- **HOUSEHOLD FOOD INSECURITY ACCESS SCALE- (HUNGER SCALE)**

Read the questions as written in your own language. Mark either yes or no.

- **DIETARY INTAKE**

Repeated 24-hour recall will be used to collect information on what the participants eat.

- **AGRICULTURAL BIODIVERSITY QUESTIONNAIRE**

Q1.Ask the respondent to tell you all the animals reared, hunted and food and food items obtained from natural habitats in the past one year. Probe for all possible answers. Record the answers in the space provided.

*Q2.*Ask the respondent to tell you all the animals reared, hunted and food items obtained from natural habitats which were used in the past and are no longer being used. Probe for all possible answers Record the answers in the space provided.

Q3. Ask for the reasons why the animals reared, hunted and food items obtained from natural habitats which were used in the past and are no longer being used .Probe for all possible answers. Record the answers in the space provided.

Completion of the questionnaires and the measurements will be done as follows:

During the first visit the following will be done:

- ✓ The Socio-Demographic and Health Questionnaire (SDHQ) will be completed
- ✓ Anthropometric measurements will be taken (weight, height, arm circumference where necessary)
- ✓ Repeated 24-hour dietary recall which will be conducted(5days apart)
- ✓ Household Food Insecurity Access Scale (HFIAS)

During the second visit the following will be done:

- ✓ Anthropometric measurements will be taken (weight, height, arm circumference where necessary)
- ✓ Repeated 24-hour dietary recall which will be conducted(5days apart)
- ✓ Household Food Insecurity Access Scale (HFIAS).