SEASONAL FACTORS IN DIETARY INTAKES AND NUTRITIONAL STATUS OF WOMEN (15-49 YEARS) AND CHILDREN (6-59 MONTHS) IN KITUI DISTRICT-KENYA

By

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DECLARATION

I Joyce Wairimu Njoya hereby declare that this dissertation is my original work and that it has not been presented for a degree in any other university

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DEDICATION

This study is dedicated to my late parents, William Wanjie and Esther Wanjiru for being the best parents I could ever have. To my ever loving husband, Robert Njoya and our four children, Eunice, Esther ,Richard and William.

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OPERATIONAL DEFINITIONS

Adaptations: Adjustments in natural or human system in response to actual or expected climatic stimuli or their effects which moderates harm or exploits beneficial opportunities like changing of crops, revising planting dates or improved irrigation.(WHO, 2008).

Climate: Prevailing weather condition of an area that is a statistical ensemble of atmospheric conditions, characteristic of a particular locality over a long period of time (e.g. 30 years) including relevant parameters such as mean, extreme values, measures of variability, and description of systematic seasonal variations. Aspects considered are rainfall, solar radiation, cloud, wind, temperature, humidity, and atmospheric pressure (Chambers, Dictionary of Science and Technology): For the purpose of this study rainfall and temperature are the climate indicators.

Climate change: It is the change of climate on time scales longer than that on which the usual working definition of climate is based on i.e. 30-50years. Mean values of atmospheric variables such as temperature and rainfall taken over N years fluctuate less and less as N increases from 1 to 30 or so , and a period of 30 years is usually adequate in most regions to provide rough estimates of extremes likely to be encountered over much longer periods.(Chambers, Dictionary of science and Technology).

Climate variability: Is a term used to denote deviations of climate statistics over a given period (such as a month, season or year) from the long term climate statistics relating to the corresponding calendar period. In this sense climate variability is measured by those deviations which are usually termed anomalies (FAO, 2008).

Chronic food insecurity : A situation of inadequate diet resulting from the continual inability of households to acquire needed food. Chronic food insecurity is generally rooted in poverty (USAID,2003) .

Coping strategy: The methods by which households deal with a crisis e.g. changing diets, selling assets, migrating or seeking other sources of income (USAID 2003).

Dietary intakes: The quantity and quality of food consumed by a person. The body requires certain amounts of the various nutrients on a daily basis for proper growth and functionality. A diet limited in any of these will cause negative consequences on an individual's nutritional status (FSAU, 2003; Wendy et. At., 2007).

Dietary pattern: Dietary patterns are meals consumed as a routine in a particular place by the people. The meals are formed from foods that are locally available from production or the market. The dietary patterns may vary from season to season depending on what is available. Households will consume the foods that are readily available to them e.g. in the rural communities, the households tend to consume more green vegetables during the rainy season than the dry season.(FSAU, 2003)

Drought: is a naturally occurring phenomenon that exists when precipitation is significantly below normal recorded levels causing a serious water imbalance that affects land resource production systems. (Riely et. al., 1999)

Food security: When all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life.(USAID 2005)

Household: People living together in the same house (usually) nuclear family, relatives or extended relatives and sharing meals regularly.

Impact: Describes the long term changes planned or unplanned in a system caused by its exposure, like an intervention or a disaster. Impacts may be judged to be harmful or beneficial (USAID, 2003).

Mitigation: Short or long term actions, programs or policies implemented in advance of a natural hazard or in its early stages to reduce the degree of risk to the people, property and productivity capacity.

Mode: This is the outcome with the highest frequency

Resilience: Ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self organization and the capacity to adapt to stress and change.

Seasonal variability: The fluctuation of rainfall within one year and usually defined in a number of dry months in a year i.e. insufficient rainfall to meet the needs of plants. This is absolute seasonality which makes a distinction between unimodal and bimodal type of climate. (Foeken,et. al., 1988)

Transitory food insecurity : A situation of temporary decline in a household's access to needed food. This can be seasonal or inter-annual. (USAID,2003)

Vulnerability: Vulnerability refers to a set of conditions resulting from physical, social, economic and environmental factors, which increase the susceptibility of a community to the

impact of disasters. Vulnerability also refers to the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. Nutritional vulnerability occurs when consumption and utilization of food of adequate quality and quantity is threatened. This can occur during periods of food insecurity, high incidences of communicable diseases, substandard care due to destitution, illiteracy, displacement or tradition (USAID 2003).

ABBREVIATIONS

ACRWC	African Charter on the Rights and Welfare of the Child
ALRMP	Arid Land Resource Management Project
AMREF	African Medical and Research Foundation
ANOVA	Analysis of Variance
ASALs	Arid and semi-Arid Lands
ASS	Africa South of the Sahara
BAZ	Body Mass Index for Age z-scores
BMI	Body Mass Index
CBS	Central Bureau of Statistics
CFCs	Chlorofluorocarbons
CI	Confidence Interval
CRC	Conventions on the Rights of the Child
ENSO	Elnino Southern Oscillation
FAO	Food and Agricultural Organisation
FEWSNET	Famine Early Warning System Network
FGD	Focus Group Discussion
FSAU	Food Security Analysis Unit
GAM	Global Acute Malnutrition
GDP	Gross Domestic Product
GOK	Government of Kenya
HAZ	Height for Age z-scores
IDDS	Individual Dietary Diversity Score
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
IQR	Interquartile Range
IU	International Units
KDHS	Kenya Demographic and Health Survey
KNBS	Kenya National Bureau of Statistics
Ksh	Kenya shilling
MDG	Millennium Development Goals

MOH	Ministry of Health
MUAC	Mid Upper Arm Circumference
OCHA	United Nations Office for the Co-ordination of Humanitarian Affaires
OR	Odds Ratio
PAMFORK	Participatory Methodologies Forum of Kenya
RDAs	Recommended Dietary Allowances
SAM	Severe Acute Malnutrition
SASE	Semi Arid Savannah Environment
Sd	standard deviation
SSA	Sub-Saharan Africa
TAR	Third Assessment Report
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Education Fund
USAID	United States Agency for International Development
WAZ	Weight for Age z-scores
WHZ	Weight for Height z-scores
WFP	World Food Programme
WMO	World Meteorological Organization
WHO	World Health Organization

ABSTRACT

Climate variability and change which is a global issue may directly affect seasons, either negatively or positively determining agricultural food production. Nutritional status of any population is highly dependent on agricultural food production and therefore depending on the seasonal effect, may result to poor or good status. In Kenya, especially in the arid and semi arid areas, seasonal variation is common, giving rise to inconsistent agricultural food production hence food insecurity.

In many communities, though the nutritional status is affected generally in the entire household, it is more severe within the child bearing women of 15-49 years of age and children under the age of five years (6-59months) who are the more vulnerable groups.
The objective of the study was to establish, the seasonal variability in food security, dietary intakes and nutritional status of children 6 –59 months of age and women 15-49 years in two climatic seasons. The hypothesis was that seasonal variability contributes significantly to the food insecurity status in Kitui.

The study was cross-sectional in which data was collected in two phases, the long rains harvest period (July 2008) and the short rains harvest period (March 2009) and these were, season 1 which had 147 households surveyed and season 2 had 171 households respectively. In both seasons, household level survey, collected data on food production, employment status and incomes, expenditures, assets, morbidity, and dietary intakes and anthropometric measurements on women and children. Independent samples t-test, and Mann- Whitney tests were used to compare the two seasons. Predictor variables for children's nutritional status

were assessed by binary logistic regression. Reference was also made to the existing food production and climatic data.

The levels of food insecurity, and the prevalence underweight and stunting in children were found significantly higher during the short rains harvest period compared to the long rains harvest period. Household median production of maize dropped by about 70%, and beans by 50% during the short rains harvest season. Dietary intakes and dietary diversity in terms of energy and nutrient intake fluctuated significantly between the two seasons, worse off during the short rains harvest period. Though the nutritional status of the women did not change significantly between the seasons, more underweight women were found during the short rains harvest period. Household income and consumption frequency of some locally produced foods positively correlated (significantly) with nutritional status. Diet based coping strategies did not seem to influence nutritional status significantly. Seasons, consumption frequency of beans per week and household size, were found to be appropriate predictors of nutritional status of children on a multivariate regression analysis.

Seasonal variability had a significant contribution on food security, dietary intakes and nutritional status of the children but not of the mothers. The short rains season was worse off than the long rains season in terms of produced food, dietary intakes and dietary diversity, employment, incomes, expenditures and nutritional status. The study recommends that adaptation measures specific to the region need to be designed to enable the small holder farmer boost the food security status and mitigate declining nutritional status.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

The Arid and Semi-Arid Lands (ASALs) of Kenya make up more than 80% of Kenya's landmass, support nearly half of the livestock population of the country and over 30% of the total human population. The Arid and Semi-arid Lands are prone to harsh weather conditions rendering the communities within this region vulnerable to natural hazards, mainly droughts. The ASALs, due to their fragile ecosystems, unfavourable climate, poor infrastructure and historical marginalization, represent a major development challenge for the affected populations, the Government of Kenya and its development (OCHA, 2008 ; UNDP, 2004)

Climate variability and change has a significant control over intra-annual seasons particularly for the agriculture and water resources sectors, at regional, local, and household scales. Though the changing climate is a global problem, local impacts are felt in the changes of weather patterns and seasons mainly the temperatures, rainfall and extreme weather (Boko et al, 2007). Weather extremes are prolonged droughts and floods and these in some cases have been linked with Elnino Southern Oscillation events (ENSO).

Seasons determine food production especially of staple crops in the rural areas. Most agricultural production in Kenya and Africa as a whole is dependent on rainfall. Seasonal rainfall dominates most of the rural activities geared towards food production and these form regular patterns of food supply levels and dietary intakes and hence the nutritional status (Ngigi, 2003). The major limiting factors in agricultural food production is the availability of soil moisture, temperatures, pests, crop disease, lack of access to inputs and improved seeds. In Kenya most rural communities face these challenges as their livelihoods depend entirely on subsistence farming

which not only supplies food but is also a source of income. Poor harvests create chronic food insecurity especially in ASALs where rainfall is erratic and unreliable. Where severe droughts and long periods of dry weather are more frequent, famine, starvation and under nutrition become rampant. The situation may also drive some household members to migrate to other areas in search of cash incomes further reducing future food production labour and hence increased food instability (Kumar, 1988)

The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) has positively associated a range of impacts with climate variability and climate change. Climate variability is distinguished from climate change by the fact that climate variability is a natural phenomenon and has been in existence in the earth's history (Leeman, 1999). Climate change on the other hand is mainly through human activity such as emission of fossil fuel gases known as the greenhouse gases, dust and aerosol accumulation, deforestation and general environmental degradation.

The damaging effect of anthropogenic change in climate is experienced in the changed frequency of extreme events like storms, droughts and floods (Leeman, 1999 ; Boko et al. 2007). Drought is the most prevalent natural hazard in Kenya affecting mainly Eastern, North Eastern, parts of Rift Valley and Coast provinces. Almost 70 % of Kenya's land mass is affected by drought where severe reduction of water and moisture in the soil causes dryness that cannot sustain plant life. The water shortage may go on for several months or years (UNDP, 2004 ; Lasage, 2007). Floods seasonally affect various parts of the country especially along the flood plains in the Lake Victoria basin and in Tana River (UNDP, 2004).

Kitui District in Eastern province is in the Arid and Semi Arid Lands and is prone to frequent and prolonged droughts. Having experienced better harvests in 2002 and 2003, the District has suffered from drought for four years from 2000-2005. This was followed by poor crop harvests for four seasons (2003 short rains, 2004 long rains and short rains and the 2005 long rains). These successive poor crops resulted in families depleting their disposable resources like grain stocks, livestock, and disposable household items, getting more and more vulnerable to food insecurity such that they became food insecure at any small shock in the food economy (Kamunge, 2005; GOK 2002-2008).

1.2 Problem Statement.

Agricultural food production in Kenya is highly dependent on climatic seasons. In the Kenyan ASALs, seasonal variation in the climate is a common phenomenon which contributes to inconsistencies in food production. As a result there is food insecurity in the households that depend entirely on rain fed agriculture for food. Kenya Government needs to fight poverty and hunger to achieve the first millennium Development Goal. This will also reduce,

1) the prevalence of underweight among children below the age of five years and
2) the population below the minimum level of dietary energy requirement per day.

However according to the government (UNDP and GOK, 2005), poverty, a root cause of hunger and malnutrition, has been increasing since 1992 when it was 44.7%, to 52% in 1997, 56% in 2002, 57% in 2005 and was projected to reach 65.9% by 2015. In Kitui the poor constitute 66% of the total population, (GOK, 2005-2010).

The national prevalence of underweight children below five years has remained the same since 1993 while stunting and wasting have deteriorated over the same period (GOK and UNICEF, 2000). The Kenya Demographic and Health Survey indicates that, the National statistics on

nutritional status for under five children is 30.3% stunting, 5.6% wasting and 19.9% underweight and recently in 2008 stunting was 35.5% underweight 16.1%, and wasting 6.7% (CBS, MOH, and ORC macro, 2003; KNBS, 2008).

Kitui District has a historical background of high malnutrition levels of children under five years of age, recording 30% stunting on a 'normal' year (Rocheleau et al.1995), and is also reported to go as high as 39% in some areas while underweight and wasting has been 34% and 6% respectively (GOK, 1994-1996). The 2002-2008 GOK report does not reflect the nutritional status of under five children and particularly under the influence of seasons. It has also been described as having undergone environmental degradation with reported crop failures in 4-6 seasons out of 10 due to drought (Rocheleau et. al., 1995).

1.3 Justification of the Study

Rapidly growing population and worsening environmental conditions has reduced food availability by the day. This has increased dependence on food aid and relief by the vulnerable communities who mainly depend on rain fed farming for their food security. Seasonal variability may affect households differently depending on the household characteristics that are associated with greater or lesser vulnerability.(Ferro-Luzzi et al, 2001). Social economic and biological circumstances of a household as well as its ability to resist seasonal food insecurity are some of the important issues of the study.

This research is important for evaluating the extent to which climate variability and change reflected in seasons affects the nutrition of specific rural households and in the design of adaptation measures. Fundamental knowledge on the dynamics of climate factors in relation to

food security and nutritional status is necessary to enhance interventions that will consider appropriate adaptations to alleviate hunger and malnutrition.

1.4 Aim of the Study

The aim of the study was to contribute towards enhancing strategies for improving the resilience of the livelihoods of the vulnerable communities in mitigation of food insecurity affected by the changing climate.

1.5 Purpose of the Study

The purpose of the study is to provide information that can facilitate formulation and implementation of appropriate interventions to alleviate the critical food insecurity round the seasons. Eastern Province, which is often frequented by drought and has poor rainfall during the year, may have significant shortage of both plant and animal based foods. It is envisaged that seasonality studies with seasonal fluctuation in mind will contribute to alleviation of food insecurity or articulation of interventions for the policy makers.

1.6 Research Objectives

1.6.1 General objective

To establish by comparing, the seasonal variability in food security, dietary intakes and nutritional status of children 6 –59 months of age and women 15-49 years in two climatic seasons.

1.6.2 Specific objectives

1 To establish and compare between two seasons the demographic and social economic status of the households to enhance the interpretation of the data.

2 To establish seasonal variations in dietary intakes of children for adequacy of caloric and nutrient intakes.

3 To determine whether there exists an association between the nutritional status of women and children and climatic seasons to facilitate knowledge of adaptations.

4 To establish seasonal diet based coping strategies of the households as these contribute directly to nutritional status of the subjects.

1.6.3 Research questions

1 What are the differences in demographic and social economic status of the study between seasons?

1. How do dietary intakes vary with climatic seasons?
2. Does the seasonal variability affect the nutritional status of women and children in a similar manner?
3. What is the influence of seasonal variability of incomes on nutritional status of women and children?
4. Is there a seasonal effect on the practise of the diet based coping strategies reflected on the nutritional status of the study subjects during the two seasons?

1.6.4 Study hypotheses

1 Seasonal variability in Kitui significantly contributes to the household food insecurity in terms of food production, incomes and expenditures.

1. Energy and nutrient intake by the children fluctuates significantly with seasons.
2. There is a significant difference in the nutritional status of women and children between the seasons.
3. There is a significant difference in the level of malnutrition of children in the households practising diet based coping strategies in Kitui.

1.8 Limitation

The duration of the study covered only two climatic seasons which are basically the long rains season and the short rains season for which data was collected. These were sufficient for comparison of data but could not give the trends over a long period.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Agriculture, Climate and Food Security

Agriculture is the major land use across the globe. Currently about 1.5 billion hectares of landmass is under crops, another 3.5 and 4 billion hectares of graze land and forest respectively (Howden et al, 2007). In the history of agriculture evolution, efforts have been made to boost global food security through agriculture. Such are like the green revolution, the Maputo declaration, World Food Summit and now the Millennium Development Goals (MDGs), (Fischer et. al., 2002)

Agriculture is sensitive to climate which dictates the choice of crops in a locality. Gradual changes in mean temperature and rainfall, water supply variability, soil degradation and recurring droughts affect the suitability of land for different types of crops (Kurukulasuriya et. al.,2006). Vulnerable communities have little or no capacity to protect themselves from environmental hazards particularly extreme events such as drought and floods as well as consequences of environmental change like land degradation, biodiversity loss and climate variability (Ngigi, 2003; UNDP, 2004). African farmers are adapting crop choices to climate with crops that are already there, (Kurukulasuriya et. al., 2008).

Agriculture is important for food security as it provides the food to eat and is a primary source of livelihoods for both rural and urban population. Food production affects positively household nutrition by a number of factors that include food security, income from sales, prices, and demand for labour among others (Hawkes et.al. 2007). The United States Agency for

International Development (USAID) defines food security as a situation that exists when all people, at all times, have physical and economic access to sufficient food that meets their dietary needs for an active and healthy life (USAID, 2003). Four dimensions that arise from this definition are food availability, stability, access and utilization (Schmidhuber et al, 2007; USAID, 2005).

Hunger and poverty are closely related and are the main causes of human vulnerability. Lack of income to purchase food not only causes food insecurity, but also lowers labour productivity, tolerance to diseases, and depresses educational achievements (Fischer et.al., 2002; Ngigi,2003). Hunger is a cause as well as a consequence of poverty, taking into account that people who are food insecure live below 2100 kilocalories per day and experience malnutrition symptoms, learning problems, inability to work efficiently and reduced resistance to disease. Ten million hunger related deaths are occurring every year, half of them children. The MDG progress report of 2005 revealed that hunger is increasing at 4 million people per year while 32 countries have a 42% prevalence of hunger where average calorie intake is lower than it was 30 years ago. Sub-Saharan Africa has 33% of its people undernourished while India has the largest number (212million) with falling wheat production (UN, 2005; One World, U.K.2008).

Access to food in many African countries is said to be severely compromised by climate variability and change. Productivity of both crop and livestock in ASALs may undergo a reduction of up to 20% due to the changes in seasonality of rainfall, i.e. in the onset of rain days and intensity of rainfall. ASALs in Africa continue to increase in size, coupled with soil erosion due to frequent flooding and decreased food yields compounds the problem of food security. In some African countries yields from rain fed agriculture could be reduced by 50% due to climate variability and change by the year 2020 (Boko et. al, 2007).

In ASALs the major constraint in food security is the per capita food production due to unreliable climatic conditions. Erratic rainfall, poor soils, and growing population are constrains to food availability. The result is that many households in SSA, though they live in subsistence farming, are net purchasers of food (Aritho, 1995). Food production patterns in Kenya are characterized by unpredictable seasonal fluctuation especially where short unstable seasons are frequent and these contribute to unstable levels of food availability (Kigutha, 1995).

Food availability is determined by the amounts of food produced, stored, processed, distributed and exchanged. It is the net amount that remains after production and imports are summed and exports removed for each item on the balance sheet. The same approach is used to determine the adequacy of a household food supply (FAO, 2008). On a rural household scale food availability is mainly controlled by seasonal food production which may fluctuate from season to season depending on the climatic weather of that year. Food distribution and storage is affected by the infrastructure at the local level which may be affected by the climate. Traditional form of food exchange which comes in form of gifts or barter may decline in times of scarcity. High market prices of food are a reflection of inadequate food supplies, and this may cause the poor households to reduce consumption below the minimum daily requirement for a healthy active life.

Food access is a measure of the ability to secure entitlements which are a set of resources, legal, political, economical or social that an individual requires to obtain access to food (FAO, 2008). The entitlement that determines a person's access to food depends on allocation mechanisms-affordability, cultural and personal preferences for particular food products. The factors that determine whether a household will have access to sufficient food through markets or own

production include income generating capacity, farm production capacity, preparation and allocation practices, wages and salary bracket, and the cost of the minimum daily food basket in relation to the daily income (FAO, 2008). Food access is a function of physical, social, and policy environment which determines how effectively households are able to utilize their resources to meet their food security objectives. Drastic changes in these conditions such as during periods of drought and conflict may disrupt production strategies and threaten the food access of affected households. These shocks can also lead to loss of productive assets like livestock, having severe implications on future production potential of households and therefore long term food security status (USAID, 1999).

Seasonal fluctuation in food production creates allocation choices like reducing daily consumption amounts to household members or allocating preferentially to working members. Food distribution schemes like the public and charitable schemes who reallocate food to the needy may collapse in times of food scarcity (FAO, 2008). Affordability is the ability to buy food. The ratio of the cost of the minimum daily food basket to the average daily income gives a measure of poverty (FAO, 2008). Rural farmers mainly earn their income from selling crop or livestock and supplying agricultural labour. When this income is affected by changes in climate and production, poverty ratio may go up lowering food affordability. Climate also influences local food prices where low income households suffer most and may resort to eating less or less of preferred foods.

Food utilization refers to conditions where food is properly used, properly processed, proper storage techniques are employed and adequate knowledge of nutrition and child care techniques exists and are applied (USAID, 2005). It encompasses the nutritional value or composition, method of preparation, social values, food safety and quality of food supply (FAO, 2008).

Physiological utilization of food is affected by illness of the person which in turn affects nutrition. It is important to note that changing climatic conditions and food security can initiate a vicious cycle where infectious diseases, cause or compound hunger which in turn makes the affected population more susceptible to infectious diseases leading to decreased labour productivity and hence more poverty, morbidity or even mortality. Any climate change manifestation, be it drought, higher temperatures or heavy rainfall will have an impact on disease development such as salmonellosis, diarrheal diseases and malaria (Schidhuber et. Al., 2007; Campbell-Lendrum, et. al., 2003)

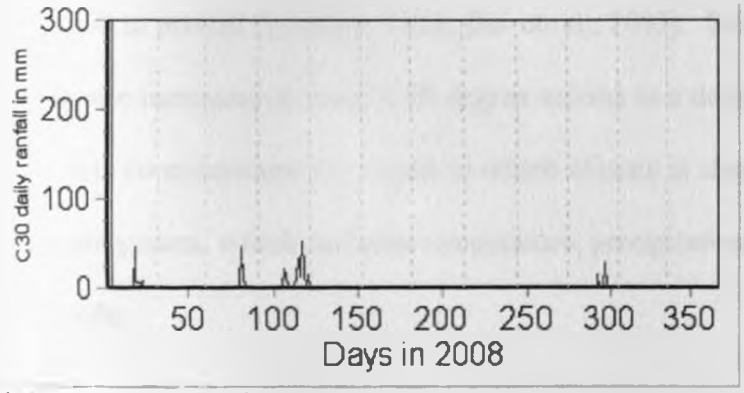
In extreme weather events like flooding where the basic public infrastructure, including sanitation and hygiene is lacking, the number of people exposed to water borne diseases like cholera increases, and thus lowers their capacity to use food. In Kenya, two severe incidents of flooding were the El Nino induced floods in 1961-62 and 1997-98 of which the latter affected 1.5 million people and took away many lives, destroyed crops and food reserves, property and high morbidity incidences were recorded (UNDP, 2004).

Food stability is the sustainability of a regular supply of food commodities. Maintaining this supply when production is seasonal is therefore challenging. With climate variability, coupled with droughts and floods food stability is threatened (FAO, 2008 ; Schmidhuber et. al, 2007). A household is food stable when adequately supplied with food at all times including periods of crop failure, loss of income or fluctuations of food market prizes. In the rural, households are rendered food insecure by climatic conditions which dictate what, how much and how frequently the food is grown (Kigutha, 1995).

In most analysis of food security conditions in developing countries, multiple indicators are used to reflect the various dimensions of the problem. The commonly used indicators in the assessment of food security conditions include those related to, food production, income, total and food expenditures, share of expenditure on food, calorie consumption and nutritional status. The relevant indicators are constructed from a set of observations or measurements of food security related conditions like measuring the total food consumed by weight and food source within a household or calculate the per capita energy intake from weights of food consumed by a household and classifying a household whether or not is insecure by the level of caloric intake (typically 80% of the recommended intake). Also the energy intake based on a 24-hour recall or weighing food portions during a survey. For some indicators like the food production deficits, income and expenditure, cut-offs may be difficult to justify as these may vary with localities (Riely, 1999).

A report by Famine Early Warning System Network (FEWSNET) gave a number of extreme events in some parts of Africa during 2007. There was heavy flooding in Kenya, Ethiopia, Sudan, Uganda, Rwanda and Somalia, that resulted in crop destruction, people displacement, outbreak of diseases and even deaths in some countries. Poor crop conditions and failure was reported in Zimbabwe in 2006-07 due to erratic seasonal rain (USAID, 2007; Tefft et. al., 2006). Drought affects 300 million people each year, the most vulnerable of whom are in Africa dry lands. Up to 14 million people in the greater horn of Africa suffer under harsh weather conditions stretching across Kenya Somalia, Ethiopia, Eritrea, Sudan, Djibouti and Uganda (OCHA, 2008). It is now apparent that if climate fluctuations become more pronounced and more widespread, droughts and floods, which are the dominant causes of short-term fluctuations in food production in semiarid and sub humid areas, will become more severe and more frequent, thus causing more food instability.

Kitui District is semi arid and is dry for most of the year hence suffering crop failure and prolonged droughts (GOK, 2002-2008). A typical rainfall pattern is illustrated by figure1 for the year 2008.This has caused food insecurity and necessitated relief food supply in some areas. Although new food and commercial crops may have increased, and the number of crops in individual fields may be greater, the total number of crops raised and the variety of plants used by any given household may be fewer than 20 years ago. The loss of many wild and indigenous plants has resulted in a net loss of diversity in locally available foods. For those with adequate income, this is compensated by purchase of foods, whereas for the poor it represents deterioration in nutritional quality, seasonal distribution, and reliability of food supply (Rocheleau et al, 1995). Seasonal variation in food security is manifested as energy stress in women and children, loss of body weight in adults and malnutrition and impaired growth in children, often leading to illness (Ferro-luzzi et al, 2001).



Matinyani meteorological station

Figure 1 Daily rainfall in Matinyani 2008

2.2 Climate Variability and Climate Change

Climate is described as the characteristic conditions of the earth's lower surface atmosphere at a specific location and encompasses the statistics of temperature, rainfall, humidity, atmospheric pressure and wind. These conditions, referred to as climate variables, whose averages are

calculated for not less than 30 years are influenced by locality- latitude, terrain, altitude, water bodies and their cover i.e. ice or snow. Weather refers to the day to day fluctuations of climate variables described in terms of weeks, months or year. Climate variability denotes deviations of climate statistics over a given period (such as month, season or year) from the long term climate statistics relating to the corresponding calendar period (FAO, 2008). Climate change encompasses all forms of climate inconsistencies i.e. any differences from long term statistics of meteorological elements calculated for different periods but relating to the same area, regardless of their statistical nature or physical causes (FAO, 2008).

Climate change is aggravated by increasing carbon dioxide and other greenhouse gases produced by human activities. It is referred to as global warming and manifesting as temperature rise, rainfall variability, change in sea level, and extreme events like droughts and floods. Periodic changes of global temperatures have been verified by direct and indirect means that date back from 1860 to present (Leeman, 1999; Ebi et. al., 2003). Scientists have recorded average global temperature increases of about 0.75 degree celsius in a decade (Easterling, 2007; McMichael et. al., 2003). To understand the extent to which climate is changing scientists monitor components of climate system, which includes temperature, precipitation, air pressure, humidity, air velocity, and clouds.

The oceans serve as reservoir for heat and greenhouse gases and may supply important data like temperature, salinity, currents, sea level and carbon dioxide. The hydrological cycle describes the seas, the rivers and how the waters flow forming an integral part of the earth's climate. Terrestrial systems like forests, soils and wetlands play a role in determining how long the green house gases stay in the atmosphere, absorbing and reflecting energy from the sun. The cryosphere refers to ice, snow, permafrost and ice glaciers (Easterling, 2007)

Factors known to have contributed to climate variations are varied, ranging from natural to human activities. Geologic factors affect climate by surface reflectivity, influencing the amount of solar energy absorbed or reflected by the planetary surface. Position of the planetary surface determines ice accumulation, continental drift or global circulation influencing largely North-South circulation patterns distributing heat to Polar Regions. Biological activities of microorganisms, plants and general vegetation, and animals with carbonate skeleton have influenced the carbon dioxide-oxygen balance over the years. Human activities like production of gases from burning fossil fuels, dust as in cement production, industrial processes, acid rain and pollutants like chlorofluorocarbons (CFCs) cause deleterious greenhouse effect and reactions with atmospheric gases (Leeman,1999; Ebi et. al.,2003)

Although decadal warming in the African continent has been recorded and seem consistent it is not uniform, e.g. temperature rise of 0.29°C in the tropical forests and 0.1-0.3°C in south Africa have been observed. In East Africa decreased temperatures around large water bodies like the coast and lakes have been recorded. (Boko et.al. 2007). Interannual and decadal rainfall variations are substantial. West Africa has experienced rainfall decrease of up to 20-40% between 1931-1990. Tropical rain forests zone has shown declines of 4% while Eastern Africa has been experiencing intensifying dipole rainfall pattern on a decadal timescale. This is characterized by increasing erratic rainfall on the northern sector and declining amounts over the southern sector (Boko et. al. 2007).

2.3 Drought

Drought can be described as the naturally occurring phenomenon that exists when precipitation is significantly below normal recorded levels causing a serious hydrological imbalance that

adversely affects land resource production systems. Drought may be classified into meteorological, hydrological or agricultural depending on the impacts.

Meteorological drought refers to a reduction in rainfall over a specific period of time, for example a month, season or year. There is no agreement on what the lack of rain or the time without rain should be before it is considered a drought. Usually the area affected determines these especially in non-arid regions. Meteorological drought leads to depletion of soil moisture and this almost always has an impact on crop production (UNDP, 2004).

Hydrological Drought Occurs when there are critically low groundwater tables and reduced river and stream flow. Reduced accumulation of snow and ice in higher elevations can result in this type of drought in nearby lowlands. Hydrological drought is distinguished by a reduction in water resources in reservoirs, lakes, rivers, underground aquifers and streams (UNDP, 2004). In Kitui District many rivers and dams swell during the rainy seasons, also recharging the sub-surface reservoirs. Soon after the rains, the dry season sets in and most rivers like Tiva, Ikoo and many dams start to dry up reducing surface water sources as well as water in the sub surface aquifers (GOK,2001-2008).

Agricultural drought is the impact of meteorological droughts and hydrological droughts on crop yields. This kind of drought is associated with extreme heat. It occurs when extended dry periods and general lack of rainfall result in a lack of moisture in the root zone of the soil. This severely damages the plants that grow in the area. Agricultural droughts are related to the availability of water for crops although some crops can withstand the reduced soil moisture conditions for long periods for example sesame, cassava and sweet potatoes, while others dry up immediately there is a reduction in soil moisture (UNDP, 2004).

2.4 Drought Experiences in Kenya

It has been documented that Kenya experiences drought on a cyclic basis. The major ones coming every ten years and the minor ones happen almost every three to four years. The 2004 drought is a replica of the previous cycle of severe droughts that affect the country every decade as experienced in 1974, 1984 and 1994. Kenya has in the past recorded deficits of food due to drought resulting from a shortfall in rainfall in 1928, 1933-34, 1937, 1939, 1942-44, 1947, 1951, 1952-55, 1957-58, 1984-85, and 1999-2000. The 1983-84 and the 1999-2000 droughts are recorded as the most severe resulting in loss of human life and livestock, heavy government expenditure to facilitate response and general high economic losses of unprecedented levels. After the El Nino induced rains of 1997 and 1998 Kenya experienced prolonged drought in many areas leading to famine and starvation (UNDP 2004). Drought experiences in Kitui District are well explained in the introduction chapter 1 of this dissertation.

Climate variability and change may affect households through seasonal variations experienced in rainfall, temperatures, floods and drought. These factors will not only affect agricultural food production but also social economics by loss of livelihoods, health and sanitation. These may translate to food availability, stability, access through distribution and availability impacting on the nutrition and health of the individuals. This is well illustrated by figure 2.

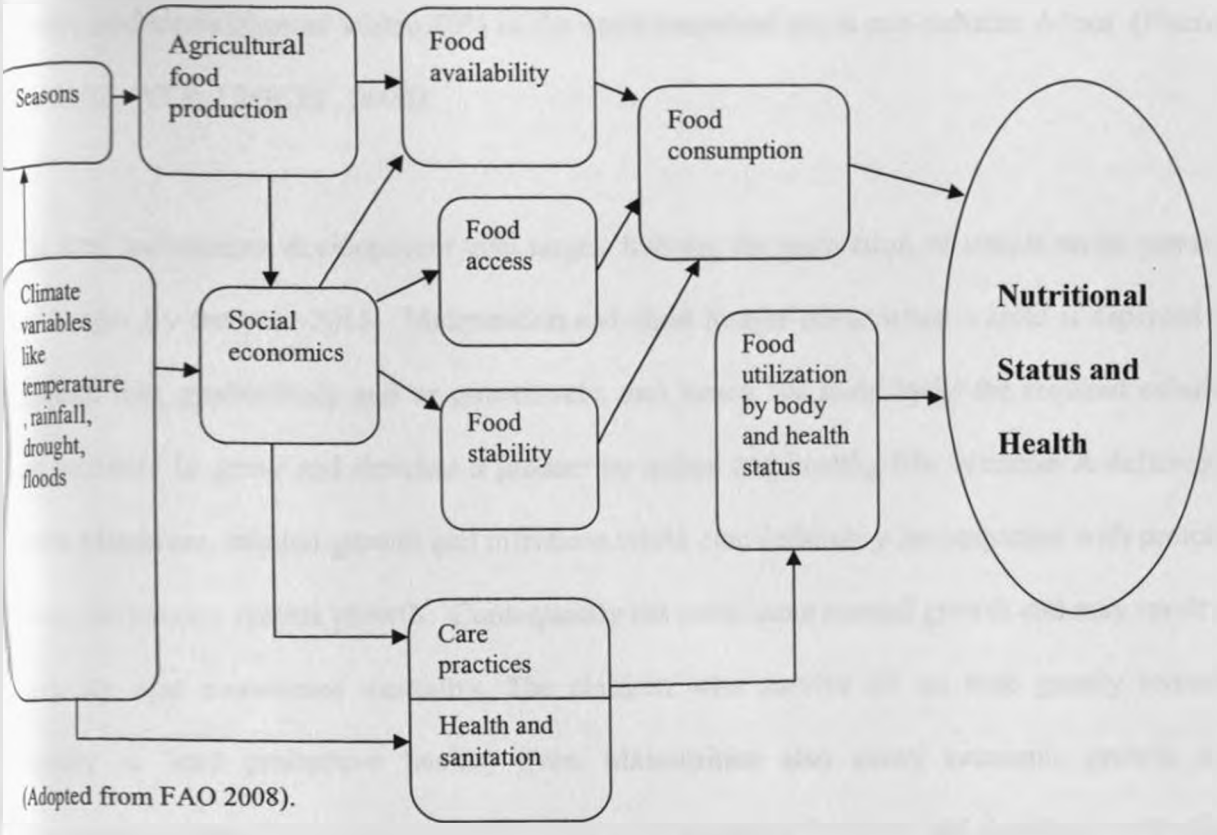


Figure2 A schematic diagram illustrating the role of climate on food security and the effect on nutritional status

2.5 Malnutrition

Over 150 million children under the age of five years globally do not receive the nutrition they require to fully develop mentally and physically (Fischer et. al., 2002; WFP, UNICEF, 2006). Ten million children under the age of five die every year and it is estimated that malnutrition, severe or otherwise contribute to over 50% of these deaths through diseases like acute respiratory diseases, diarrhoea, measles, and malaria where malnutrition plays an underlying factor (Briend et al, 2006). Malnutrition therefore, remains a major public health problem in the developing world. It is a fairly common condition associated with high mortality and morbidity and requires specialized treatment and prevention interventions. (Briend, et. al., 2006). Africa experiences

hronic undernourishment where 40% of the undernourished are in sub-Saharan Africa. (Fischer l al 2002; WFP, UNICEF, 2006).

The first millennium development goal targets halving the proportion of people under poverty nd hunger by the year 2015. Malnutrition and child hunger occur when a child is deprived of dequate diet qualitatively and or quantitively, and hence, the body lacks the required calories nd nutrients to grow and develop a productive active and healthy life. Vitamin A deficiency auses blindness, stunted growth and infections while zinc deficiency accompanied with protein-nergy deficiency retards growth. Consequently the child lacks normal growth and may result in morbidity and sometimes mortality. The children who survive do so with greatly reduced capacity to lead productive healthy lives. Malnutrition also slows economic growth and perpetuates poverty through low productivity, poor cognitive function and deficits in schooling and health care costs (WFP, UNICEF, 2006). Malnutrition in this context takes three forms: (1) failure to grow linearly resulting in stunting, (2) loss of the tissues of the body resulting in wasting and (3) accumulation of fluid resulting in kwashiorkor (also called nutritional oedema, or hunger oedema). The prevalence of each of these is assessed during a nutrition survey by taking anthropometric measurements and examining for oedema. Children below –3z score or <70% of median of the same child in reference population or if they have oedema on both feet, have severe acute malnutrition (SAM). Global acute malnutrition (GAM) is used to include all children with moderate wasting, severe wasting or oedema or a combination of these conditions. Oedema is assessed by pitting on both feet and its presence is a sign of kwashiorkor . The child is classified as severely malnourished even if the weight-for-height (WHZ) z score and percentage of median is normal. Weight-for-age z score, an indicator of child nutritional status has been selected as a millennium development goal indicator, as it reflects both chronic and acute under nutrition. (Yeudall et. al., 2007.

An important corollary of this is that if the result of the anthropometric survey does not give rise o concern, there could still be major micronutrient deficiency in the population that is ndetected, which is an underlying cause for illness and or death. Malnutrition from type 1 nicronutrient deficiency,(iodine, iron, VitA, and C) are not normally assessed by anthropometric neasurements though they may cause morbidity and or mortality in the community. They do not affect growth but they precipitate anaemia, scurvy or impaired immunity. Type 2 micronutrient deficiencies due to magnesium, sulphur, phosphorous, zinc, potassium, sodium, and chloride may cause growth impairment.(GOK, 2009)

2.6 Dietary Intake

Dietary needs are primarily a function of age, gender, reproductive status, size and activity levels. Infants, pregnant women and lactating women, have the highest overall needs, relative to their size, for calories, proteins, vitamins and minerals (USAID, 1999). Food availability, stability, accessibility and care practices influence the quantity of food consumed, variety or diversity of the diets, frequency of consumption, quality of food, proportion of cereals and of other essential foods in the diet (FSAU, 2003). Dietary intakes in a household reflect the quantity and quality of food consumed and becomes the criteria used to determine the nutritional status of household members. Diet quality refers to nutrient adequacy or the diet that meets both caloric and essential nutrient requirement. In terms of caloric intake and dietary diversity, dietary intake is often considered to be a strong proxy for nutritional status even though it is one of the immediate causes of malnutrition (Wendy et. al., 2007). The body requires certain amounts of various nutrients on a daily basis for normal functions and proper growth. A limitation of any of these will have negative consequences on an individual's nutritional status (FSAU, 2003).

The dietary methods used to assess dietary intakes during a survey involve assessment of food consumption over a period of time. The common ones are, 1) the 24-hour recall (or multiple 24-hour recalls), 2) a food frequency questionnaire (typically covering a week), 3) direct observation (with or without weighing food portions) and 4) dietary history (over a month or longer). The 24-hour recall is a quantitative method that provides information through the respondents, of the foods consumed within the previous 24 hours, then converted into measurements of grams or millilitres. Food composition tables or computer packages are then used to compute the energy and nutrient levels for the household or the individual. The food frequency recall is a qualitative method that establishes the frequency of consumption of specific foods within a period of time normally a week or two. The data may be coded as 'frequently consumed', 'not frequently consumed', or 'never consumed' depending on the interest of the survey. For seasonality studies the data taking process is repeated as needed .(FSAU, 2003)

Meeting of nutritional requirements from the diet requires appropriate dietary practices, which are strongly influenced by seasonal food availability, nutrition knowledge and cultural bias, and competing demands for the time of the household caretaker in preparation of quality meals. The health status of the individual is a factor in dietary intake in terms of good or poor appetite, sicknesses like vomiting, diarrhoea and metabolic imbalances that are associated with common diseases (USAID, 1999). The dietary intakes for every community follows mainly the availability of locally grown foods especially in the rural areas and these foods form the dietary patterns which evolve over a long time. Changes in incomes or prices of food commodities affect the ability of households to obtain food that is available in the markets and consequently the dietary intakes may fail to meet the minimum requirements (Kigutha, 1995). Rural communities engaged in heavy manual agricultural labour may require more calories on average than urban based populations. Furthermore they may be in areas of extreme threats of droughts, unstable

cropping seasons, conflicts and other risks and particularly those households lacking diversified incomes and assets to cope with those risks are constantly food insecure and their dietary intakes are highly compromised (USAID, 1999).

2.7 Health, Water and Sanitation

Good health in the population is influenced by a number of factors some of which are knowledge and environmental. Poor health may lead to families sinking deeper into poverty and malnourishment due to inability to engage in productive activities, incomes spent seeking medical services and drugs at the expense of food. It becomes a cycle where poor health increases food insecurity and vice versa (FSAU, 2003). Outbreak of certain diseases like malaria and diarrhoea follow seasonal patterns like droughts and floods (GOK, 2002-2008). Sanitation issues like human waste disposal, garbage and general household environment cleanliness may affect disease outbreaks and hence interfere with food consumption and utilization. In the rural areas, the presence of a pit latrine and the general home organization is an indication of good hygienic practices.

Water availability is an important indicator of food security. Sufficient and safe water is essential in households for drinking and chores like cooking and washing. In areas frequented by droughts, like the ASALs, water is a rare commodity. Water catchment areas and sources dry up meaning that the people have to spend longer hours looking for water. Risk of infections from contaminated water sources is also high especially where disposal of waste is not proper. Usually after the rains most of the seasonal rivers do not last for long and people have to depend on wells, springs and dams as sources of water (GOK, 2002-2008). Access to safe and adequate water is a fundamental right to every human being which has special significance for the lives of women and children. This is guaranteed by the Conventions on the Rights of the Child (CRC)

nd in the African Charter on the Rights and the Welfare of the Child (ACRWC) which onsiders the provision of adequate and safe water and sanitation as basic right for survival. In Kenya, access to safe water is defined as having reasonable access to safe water supply including reated surface water, untreated but uncontaminated water such as piped water, roof catchments, orehole water, protected springs and wells (UNICEF, 1998)

2.8 Role of women and Seasonal Household Nutrition

Women have a key role in family health and nutrition through maternal and child caring practices such as infant feeding. Women also play a big role in agriculture whereby, they may be the core food and labour producers particularly in the rural small scale setup (Joffe, 2007). This leaves the women with little or no time for hygiene behaviours and interaction with children. A study by IFPRI has indicated that heavy work requirement can be a cause of decline in nutrition. Coupled with inadequate food supplies, it is reflected in a reduction of body weight of working household members (Kumar, 1988). Women on the whole have the responsibility of providing farm labour, cultivation, weeding and harvesting of crops. This is in addition to all domestic chores like fetching water, firewood and looking after the families. In times of famine, women are the majority in collecting food relief and even working in 'food for work' programmes (GOK, 2002-2008). All these gender challenges contribute to the woman's inability to realize adequate nutritional health for her and the family. During the post harvest dry season, households have higher per capital caloric intake which is maintained as long as the food lasts. At the beginning of the wet season when stocks of food have diminished, the households are unable to meet the basic requirements of nutrition for the members. There is also demand for agricultural labour that accompanies rainy seasons which takes a toll on the nutritional energy requirements of the household members, creating negative caloric balance (Ferro-Luzzi et. al., 2001). Women empowerment involves access to and control of resources which extends to their decision

making about employment, income, household assets, fertility, and sexuality, freedom of movement, information and time.

2.9 Gaps in Knowledge

Seasonal variations as a result of changing climate have in most cases negatively affected the livelihoods of rural communities who depend mainly on rain fed agriculture for food and income. Although climate variability and climate change has long been recognized to have an impact on food production (Fischer et. al., 2002), the consequences in the short and long term have not exhaustively been researched on (Boko, 2007). Climate variability and change is global but the impacts are locally felt (FAO, 2008). These impacts need to be assessed at household level so that the poor and vulnerable people who depend on rain fed agriculture can be targeted in research and development activities like poverty alleviation. In Kenya, study of local impacts of climate variability and change in relation to food, water and diseases on vulnerable communities is essential in order to enhance their resilience and to improve their capacity to cope with the challenges of harsh climatic conditions. There is also need to establish the trends in nutritional status of rural vulnerable groups in the event of prolonged harsh climatic conditions.

CHAPTER THREE

3.0 STUDY SETTING AND METHODOLOGY

3.1 Background Information on the Study Area

3.1.1 Location , size and administration

Kitui District is located in Eastern Province of Kenya bordering Tharaka and Embu to the north, Machakos and Makueni to the west and Tana River to the east. It covers an area of 20,000sq.km. including the 6,400.sq km. of uninhabited Tsavo National Park.

The district is divided into eleven divisions namely ,Kitui Central, Yatta ,Mutomo, Kabati, Ikutha, Chuluni, Mutito, Mutha, Matinyani, Mutonguni and Tsavo national park. The divisions are then divided into 44 locations and 171 sub-locations. Kitui holds four parliamentary constituencies which are made up of the following divisions

Constituency	Divisions
Kitui Central	Central
Kitui West	Mutonguni, Matinyani, Yatta.
Kitui south	Mutomo, Mutha, Ikutha.
Mutitu	Mutitu, Chuluni, Mwitika.

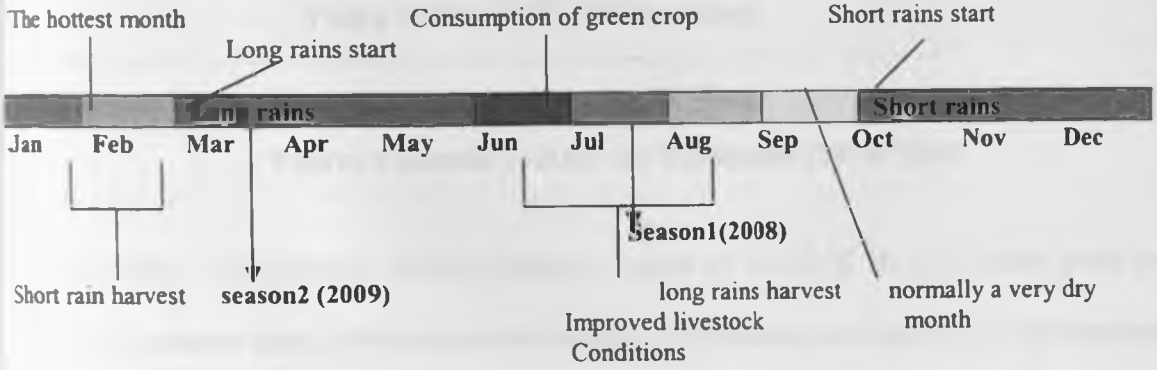
Source GOK, 2002-2008.

Kitui has a current projected population of 628,521 from population census in 1999.The population grows at a rate of 3.22% with 156,059 households. The under five years are 107,122 making about 17.0% of the total population. Boys are 54,115 (8.6%) while girls are 53,007 (8.4%) under five years of age. The females are 322,017 (51%) of which 143,330 (23%) fall between 15 and 49 years. This population represents the female reproductive age which requires health facilities for both mothers and children. The age group 0 to 14 years and over 60 years

ccount for 56.8% which means 132 dependants for every 100 economically active persons of 15 › 49 years (GOK, 2002-2008)

.1.2 Climate and topography

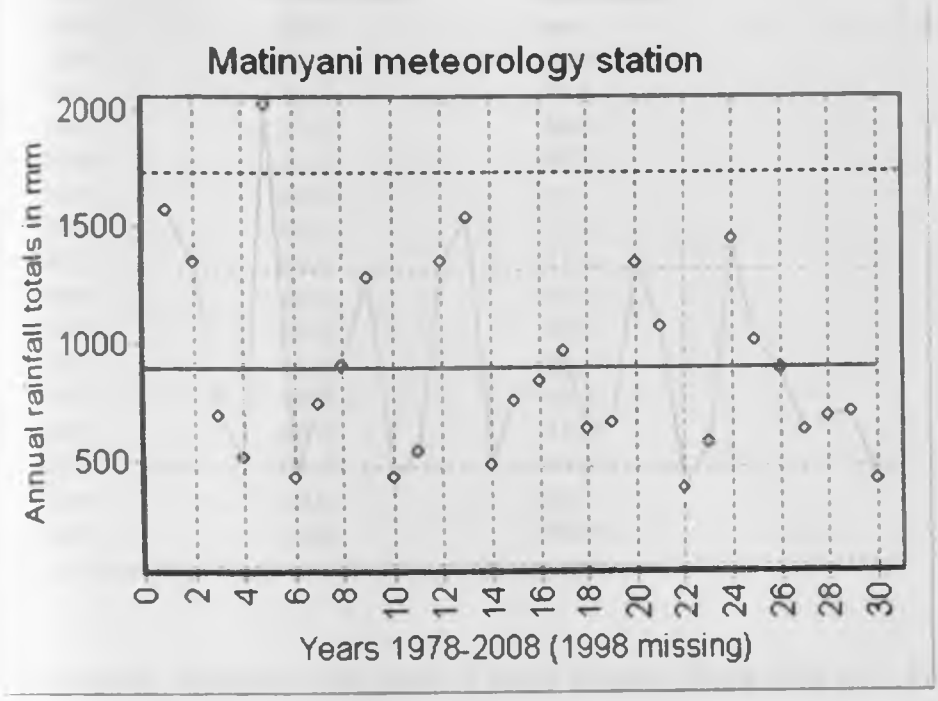
Kitui district is classified as arid and semi-arid with hot and dry weather for most part of the year eceiving short periods of unreliable and erratic rainfall. The mean annual rainfall is normally ess than 1100mm. Mean temperatures range between 22°C and 40°C . The district experiences a bimodal type of rainfall having two planting seasons. This is illustrated by figure 3 showing a year round rainfall and food production activities as determined by the weather patterns, the long rains in April and May and the short rains in November and December.



adopted from ALRMP Kitui

Figure 3 Timeline for agricultural activities Kitui District

Rainfall follows topographical features of the landscape, in that the hills in Kitui Central and western part of the district receive 500-760mm per year while the eastern and southern lowlands receive less than 500mm per year. Endai hills in eastern receive a mean rainfall of 500-1050mm per year. Figure 4 gives some historical data on annual rainfall trends for Matinyani station which was within the research area referred to later.



(Source of data: Department of meteorology Nairobi, 2009)

Figure 4 Annual rainfall for Matinyani (1978-2008)

Temperatures vary between annual minimum values of 14-18 °C in the western parts and 18-22°C in the eastern parts. Maximum mean annual temperatures are 26-30 °C in the western parts and 30-34°C in the eastern part of the district. Kitui district slopes from west to east lying between 400m and 1830m above sea level. Table 1 shows minimum and maximum temperature trends for Makindu meteorological station in Eastern province which has a similar climate as Kitui for 15 years.

Table 1 **Mean maximum and minimum temperatures for Makindu meteorology station**

year	maximum	minimum
1986	28.8	xxx
1990	28.0	16.9
1992	28.5	16.9
1993	28.5	16.9
1994	29.0	17.3
1995	28.9	17.1
1996	29.0	17.3
1997	28.8	17.4
1998	28.3	17.4
1999	29.0	17.2
2000	29.0	16.8
2001	28.9	17.3
2002	29.0	17.6
2003	29.7	17.6
2006	29.0	17.7
2007	29.6	16.9

Source of data: Department of meteorology Nairobi, 2009

Yatta plateau stretches from north to south between rivers Athi and Tiva. The high areas are Kitui Central, Mutito hills and Yatta plateau which receive a lot more rainfall and therefore are most productive. Many seasonal rivers in the district flood during the rainy season but turn into dry sand beds during the dry season and become important sources of water for the community and their animals. Shallow wells are dug along dry river bends are dug during the dry months of June-October and January-March to supply water for households and some irrigation. River Tana separates Kitui from Embu and Tharaka-Nithi and its tributaries drain the northern part of the district (GOK, 2002-2008)

3.1.3 Agriculture and social economics

The main limiting factors for settlement and agriculture are the lack of rainfall and reliable sources of surface water. The latter has further been made worse by disruption of stream flow due to deforestation. Most streams are intermittent and deeply incised. Rainfall is bimodal coming in April/May as long rain and in November/December as short rains which are more

reliable. Temperatures are hot and dry ranging from 16°C to 34°C. Climate conditions has influenced food productivity and settlement patterns where Kitui Central and surroundings areas are high potential areas receiving good rainfall and having the highest population density (Rocheleau et al 1995; GOK, 2002-2008).

Agricultural food production, mainly rain fed, contributes to the major economic activity in the district, and the communities are mainly farmers carrying out both livestock and crop production. Irrigated agriculture only takes place on small plots along the riverbanks. During prolonged dry periods the farmers are dependent on relief food. In 2004 and 2005 up to 50 percent of the inhabitants of Kitui received food aid. For food security and income, the sector is greatly challenged by the climatic conditions of the area. Pastures and water for animals lasts only a few months after the rains, leaving the animals without grazing fields and water. Arid-Agro-Pastoral is done in areas devoted to extensive livestock farming giving way to farming activities due to population pressure in the semi-arid zones. Pure pastoralists are found in the drier areas while ranching is done in less fertile semi-arid areas. Many households in the rural areas of Mutitu, Mutomo, and Kwa-Vonza keep cattle for milk and beef. The breeds for beef include the East African Small Zebu and the crosses of Boran and Sahiwal. Dairy cattle mainly kept in Central and Kwa-Vonza include Jersey, Sahiwal, Guernsey, Aryshire and Friesian. Goats are kept throughout the district, the East African Small goat and the crosses between Galla and Boar goats are popular. The red Maasai sheep and crosses of doper are kept together with the goats in Mutitu, Mutomo, Central and Kwa-Vonza. Local birds and are kept for meat, eggs and income.

Growth of drought resistant crops such as sorghum, beans, sunflower, pigeon peas, and cow peas is encouraged in the dry areas such as Mutomo, Mutitu, and Kwa-Vonza as a climate adaptation strategy. Maize and beans dominate the highlands of the central part of the district since it has

good rainfall. Mangoes, papaws, bananas and citrus trees are grown in between other food crops in the whole district. Along some river beds, irrigation of vegetables like kale, spinach, tomatoes, onions, capsicum, cabbages and chillies is carried out in most cases manually.

Besides farming the other economic activities are sand harvesting, charcoal burning, brick making and basket weaving. Sand harvesting is common along River Nzeeu near Kitui town and many other smaller sites. Brick making is a popular business in the area as most of the rural houses are made of bricks. Tsavo East National Park occupying an area of 6,400km², has a large population of wildlife, which attracts tourists in the country. The park has no economic impact on the district since the revenue collected goes to Kenya Wildlife Service and not Kitui County Council (GOK, 2002-2008; Lasage, 2007).

3.1.4 Education

Early childhood schools were 789, primary schools were 820, secondary schools were 89 and youth polytechnics were 25. Most of the schools are in central while Kyuso has the least. Most schools and training institutions outside Kitui town are poorly equipped and hence are underutilized. This and poverty situation contribute to the low enrolment levels. Though the main focus in education is to reduce illiteracy and school dropout rates, the priorities are often shifted to emergency programmes due to persistent droughts (GOK, 2002-2008).

3.1.5 Infrastructure

A total of 3,373km of classified and unclassified road network, most of which are in Kitui Central. Tarmac roads only cover 53 kms. The international trunk road from Thika passes through Mwingi and Kyuso, a distance of 143 kms going towards Bura to the west. Most Of the road network is in poor state and impassable during the rainy season making some areas like Mutitu, Mwitika, and Mutha inaccessible. Electricity and telecommunication is found only in

few market centres like Wikililye, Mulutu, Mutonguni, Matinyani and Kabati creating jua kali activities in these centres. The focus has been on improvement of roads, rural electrification, provision of water to Kitui town and its environs. Construction of bridges like Tiva and Mwitsyano is going on and this would open up Kitui during the rainy season (GOK, 2002-2008)

3.1.6 Poverty and drought

Poverty is a great challenge in the district. The poor make up 66% of the district population and these are people unable to meet basic needs like food, good shelter, clothing and medical services. A big portion of the district is low and medium potential in agricultural activities (98%), leaving only 2% of the area as high potential. This gives rise to food insecurity and poverty trends have increased since year 2000. The District has suffered from drought for four years from 2000 to 2005 with better harvests experienced in 2002 and 2003. This has contributed to the district suffering very poor crop harvests for a number of seasons (2003 short rains, 2004 long rains, 2004 short rains and the 2005 long rains). These successive poor crops have resulted in families depleting most of their disposable resources e.g. grain stocks, livestock, and disposable household items getting more and more vulnerable to food insecurity such that they easily fall into high food insecurity due to any small shock to their food economy (Kamunge, 2005; GOK2002-2008).

Water is the most essential development commodity in this area, of which the major sources are the seasonal rivers. Only 6 percent of the inhabitants have access to potable water and this scarcity forces women and girls to walk up to 20 kms in dry periods to water sources. The low lying parts of the district like the eastern and central parts are vulnerable to floods during the heavy rains causing impassable roads, disease outbreaks in both human and animals and soil erosion (GOK, 2002-2008; Lasage, 2007).

3.1.7 Nutritional status

The unfavourable and unreliable climate which leads to inadequate and variable food crop levels has contributed to rampant malnutrition in Kitui district. Going by the indicators for the children below five years, stunting is 30%, wasting 6%, and underweight 34% (GOK, 1994-1999). Women of 15-49 years old represent the female reproductive age group who require proper nutrition and health facilities. Though no nutritional record is in the government report, the national statistics indicate that the mean Body Mass Index (BMI) for women aged 15-49 is 23 and only 2% of this population fall below a BMI of 16, the lower cut-off. Low BMI is an indicator of wasting and poor nutritional status (GOK, 1994-1999; GOK, 2002-2008; CBS; MOH; and ORC macro, 2004).

3.1.8 Heath facilities

Kitui District has 92 health facilities, most of which are in Central and Kabati divisions. Kitui district hospital serves as the referral health facility in the District. The rural health facilities are poorly equipped and understaffed. With regard to the population size and vastness of the area, the health facilities are far from being adequate. HIV/Aids infection rate and its complications has been on the increase (14%) and the hardest hit is the 15-49 years age group, taking up 40% of the bed occupancy in hospitals. This has weighed down the health facilities and weakened the economically productive population especially in Kitui and Mutomo townships (GOK, 2002-2008).

3.2 Methodology

3.2.1 Study design

The study was cross-sectional, analytical with comparative elements. The study area was visited two times, in July 2008 and March 2009 and data collected. These two data sets are referred to

as season 1 and season 2 respectively. Season 1 was selected purposely as a period soon after the harvest from the long rains crop which had been planted in March-April. Season 2 was the period after the short rains harvests. However this second season was marked by poor harvest compared to season1 due to the failure of short rains leading to a period of prolonged drought.

The study also engaged comparative elements in that variable outcomes were statistically compared between seasons 1 and 2. The seasons were taken as the independent variables. Household descriptive variables like incomes, expenditures and food production were taken as intermediary variables while dietary intakes and nutritional status served as dependent variables.

3.2.2 Study population

The study population consisted of households within the selected study area.

3.2.3 Sample size determination

The sample size was determined based on the prevalence of malnutrition of children under five years in Kitui District which is 30% as documented in the District Development Plan (GOK, 2002-2008). A statistical formula by Fischer et.al. (1991) for a population size greater than 10,000 was used.

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

where N=the desired sample size group,

Z=the standard normal deviation set at 1.96 corresponding to 95% confidence level,

p=the proportion of children estimated to be malnourished, 30%.

q =1-p is the proportion of children estimated to be well nourished, 70%.

d =degree of desired accuracy set at 0.1

$$N=\frac{2\times1.96\times1.96\times0.3\times0.7}{0.1\times0.1}=161$$ (Fisher et al 1991)

A 10% attrition rate which is 16.1 to give the desired sample size for each season as 178. In season1, a total of 162 children from 147 households were assessed for nutritional status while in season2, the sample size was 222 children from 171 households. The child aged 6-59 months was taken as the most vulnerable to nutritional stress, and therefore the prevalence of child malnutrition in Kitui District was used to determine the sample size which subsequently determined the number of households visited.

Anthropometric measurements were taken for all eligible children within the selected households. Women were selected on the basis of their age, between 15 and 49 years which is the reproductive age group. A total of 134 women in season1 and 157 in season2 had their nutritional status assessed. Not all households had eligible women. Some of the households had more than one eligible child and as such the study resulted with a higher number of children than the women, (see section 3.2.6 for inclusion and exclusion criteria).

Food consumption data was obtained by a 24-hours dietary recall for the index child. For this, a sub-sample of 30 children in each season was taken determined by the 10% or 30 rule, whichever is higher. Where households had more than one eligible child, simple random selection of one was done.

3.2.4 Sampling frame

Kitui District is divided into four Agro-Ecological zones based on the land use and vegetation depending on the rainfall patterns.

- Zone A-Arid –Agro-Pastoral: Areas normally devoted to extensive livestock farming which due to population pressure are giving way to crop farming development.

- Zone B-Semi-Arid farming: Areas with good potential for Agriculture development, which are presently cultivated.
- Zone C –Semi-Arid Ranching: Areas less fertile but suitable for drought resistant crops.
- Zone D-Arid-Pastoral: The area is not viable for crop farming but has pastoral farming.

The study area was purposively selected in zones A and B since they had agricultural activities. The divisions, locations and sub-locations were purposively selected on the basis of accessibility. The number of villages per sub-location was decided based on the size of the villages. The number of households per village depended on the accessibility of the households. The sampling frame consisted of a list of potential villages in zones (A&B). In each zone, the divisions, locations and sub-locations were identified from which the households were obtained. The households with a child 6-59 months were then randomly selected as shown in Figure 5 which illustrates the sampling frame for the study area

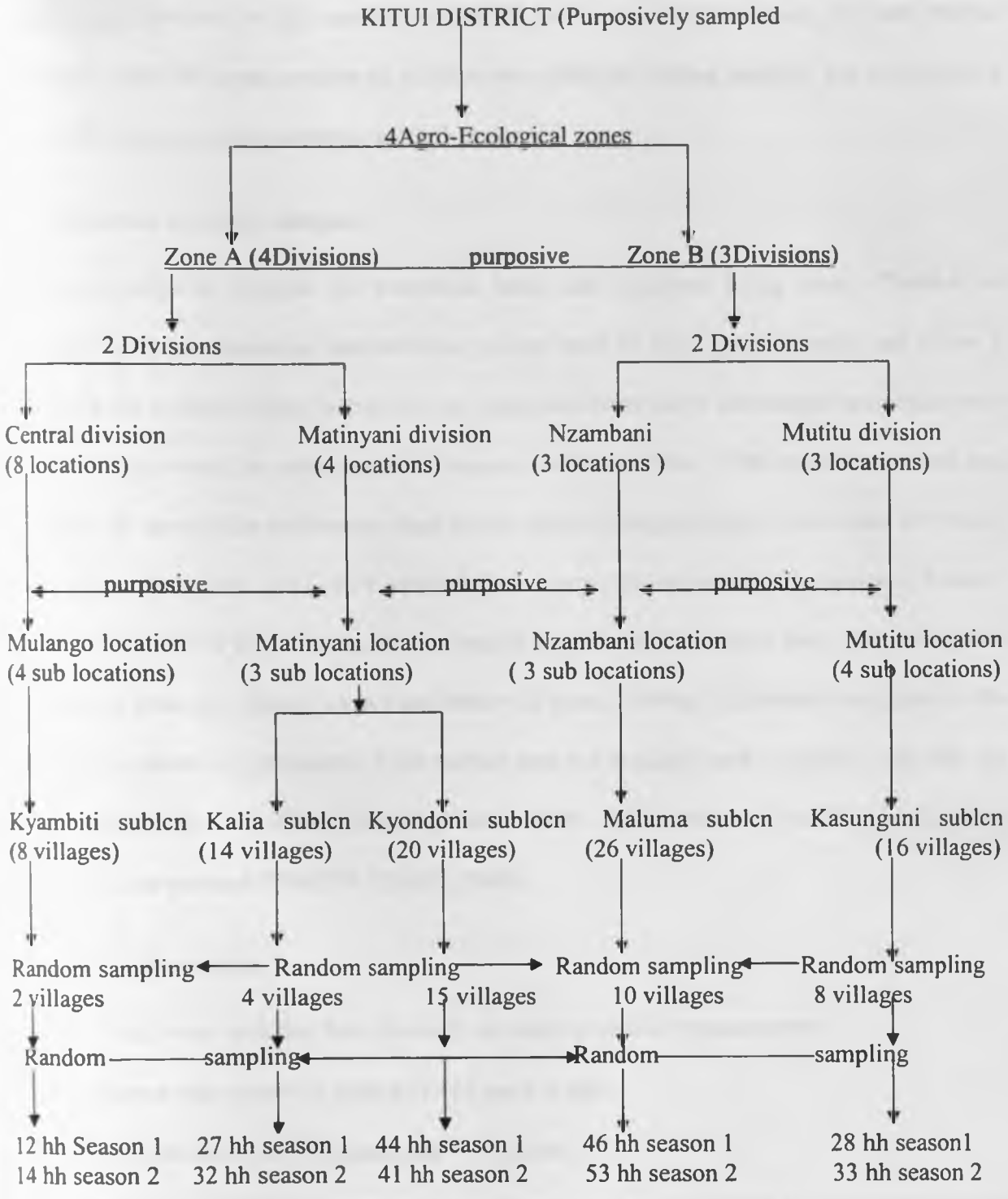


Figure 5 Sampling Frame

The households were selected on the basis of having a child within the age of 6-59 months. During the first season the starting point for each village and direction of movement were randomly selected (tossing a coin, pen or stick) thereafter moving in one direction and

conducting interviews in the nearest household, and continuously choosing the next nearest household until the target number of children was obtained. During season2, the same starting point and direction of movement in season1 were used.

3.2.5 Selection of survey subjects

The study subjects included the household heads and members living there. Children for anthropometric measurement were selected on the basis of their age, 6 months and below 5 years. All the children falling within this age group and belonged to the selected household were included in the study for anthropometric measurements regardless of the nutritional status, and this gave all the eligible children an equal opportunity of being included in the study. For the 24 hour dietary recall, the child (6-59 months) from every fifth household was selected. Random selection was used if they were more than one in one household. Women were also selected on the basis of their age, from 15 years and below 50 years. Priority of selection was given to the children's mothers or caretakers. If the mother was not available and caretaker's age was not within the set age, a woman whose age falls within 15-49 years and residing in the same household was selected (UNICEF, USAID, 2006).

3.2.6 Exclusion criteria

The following were excluded from the study for anthropometric measurements:

- Women who were <15 years and >49 years of age.
- Children who were <6 months and >59 months.
- Chronically ill or physically challenged members of the household. (A chronically sick or physically challenged child may not represent growth rates expected of a normal child).

3.2.7 Recruitment and training of enumerators

Four enumerators were recruited from the study area, and were of secondary school level who knew the area well. The area chief on request gave contacts of six people with form four level education. The researcher interviewed them and selected four who were found qualified for the job. Two of them had participated in a research survey previously. In phase 2 of the data taking two of the enumerators were replaced with new ones as they had joined college. The selected team in both season1 and 2 was trained for two days by the researcher on the questionnaire, taking anthropometric measurements for both women and children, sampling procedure, purpose of survey and discipline/ethics in the field. They also rehearsed the questionnaire between themselves to ensure uniform understanding of the questions, (Refer to appendix 7 for training manual).

3.2.8 Study clearance and permit

Prior to the study period, a research permit was obtained from the Ministry of Higher Education Science and Technology for the research and data collection in Kitui District covering the period July 2008 to September 2009. The researcher also reported to the District Commissioner and District Education Officer Kitui district who issued a written authorization to conduct the research in the villages. The Chiefs in the respective study locations were also kept informed of the activities.

3.3 Data Collection Procedure

3.3.1. Data collection tools

The data was collected by use of a structured questionnaire which was pretested before the study started. It contained sections on demography, social economics, incomes, expenditures, farming activities, dietary intakes, water and sanitation, morbidity and nutritional status, appendix 1.

Food frequency recall tool: This was a tool designed in form of a table was used for assessment of food consumption or dietary intake. It gave the frequency of types of food commonly consumed in a time frame of one week.

The 24-hour dietary recall tool: This was a tool designed in form of a table that was used to obtain data on dietary intake over a 24 hour period. It indicated the type of meal, the ingredients used in the preparation of the meal, the food and drinks the child took and leftovers for each meal in household measure, (FSAU, 2003).

Equipment: For anthropometric measurements the study used Salter hanging scales, height boards and MUAC tapes for the children. 'Step on' Salter balances and tape measures were used for the women. Measuring cylinders, bowls, cups and spoons were used to estimate the ingredients and foods consumed by the index child.

3.3.2 Pre-testing of the tools

The questionnaire was pre-tested by the team of enumerators and the researcher. The pre-testing was done in a village which was not part of the study area but was similar in terms of household social economic characteristics and this covered 10 households. Every part of the questionnaire was filled and anthropometric measurements taken under supervision of the researcher. Sections of the questionnaire not well understood or had a problem were corrected thereafter and this data was not included in the final analysis.

3.3.3. Data collection

3.3.3.1 Demographic and social economic data

This section gave the household characteristics in size i.e. all household members, sex, ages, marital status, household head and relationship to the other members and duration of stay in the home, education and occupation. Information of house and living conditions was collected as type of building materials, type of fuel and lighting used by households. Land and properties

owned like motor vehicles, electronic goods like television, radio and mobile phones, household furniture like sofa sets and farm implements like ploughs, wheelbarrows, jembes, or pangas were listed. The household cash income (an intermediary independent variable) assessed by taking the data on salaries or casual labour wages earned per month for both household head and spouse, income earned from business, handcraft, sale of livestock and crops and remittances. Household expenditure data was collected as money spent on a monthly basis on food, housing, education, medical, clothing, transport, loans and leisure.

Food production data was given by the farming activities in terms of the livestock kept and their numbers, the crops produced in the previous season mainly the staples, and the amounts in kilograms. The respondents was asked how much of each crop was harvested in the previous season in relative quantities, the amounts that were sold , consumed and stored. These quantities were then converted into kgs per household for the purpose of analysis by the researcher. This was repeated during the two periods of data collection.

3.3.3.2 Seasonality

This was marked by the climatic seasons. The two seasons were marked using the local planting and harvesting dates for the study area. For the long rains harvest or season1, planting was in March and harvesting in June and data was collected in July. For the short rains harvest or season2, planting was in October and harvesting in February and data collected in March. Data for rainfall and temperature for the area was provided by the Meteorological Department. It was also taken as the main independent variable as explained in the study design.

3.3.3.3 Food security

Food security indicators were multiple. The study considered the following indicators to classify a household as food secure or otherwise. (1) The amount of food harvested per household in a season and the period the food lasted thereafter. The households were categorised as follows,

Households without food stocks.....critical food insecurity

Households with food to last up to 3months.....food insecure

Households with food to last 4-6months.....moderate food security

Households with food to last 6 months and over.....food secure.

Kitui having a bimodal type of climate is expected to harvest food crops twice a year and so households with adequate food to last 6months would be food secure until the next harvest.

(2) The food expenditure and share of expenditure on food. The households that spent a big share of the household expenditure, more than 70% on food were likely to be food insecure. (USAID, 2003)

(3) The households were classified by the calorie intake level using a minimum cut-off which is typically 80% of the RDAs (Riely et.al., 1999).the food intake was calculated from the 24-hour dietary recall for the index child. The minimum energy and nutrient requirement as per the age group of the child are given in table 3 section 3.3.5.

4) The median income for the households in both seasons as the households visited were generally of the same social economic status.

3.3.3.4 Dietary intake

The 24-hour dietary recall was carried out for the household child aged 6-59 months on a sub-sample of 30 children in each season. The respondent or caretaker was asked to recall in detail the type and quantity of foods consumed by the index child during the previous 24 hours. The types of food were listed. Then the quantities of each ingredient recorded, first in household

measure and then in millilitres as measured by the interviewer using water as the equivalent. The amount served to the child was also measured using the household measure and then converted to millilitres. Any leftovers were then subtracted from the original meal. Children below two years and breastfeeding were noted so that the breast milk intake may be evaluated in terms of energy and nutrients it provided. Data on breast milk quantities that a normal child takes per day depending on the age was obtained from WHO guidelines (table 2) and was used in the 24hour dietary recall as follows.

Table2 Mean breast milk quantities taken by a child per day in developing countries by age group

Age in months	milk g/day	Energy kcal/day	protein g/l	VitAμ/l
6-8 months	660	403	10.5	500
9-11 months	616	379		
12-23 months	549	346		

(WHO, 1998)

These quantities and the complementary feeds were used to calculate the total energy in kilocalories, protein and VitA value of the food. The household dietary intakes were also indicated by the food frequency recall. The respondent was asked to recall the number of times a particular food was consumed in the household within a week or month. The data was converted to frequency per week.

3.3.3.5 Nutritional status

Nutritional status was a dependent variable indicated by the weight-for-age, height-for-age, BMI for age and MUAC for the children and BMI and MUAC for the women. Anthropometric body measurements were carried out on both women and children as detailed below.

Weight

Children of 6-59 months were weighed with minimum clothing like light pant, with no shoes or head gear. Salter scales with plastic pant for hanging the child were used. The scale was hang using a rope on a tree branch or a convenient place and adjusted to zero with the plastic pant on. The child was then slipped into the pant and hang on the balance. The weight was then recorded to the nearest 0.1kg. Reading was done twice and the average recorded as the weight of the child. A step-on Salter scale was used where a hanging balance for the children could not be used. Mothers or caretakers were asked to remove any heavy clothing like sweaters, jackets or shoes before their weights were taken. A step-on Salter scale was used, adjusted to zero before the subject was asked to step on it. The weight was taken twice and the average recorded as the weight to the nearest 0.1kg. Scales were calibrated using a known weight prior to study (UNICEF, USAID, 2006).

Height

Children below two years had their length taken while lying down on the height board. The child's head in an upright position against the board base, the legs together stretched to a full extent and the feet at right angles with the legs against the cursor of the board. The length was read to the nearest 0.1cm.and an average of two readings taken. The children above two years were made to stand upright on the base of the height board and the height taken when the head was facing horizontally and the feet straight to the nearest 0.1cm. Two readings were taken to get an average height. Mothers and care takers were asked to stand on a hard flat surface with their

back against a straight wall without shoes or headgear. The back of the head, back, buttocks calves, and heels touching the wall, and feet together. The top of the head was marked against the wall and that height in centimetres taken using a tape measure (UNICEF, USAID, 2006).

Mid-upper arm circumference (MUAC)

Mid upper arm circumference of the mother or caretaker and children was measured on the left arm. While the arm was bent, the length between the bone at the top of the shoulder and the elbow bone was measured. The middle was marked with a pen. The arm was then relaxed alongside the body and the tape was wrapped round the arm at the midpoint such that it was in contact with the skin when the tape was neither too tight nor too loose. MUAC was then read in centimetres to the nearest millimetre. Adult MUAC tapes were used for women and appropriate MUAC tapes for children were used.

Oedema

The children were assessed whether they had nutritional oedema or not. The feet, just above the ankle of the child were gently pressed with the thumb. After three seconds, the thumb was removed and if a depression was observed on both feet for several seconds, it indicated bilateral oedema and the child was recorded as having nutritional oedema.

3.3.3.6 Water and sanitation

Data on water and sanitation included sources of water during both dry and wet seasons, water availability and rainwater harvesting. Also the time taken to collect water from the main source was recorded.

3.3.3.7 Secondary data

Climate data i.e. rainfall and temperatures for a period of 15years was provided by the Meteorology Department, Nairobi. Other secondary data was obtained from key informants, agriculture office Kitui, and Arid Land Resource Management Project (ALRMP) in special programmes in Kitui.

3.3.4 Data quality control

The enumerators were thoroughly trained on data collection, closely supervised by the researcher to make sure the procedures were followed. Every day the filled questionnaires were reviewed, mistakes corrected and doubtful data was confirmed the following day. Weighing equipments were zeroed before taking any measurements. Data was flagged for outliers and children's nutritional status as described in sections 3.3.5 and 4.10.1 .

3.3.5 Data entry, cleaning and analysis

The two data sets for the two seasons were coded in the same way and entered in computer using SPSS version 12 software. Data cleaning was done by running frequencies and cross tabulation, for categorical data and scatter plots for continuous data to flag out the outliers. To avoid the assumption that the data was normally distributed both parametric and non-parametric statistical analysis were used where necessary to compute the mean, median, standard deviation, confidence intervals and interquartile range wherever relevant. To compare the two seasons, mann-whitney test was used to compare median values and independent sample t-test was used to compare means. Both tests obtained p-values. A p-value less than 0.05 was significant. Chi square test was used for association of two categorical variables. Correlation was used for trend relationships of variables. Binary logistic regression was used to compute variables like incomes, food production, seasons or dietary intakes as nutritional status predictors. The principle of logistic regression is based on the equation; (Field, 2005)

$$P(Y) = \frac{1}{1+e^{-(Bo+B1X1+B2X2+.....BnXn+\ i)}}$$

Where P(Y)=probability of outcome variable Y occurring given known values of X1, X2,...Xn

Bo= a constant or y intercept

X1=predictor variable

B1= coefficient attached to the predictor variable

i= residual term

To analyse the 24-hour recall, dietary intake, National Food Composition tables, (Sehmi, 1993) and Nutrisurvey software were used to compute the kilocalories and nutrients consumed from the various ingredients used in preparation of the food. The Recommended Dietary Allowances (RDAs) were calculated using consumer unit (cu) in terms of energy requirement. One consumer unit was taken to stand for the consumption equivalent of a nominal male adult (as a reference) of 20-29years estimated to need 2960 kilocalories per day. The requirements were calculated as a ratio of the consumer unit based on the WHO international recommendations. It was also found that the protein requirement per consumer unit is 50g per day and this was used to calculate the protein requirements for the children (Niemeijer et. al., 1991). The following consumer units in table 3 were used to calculate protein and energy requirements.

Table 3 Consumer units and RDAs by age group

Age(months)	Boys	Girls	kcal/day	protein g/day
6-11 months	0.3cu	0.3cu	888	15
12-23months	0.4cu	0.4cu	1184	20
24-59months	0.5cu	0.5cu	1480	25

(Niemeijer et. al., 1991)

Dietary diversity was obtained by listing the various foods consumed by the child in the 24hours and grouping them as per the method in the FAO guidelines for measuring household and individual dietary diversity. For children above 6 months, a minimum of four food groups is regarded as satisfactory, appendix 8, (FAO/EC and FANTA, 2008).

For the nutrition status of the children, anthropometric measurements were computed into the indices weight-for-age, height-for-age and BMI-for-age using AnthroPlus software. Z-scores (deviation from the median) were calculated by use of WHO reference standards 2007. The z-scores were flagged as follows,

Nutrition index	lower sd	upper sd
WAZ	-6.0	+5.0
HAZ	-6.0	+6.0
BAZ	-5.0	+5.0

The computed z-scores whose values were outside the range were flagged and excluded in the analysis since flagged data was not exported to SPSS software. The nutrition indices and the z-scores were used to interpret the nutrition status with the following cut-offs.

WAZ	-3.0sd≤WAZ< -2.0sd	moderate underweight
	WAZ≤ -3.0sd	severe underweight
HAZ	-3.0sd≤HAZ<-2.0sd	moderate stunting
	HAZ<-3.0sd	severe stunting
BAZ	-3.0sd≤BAZ<-2.0sd	moderate wasting
	BAZ <-3.0sd	severe wasting.

Mid upper arm circumference (MUAC) for the children was taken to indicate wasting levels, with the following cut-offs

12.5cm≤MUAC<13.5cm	moderate wasting
MUAC<12.5cm	severe wasting

Body mass index (BMI)

Body Mass Index, also called Quetlets Index is the ratio of the weight of the person in kilograms, to the square of the height in meters. It is one of the anthropometric indices used to assess body composition in terms of wasting or obesity mostly in adults. An adult person having a BMI of less than 18.5 is considered to be underweight and above 25 is overweight

For the mothers/caretakers (15-49 years), the body mass index (BMI) was calculated as stated above with the following cut-offs.

<17.0	severe underweight
17.01-18.49	moderate underweight
≥18.5	normal to obese

CHAPTER 4

4.0 RESULTs

The first set of data was collected from middle of July to first week of August 2008, a period after the long rains harvest. This was season 1 in which 147 households with a total population of 710 persons were visited. The second set of data was collected from mid-March to mid-April 2009 after the short rains harvest. This was season2, in which 171 households with a population of 928 persons were sampled.

4.1 Demographic Characteristics

4.1.1 Age and household size

The average household size was 4.8 (sd 1.71) and 5.3 (sd 2.13) in season1 and 2 respectively with a median household size of 5.0 in both seasons. The overall male to female ratio was 1:1.1, for both seasons and for the age group 15-24years the ratio varied to 1:2.7 inseason1 and 1:1.7 in season 2, table 4. The children below five years were about 1/3 of the total population in both seasons.. The age dependency ratio was 89.8% in season1 and 99.6% in season 2. Table 4 gives some household characteristics.

Table 4 Selected household demographic characteristics

Household characteristics	season1(long rains harvest) N=710 (n=147*)	season2(short rain harvest) N=928 (n=171*)
Household size (mean)	4.8(sd 1.71)	5.3(sd=2.13)
Females %	52.4	51.5
Ratio of male: female	1:1.1	1:1.1
Children (below 5years)%	27.3	30.3
Women (15-49 years)%	27.6	24.0
Female household heads%	15.0*	23.4*
Age dependency ratio	89.8	99.6

* households

The residence status indicated whether a household member was residing within the home or elsewhere visiting the home regularly. The study found that most households were nucleus families, 39% in season1 and 35% in season 2 where 95% in season 1 and 93% in season 2 were residing in their homes fulltime. The study found no significant difference in the residence nature of males to females with seasons. A small number 5% in season1 and 7% in season2 were residing elsewhere either for employment or business.

4.1.2 Education levels

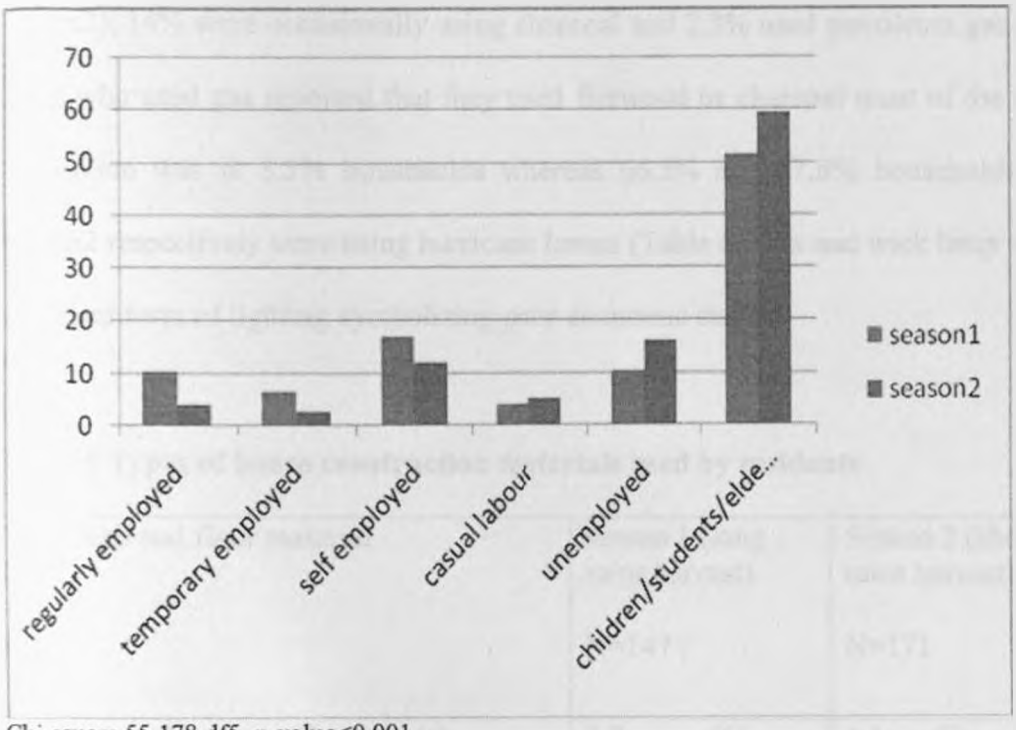
The study found that the majority of residents 69.5% during season1 and 65.5% in season2 had level 8 education. This is illustrated in appendix4. The individuals with no formal education were mainly the aged and pre-school children and formed 13.5% in season1 and 14.1% in season2 of the study population. Less than a quarter of the caretakers or mothers (21.1% in season1 and 19.3% in season2) had secondary or above secondary education. The number of persons with primary education compared to those with secondary education dropped from 21.5% in season1 to 12.2% in season2.

4.2 Social Economic Characteristics

4.2.1 Seasonal occupation trends

A general decline was observed in the number of people employed in season2 compared to season1. The level of unemployed persons also rose by about 6% in season2 as indicated in figure 6. The regularly employed persons were those holding permanent jobs like teaching, clerical, factory workers and in businesses enterprises. Temporary and casual employees also referred to as 'kibarua' by the residents were those in jobs like transport industry, hotels, masons, farm attendants, shops and small businesses. Self employed sector did mainly, brick making, sand harvesting, farming like growing own vegetables for sale in town or village and basket

weaving. Those unemployed were mainly the school leavers looking for jobs and housewives. The young children and those in school, elderly people over 60 years, formed over 50% of the population giving rise to high dependency ratio.



Chi-square 55.178 df5, p-value<0.001

Figure 6 Households' occupation by seasons

4.2.2 Housing status and welfare facilities

The type of houses occupied by the residents represented the welfare status of the household. The households that were visited during the two study periods were found almost similar in construction of houses. Most residents, over two thirds, lived in brick walled houses plastered or otherwise with corrugated iron roofs in both season1 (long rains harvest) and season2 (short rains harvest). The bricks were made of soil baked into a cake of stones and joined together by cement to make walls. Some of these walls were plastered which made the house acquire a higher status while a few were made of mud, wood or iron sheets. Brick making was an occupation by residents especially the young people to earn a living. The houses were generally small but a

few were big and modern made of stone blocks which was a sign of good economic status. A homestead having only one shelter with one or two rooms indicated some level of poverty (FGD). Table 5 gives the characteristics of the main house sampled during the two seasons.

Firewood was the main source of cooking fuel (used by 98.6% in season1 and 83.6% in season2), 14% were occasionally using charcoal and 2.3% used petroleum gas in season2. Even those who used gas reported that they used firewood or charcoal most of the times. Electricity connection was in 3.5% households whereas 66.5% and 67.8% households in season1 and season2 respectively were using hurricane lamps (Table 6). Tin and wick lamp was regarded as a low class form of lighting symbolizing poor economic status.

Table 5 Types of house construction materials used by residents

Roof, wall and floor material		season 1 (long rains harvest) N=147		Season 2 (short rains harvest) N=171	
Roof material	Grass/thatch	3.7	(6)	4.1	(7)
	Iron sheets	82.3	(135)	91.8	(157)
	bricks	1.2	(2)	4.1	(7)
Wall material	Mud	17.5	(25)	15.8	(27)
	Plaster	28.7	(41)	40.4	(69)
	Wood	2.8	(4)	2.9	(5)
	Iron sheets	2.1	(3)	2.9	(5)
	Brick/block/stone	42.7	(70)	38.0	(65)
Floor material	Mud	44.8	(64)	46.2	(79)
	cement	55.2	(79)	53.8	(92)

(Figures in parenthesis represent the number of houses)

Table 6 compares the lighting and fuel sources used by the households in the two seasons, where firewood was found to be the main source of cooking fuel and hurricane lamp as the main source of lighting. The household welfare possessions were found similar during the two seasons as shown in table 7.

Table 6 Means of cooking and lighting by seasons

Means of cooking and lighting		season 1(long rains harvest N=147 (%)		season 2(short rains harvest) N=171(%)	
Means of cooking	Firewood	98.6	(145)	83.6	(143)
	Charcoal	1.4	(2)	14.1	(24)
	LPG Gas	0		2.3	(4)
Means of lighting	Tin and wick	23.8	(35)	27.5	(47)
	Hurricane	74.1	(109)	69.0	(118)
	Electricity	2.1	(3)	3.5	(6)

(figures in parenthesis represent number of households)

Table 7 Household possessions in the two seasons

Possessions	season1(long rains harvest) N=147 (%)		season2(short rans harvest) N=171(%)	
Vehicles	6.1	(9)	2.9	(5)
Electronics (television/radio/cell phone)	85.7	(126)	86.1	(149)
Sofa set	33.3	(49)	32.4	(56)
Ox plough	10.9	(16)	21.4	(37)
Other farm implements	98.0	(144)	94.2	(163)

(figures in parenthesis represent number of households)

4.3 Seasonal Water Sources and Sanitation

Water availability is an important factor in food security as it plays a role in food preparation and general hygiene of the households. Water sources were limited as can be seen from table 8. The main source of water was the rivers in both seasons. The time taken by the households to collect water is also illustrated in table 9. More than half of the households had water within 15 minutes walking distance but some had to travel far taking even two hours.

Table 8 Water sources during the two seasons

Water source	season1(long rains harvest)	season2(short rains harvest)
	% N=147	% N=171
	(July-August)	(March-April)
River	53.1	48.0
Piped	34.6	27.4
Borehole/well	10.9	24.0
Dam	1.4	0.6

Table 9 Relative distance in terms of time used by households to water source

Time	season1 (N=147)	season2 (N=171)
	%	%
≤15 minutes	60.3	58.4
16-30 minutes	26.0	30.4
30-120 minutes	13.7	11.2

Most boreholes were privately owned and water was for sale. Piped water was occasionally available but and not in every household. Boreholes and some wells offered water almost constantly and like the piped water, it was for sale. The water sources and the time used by households to collect it from source did not vary between seasons. Majority of the households 91.2%, in season1 and 97.6% in season 2, had pit latrines.

4.4 Seasonal Pattern of Incomes and Expenditures

Households are economic units and may have varied incomes as portrayed in table 10. The main sources of income were non farm incomes which contributed over 80% of the total household income. The annual crops, harvested once a year were pigeon peas sorghum, millet, sweet potatoes, arrowroots and cassava. The biannual crops harvested twice a year were maize, beans,

green grams, and cowpeas. Some perennial crops like mangoes, oranges paw paws, and bananas were also a source of income. Sale of these crops was done soon after harvest. Most of the vegetables sold were from small scale irrigation gardens along river beds or near wells. Remittances were financial assistance received by the households from either people working elsewhere like relatives or organizations. The incomes realised from crops was converted to monthly depending on the number of times the crop was harvested in a year.

There was no significant difference in median total monthly incomes between season1 (median=4333, IQR=2167-7964) and season 2 (median=4500, IQR=3000-8000) p=0.520. However incomes from farm products fluctuated significantly with seasons. The median daily income was ksh.143 in season1 and ksh 148 in season 2. (appendix 8). The incomes from sale of cereal crops, root crops, fruits, vegetables, were significantly higher in season 1 than season2,(mann-whitney test for the difference in median, $p<0.05$) table 10. There were more sales of livestock in season 2 than season1, though not significant. Non farm incomes did not vary significantly with seasons. On the overall the farm based incomes namely from cereals, root crops, fruits, vegetables and livestock contributed 8.0% in season1 and 1.4% in season 2 to the total household income

Table 10 Households' monthly or seasonal incomes in ksh. by season

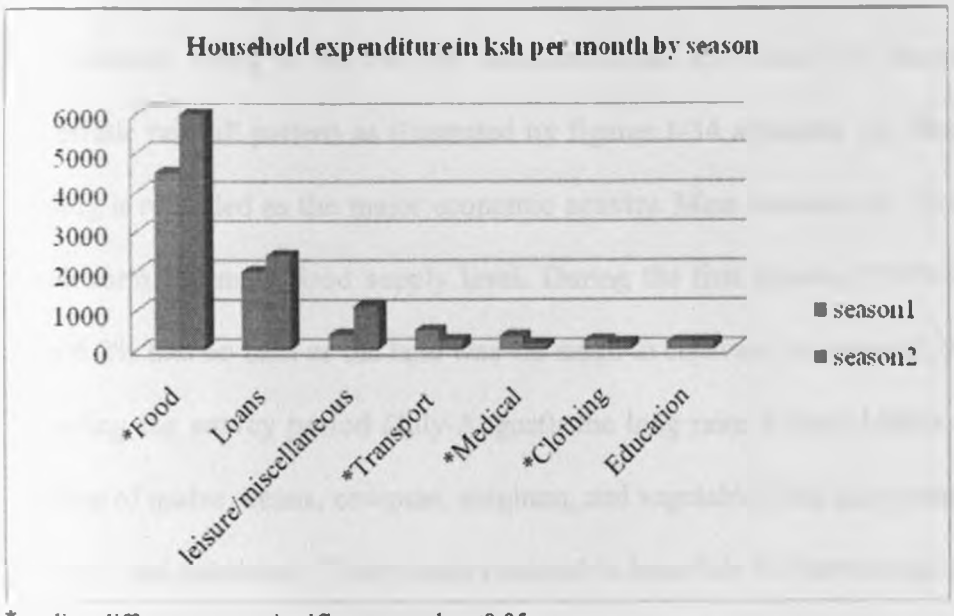
Source of income	Season1 (long rains harvest) N=147			Season 2 (short rains harvest) N=171			P-value
	N	median ksh	IQR ksh	N	Median ksh	IQR ksh	
Husbands Salary p/m	55	4500	3000-8000	90	4050	3000-8000	0.600
Wives' salary p/m	19	5000	2000-8000	12	3150	2000-6000	0.116
Casual labour p/m	32	4000	2000-5100	24	4000	3000-4375	0.639
Cereals p/season	45	3600	1900-7750	12	2000	638-4275	0.027*
Rootcrops p/season	38	2000	1150-4575	10	1350	475-1525	0.046*
Fruits p/season	51	1500	750-2400	50	750	600-1500	0.040*
Vegetables p/season	25	3000	1125-4650	11	1000	500-2100	0.042*
Livestock p/month	13	250	200-1000	15	900	450-2400	0.110
Business p/m	15	3000	1500-7800	26	4750	1150-10000	0.878
Remittances p/m	3	1500	200-3000	13	1400	750-2000	0.949
Homecraft p/m	6	500	175-7500	10	600	400-1625	0.707

(IQR- inter quartile range)
* significant

The cash expenditures were considered proxy estimates of the incomes. There was significant difference in the median total expenditures per month between season 1 (median=5738, IQR=3905:7964) and season 2 (median=6516, IQR=4858:8550) p=0.007 Mann-whitney test. The total monthly incomes correlated significantly with expenditures ($r=0.230$ $p<0.05$). Total monthly expenditures correlated with daily food expenditures ($r=0.520$, $p<0.01$)

The household share of expenditure on food also increased during season 2 from a median of Ksh150 to Ksh 200 daily ($p<0.05$) and this also increased the number of households spending more than 70% of the total expenditure, on food from 64.1% in season 1 to 75.9% in season 2 indicating a growing situation of food insecurity, appendix8. This observation was significant,

(Chi-square value; 5.187 df=1 ,p=0.023) The monthly expenditures varied in both directions between the two seasons. There was significant difference in food, clothing and transport expenditures between season1 and 2. More money was put in food purchases in season 2 and these expenditures are illustrated in figure 7.



*median difference was significant, p-value<0.05

Figure 7 Median household expenditures per month.

Some of the social demographic characteristics of the households were cross-tabulated with the children's main nutrition indices and the women BMI. These were the sex, education and occupation of the household head. During season 2 there was a significant association of the sex of household head and prevalence of underweight children, χ^2=6.648 p=0.01. Based on the odds ratio, prevalence of underweight children was 2.95 times more likely in female headed households than in the male headed households pointing to the fact that during food challenging times, children are more vulnerable. There was an association between levels of stunting and occupation in season2, χ^2=3.9, p<0.05 as more stunting was found in households whose head was unemployed. The study did not find any significant relationship in education of the household head and nutrition indices of children and women. The women BMI correlated positively with household total expenditure(r=0.304,p=0.01)in season2,and total

income(r=0.296,p=0.01), husbands salary(r=0.314,p<0.05), livestock income(r=0.719,p<0.01), protein and caloric intake (r=0.411 and 0.375 respectively p<0.05) in season1.

4.5 Farming and Seasonal Food Production

4.5.1 Crop farming

Kitui District, being in the arid and semi-arid areas is hot and dry, characterized by unreliable and erratic rainfall pattern as illustrated by figures 1-34 appendix 18. Despite that predicament, farming is regarded as the major economic activity. Most farmers rely on rainfall for their crops which form the main food supply level. During the first season, 93.8% grew food crops. The other 6.2% had no land or the land was too small to cultivate. In season 2, 96.5% grew crops. Preceding the survey period (July-August), the long rains in mid March were accompanied by planting of maize, beans, cowpeas, sorghum, and vegetables like kale, tomatoes, spinach, onions, cabbage, and capsicum. These crops matured in June-July for harvesting. Maize and beans were harvested dry for storage and some sold for income. Most pigeon peas were harvested green for household consumption or sale. Cowpea leaves were an important vegetable especially during the rainy days and also seemed to persist longer in the dry season than other vegetables. The households that had harvested maize were 89.1%, 69.4% had beans and 55.8% pigeon peas in the first season.

Kitui experiences a bimodal type of rainfall and planting is done twice a year, hence the second planting was in October-November during the short rains for the crops to mature in January-February. Though the residents reported poor rainfall and crop failure, 53.8% of the households had harvested some maize, 20% beans, 8.2% sorghum and 5.3% cowpeas. Most of the crops had dried up before harvesting. These timeline activities are well illustrated by figure 3 in chapter 3. Table 11 gives the median production in kgs of major foods which shows differences in both

quantities produced and the number of households in the two seasons. The production of main staples, maize and beans was significantly higher in season1 than season2.(mann-whitney-test, $p<0.05$ for maize and beans.). Matinyani one of the study areas where the total annual rainfall for 2008 was 427 mm, distributed in two seasons as in figure 3. The March-May season, referred to as the long rains had a total rainfall of 359mm and the median harvested maize in June-July was 180 kg per household. The short rains amounted to 68 mm in October-November followed by a harvest in February-march the following year. This was season 2 and the median maize production was 50kg per household. Production of beans also fluctuated from 30kg per household in season1 to 15kg per household in season 2. This fluctuation created food shortfall in many households as recorded in table 11.

Table 11 Median food production per householdin Kgs by season
N=147 in season1 and 171 in season2

Food	season	n	median in kg/ hh	IQR kg/hh	Significance p-value
Maize	1	131 (89)	180	60-270	0.001**
	2	92 (54)	50	20-90	
Beans	1	102 (69)	30	10-90	0.006**
	2	36 (21)	15	5-20	
Tomatoes	1	17 (12)	350	95-600	0.001**
	2	8 (5)	35	20-163	
Sorghum	1	0	-	-	-
	2	14 (8)	7.5	2-30	
Mangoes	1	68 (46)	490	210-700	0.404
	2	58 (34)	700	350-700	
Oranges	1	24 (16)	210	70-210	0.099
	2	5 (3)	50	43-180	
Kale	1	25 (17)	400	180-1000	0.001**
	2	14 (8)	70	40-175	
Sweet Potatoes	1	17 (12)	140	50-210	.0122
	2	2 (10	35	20-50	
Cassava	1	46 (31)	95	45-210	0.170
	2	6 (4)	60	35-98	
Cowpeas	1		-	-	-
	2	9 (5)	10	8-50	
Pigeonpeas	1	82 (56)	90	20-90	-
	2				
Bananas *	1	36 (25)	4	2-5	0.773
	2	1 (0.6)	3	3-3	
Arrowroots	1	2 (1)	26	2-50	-
	2		-	-	

* bananas are in bunches, **significant at 0.05 level based on Mann-whitney test.

Figures in parenthesis represent percentages

The size of the land was an important determining factor of the farming potential of a household not only for household food but a source of income. In rural Kitui 80.6% of the households owned 2.5 or less acres of land while 18% had over 2.5 but not more than 5 acres. However not all this land was being utilized for food production as shown in appendix 6. Majority of farmers, about 83.6%, in season1 and 77.9% in season2 cultivated 2.5 acres or less. The figures 8, 9 and 10 also show that the amount of food produced per household increases with acreage but production went down as land increased beyond 5 acres.

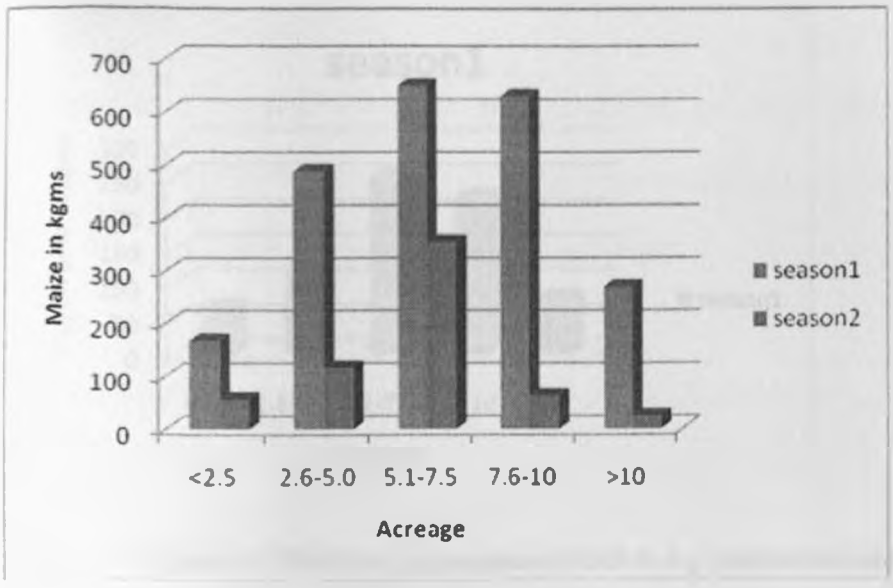


Figure 8 Median maizeyield in kg per household by total land.

The production of main food crops reduced drastically ($p<0.05$) during season 2 (short rains harvest) as indicated by the figures 8, 9,10 and 11.

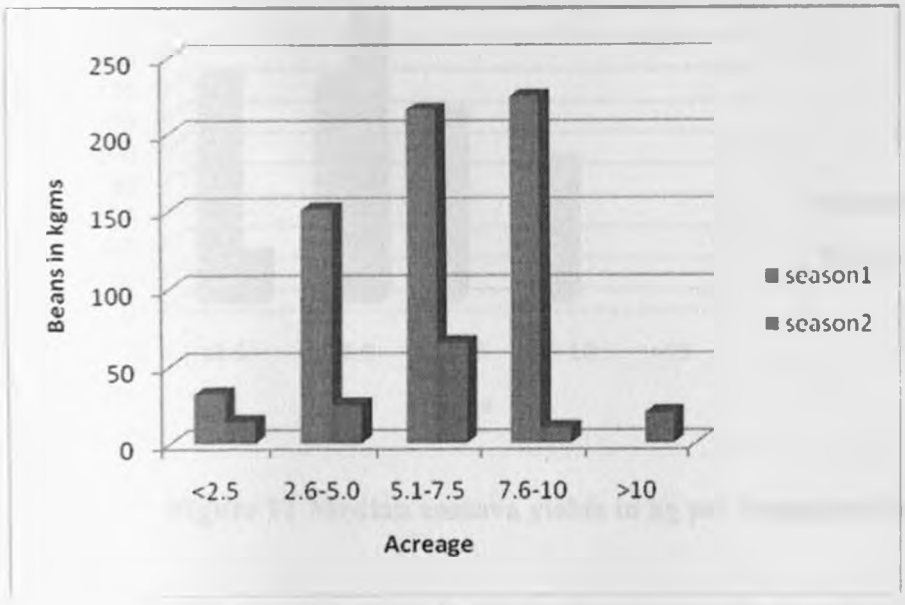


Figure 9 Median beans yield in kg per household by total land.

Pigeon peas was harvested during season1only since it is an annual crop.

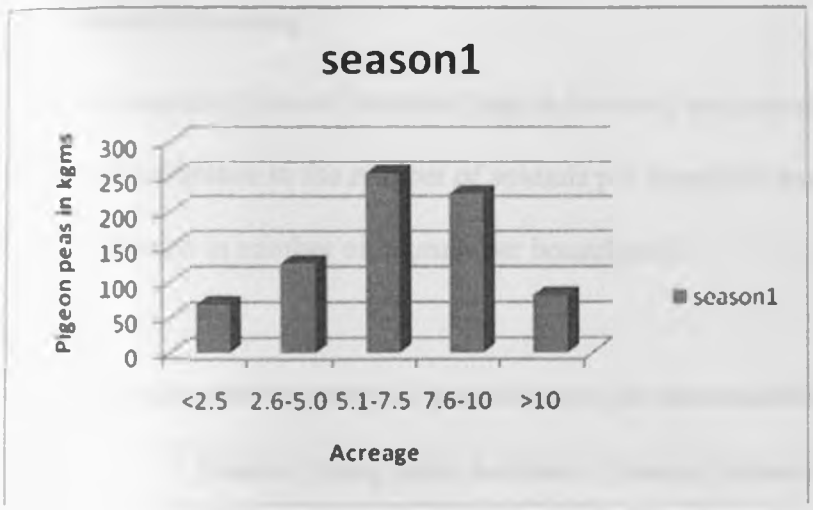


Figure 10 Median pigeonpeas yields in kg per household by total land.

Cassava was the main root crop produced by about 30% of the households during season1 and 4% in season2.

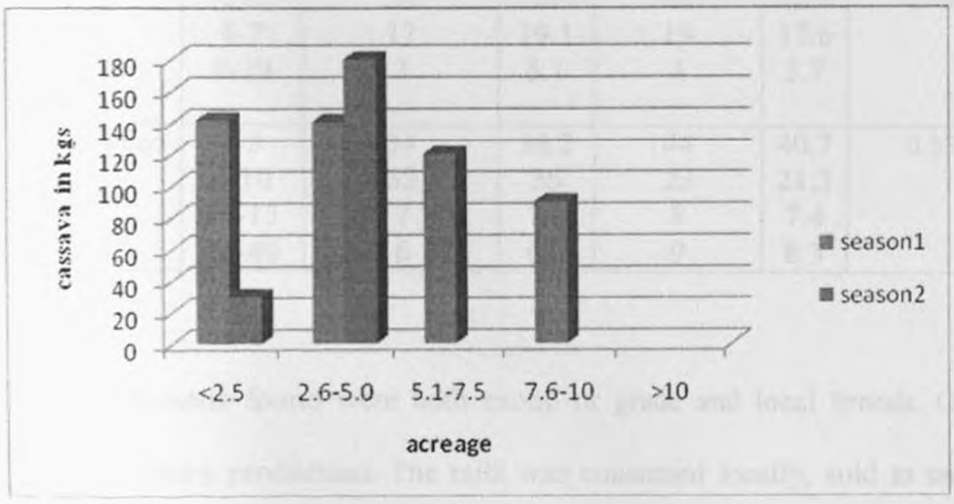


Figure 11 Median cassava yields in kg per household by total land.

The main purpose of farming by the study households was to produce food for home consumption. This was mainly true of the staples and vegetables. The other reason was to obtain some income. In season one, 93.8% did some crop farming and 61.8% kept livestock. In season two, 96.5% had crops and 63.5% kept livestock. Many of the households did both.

4.5.2Livestock farming

The most common types of livestock kept in the study area are shown in table 12 . There was no significant difference in the number of animals per household between seasons 1 and 2 (t-test for mean difference in number of animals per household).

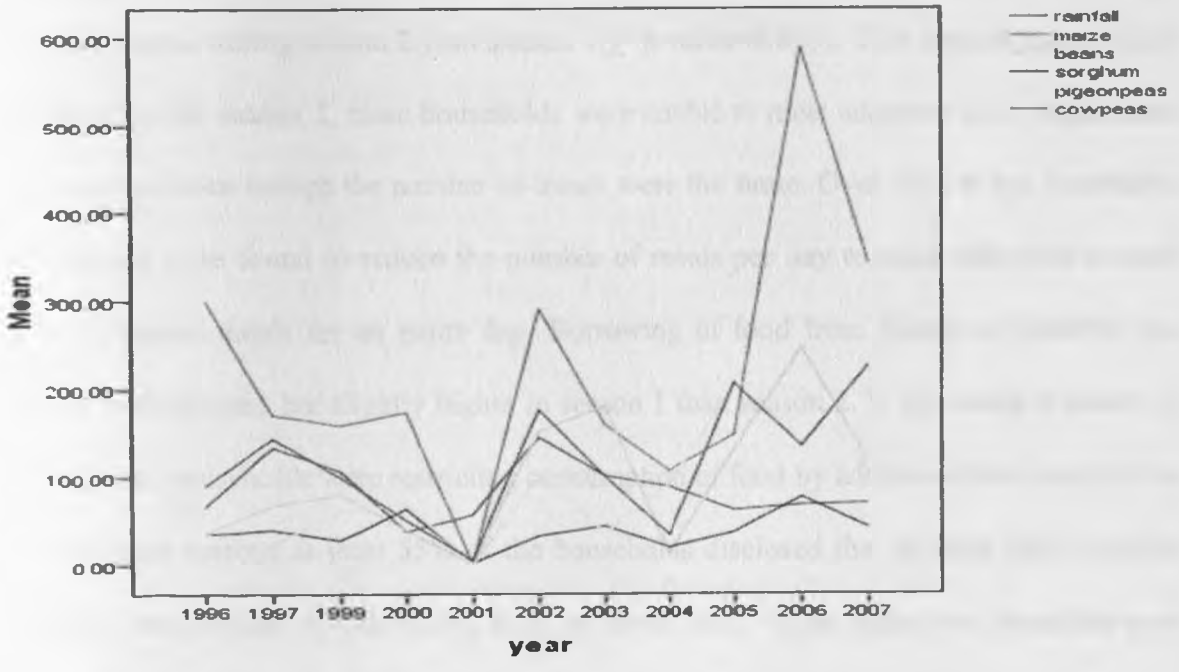
Table 12 Types and numbers of animals kept per household by seasons

	Season 1(long rains harvest) N=147			**Season 2 (short rains harvest) N=171**		
Type of livestock	Nos.	Number of households	%	Number of households	%	Significance p-value
Cattle	1-2 3-4 5-10	26 11 3	29.2 12.4 3.4	24 15 7	22.2 13.9 6.5	0.269
Goats	1-3 4-7 8-20	38 17 3	45 19.1 5.1	46 19 4	42.6 17.6 3.7	0.784
Local chicken	1-5 6-10 11-15 16-40	34 32 7 6	38.2 36 7.9 6.9	44 23 8 9	40.7 21.3 7.4 8.3	0.537

The type of cattle found were both exotic or grade and local breeds. Grade cattle were for commercial dairy production. The milk was consumed locally, sold to neighbours and nearby hotel businesses. The bulls were kept for meat. The local breeds produced little milk for home consumption and the bulls were mainly for cultivation. Goats were preferred to sheep because they survived better in the prevailing dry conditions. They were kept for traditional purposes and for sale when needs arose. Goats' milk was used for tea by some households. Chicken were the local breeds used for eggs, meat and for sale as a source of income.

4.6 Problems in Food Production

Inadequate rain was one of the major problems expressed by 82.4% of the residents in season1and 80.3% in season2. The critical food insecurity experienced in season2 was attributed to rainfall failure resulting to over 80% of the households having no food socks as illustrated in table 14. More often than the routine, seasonal rainfall failed leading to food insecurity in most households. As a result families were faced with insufficient diets in calories and nutrients. Figure11 shows how food production especially maize, has been fluctuating with rainfall over the years showing some correlation between the amount of rainfall and food produced. The farmers basically depend on rainfall for food production. During season1, 89% of the residents responded that the years 2006 and 2007 harvests were better than the 2008, 85.7% said that rainfall patterns had changed with 89.8% saying that the amount of rainfall had declined over the last five years. During season 2, a similar response was received.



[Source: Kitui agriculture office and Nairobi meteorology department] rainfall figures are '10

Figure 12 Annual food production trends in '00 bags and total annual rainfall in mm.

Poor soil fertility w as reported by 54.3% and 28.6% of residents in season 1 and 2 respectively as most of them had no access to fertilizers, good seeds and means of pest control. Postharvest losses of the main staples due to pests or weevil infestation and rotting was also cited as contributing to food insecurity.

4.7 Adaptation Methods and Coping strategies

Some of the households had wells, boreholes or the farms were alongside seasonal river valleys in which shallow wells were dug to obtain water for irrigation. There were 25.3% and 28.3% of the households in season1 and2 respectively growing vegetable crops from these water sources using manual irrigation. The crops were a boost to household diets as well as a source of income. Table 13 shows the coping strategies by the study residents during the study period. Among the most popular strategies was the reduction in the size of meals and the number of meals a household had in a day. The number of households who reduced the size of meals was significantly higher during season 2 than season 1(χ^2 p-value=0.013). This implied that in times of food scarcity like season 2, more households were unable to meet adequate daily requirement of their nutrition even though the number of meals were the same. Over 75% of the households in both seasons were found to reduce the number of meals per day to cope with food scarcity while 45% skipped meals for an entire day. Borrowing of food from friends or relatives was common in both seasons but slightly higher in season 1 than season 2. It was noted in season 2, significant more households were restricting consumption of food by adults to allow more for the children. In both seasons at least 55% of the households disclosed that at times they consume seed stock. Consumption of wild fruits, toxic or taboo food, rotten maize and immature crop increased during season 2 as shown in table 13.

Table 13 Households' coping strategies by seasons

	Coping strategy	Households in season 1 n=147 %	Households in season 2 n=171 %	Chi-square p-value
1	Reduced in the size of meals	58.2	78.8	0.001
2	Restricted adult consumption to allow more for children	33.6	61.8	0.001
3	Used less preferred or cheaper food	49.3	86.5	0.001
4	Borrowed food from friend or relative	67.1	52.9	0.012
5	Reduced number of meals	78.8	76.6	0.610
6	Skipped food consumption for an entire day	49.9	45.3	0.255
7	Fed working members at the expense of non working person	4.8	8.78	0.213
8	Purchased food on credit	87.0	83.5	0.430
9	Consumed wild, toxic or taboo food	11.6	18.8	0.079
10	Consumed immature crop	37.7	40.0	0.729
11	Consumed rotten maize	3.4	5.9	0.428
12	Consumed seed stock as food	55.5	63.5	0.168
13	Withdrew children from school	13.5	12.1	0.724
14	Sent hh members to eat elsewhere	0.7	8.2	0.001
15	Begged or engaged in degrading jobs	3.4	39.3	0.001
16	Individual or hh migration	0.7	17.6	0.001
17	Sold hh goods or farm implements	10.3	23.5	0.001
18	Sold livestock	15.1	32.1	0.002

4.8 Seasonal Dietary Sources

The food consumed by the study households was mainly from subsistence farming, purchasing, and to a smaller extent food gifts, food for work, borrowing and famine relief. Farming was portrayed as an important activity in food availability in that during the first season 89.7% of the households reported having some food stocks to last between one and ten months depending on

the quantities harvested and the size of the households. In the second season, only 15.4% households reported having some food stocks. The foods that were mainly stocked were maize, beans and pigeon peas. The other staples like sorghum and cowpeas were in small quantities lasting less than a month or consumed while still in the farms. Table 14 shows the number of households food stock status and the duration the food lasted.

Table 14 Households' food stock by seasons in percentages.

	Season 1 % N=147	Season 2 % N=171
Households with no food stocks	10.3 (15)	84.6 (145)
Households with food to last 1-3months	38.1 (56)	11.7 (20)
Households with food to last 4-6 months	32.0 (47)	2.3 (4)
Households with food to last 7-10months	19.7 (29)	1 (2)

Figures in parenthesis represent household numbers

In the second season the majority 84.6% of the households, were food insecure and were either purchasing, for those with adequate income, borrowing or receiving relief food. Most of those who had food stocks in season2 consumed it within three months after harvest.

4.9 Dietary Intakes and Adequacy by seasons

Dietary intakes were strongly determined by what was grown in the farms. The availability of a particular food was assessed by how frequently the food appeared in the diet on a weekly basis. Table 15 gives a tabulation of the major foods that were consumed at the time of the study during the two seasons.

Table 15 Dietary intakes of the foods by residents and the frequency per week

Season1 N=147			Season2 N=171		
Type of food	Mode*	Households %	Mode*	Households %	p-value
Maize	7	70.7	7	79.5	0.249
Sorghum	7	45.5	7	43.8	0.759
Millet	7	9.5	7	7.0	0.785
Irish potatoes, rice wheat, Matoke, sweatpotatoes	1-2	24.9	1-2	24.8	>0.05
Cassava	1	25.2	1	11.7	0.014
Kale	7	36.1	7	50.9	0.011
Cabbage, carrots	1-2	20.1	1-2	18.2	>0.05
Cowpea leaves	1-2	15.6	1-2	15.2	0.001
Pawpaws	7	36.1	1-2	22.2	0.060
Mangoes, oranges	1-2	35.7	7	4.7	0.027
Beans	2-3	54.4	7	50.9	0.001
Pigeon peas	7	46.9	1	1.2	0.014
Greengrams, peas	1	5.3	1	14.0	0.642
Beef, chicken,	0.25-2	38.8	0.25-2	30.7	>0.05
Eggs	1-2	29.9	1-2	36.8	0.049
Milk,fat, sugar	7	90.3	7	89.8	>0.05

*frequency (number of days per week) the highest percentage of households consume the food(s)

Maize was consumed daily by 71% households in season1 and 80% in season2. Sorghum was equally popular for porridge mixed with maize and or millet. Beans and pigeon peas were grown in the region and formed the major protein sources of plant origin in the diets. There was a significant difference in the mean frequency of consumption of both beans and pigeon peas between the seasons, $p<0.05$.

4.9.1 Dietary diversity

The foods that were consumed by the children over the 24-hour dietary recall are grouped in appendix 10. The Individual Dietary Diversity Score (IDDS) calculated for the children below

five years had a mean of 5.3,s.d.;1.2 95% CI:4.8; 5.7 for season 1 and 4.4, s.d.;1.2, 95% CI:3.9; 4.8 for season 2. The mean difference of 0.9 was significant by independent samples t-test, p-value= 0.009. The significant difference implies that in season 2 the children had less variety of foods which may have lowered the caloric intake and quality of diets in terms of nutrients.

4.9.2 Dietary adequacy

The mean energy intake from the 24hour recall was 1158.33kcals, s.d. 503.6, 95%CI:970.3-1346.4 in season1 and 931.6 kcals, s.d. 400.2, 95% CI:784.8-1078.4 in season2. The mean difference was 239.5kcals and was statistically significant, t-test, p-value= 0.047. The mean protein intake was 30.0gms, sd 16.7 in season 1 and 21.7gms, sd.9.3, 95% CI: 18.3:25.2 in season2. The mean difference (8.5) was significant, (t test, p-value =0.015). Table 16 gives the percentage children and the consumption level of calories and protein.

The households that were not meeting at least 80% of the Recommended Dietary Allowance in calories and protein were regarded as food insecure. From table 20, 50% and 73.3% of the children were getting less than 80% of their daily dietary energy requirement in season 1 and 2 respectively. For protein intake per day, season1 had 23.3% and season 2 30.0% of the children below 80% of the daily requirement. The vitamin A intake was slightly higher in season1 (mean of 543 IU, sd; 342) than season2 (mean of 507 IU, sd; 477) though it was not statistically significant. (t-test for the equality of mean, p-value=0.736. Appendix 12 indicates that a larger percentage of the children in the 25-59 months age group (43% season1 and 53% in season2) were not meeting 80% of the Recommended Dietary Allowance in calories and in protein they were 20% in season1 and 23.4% in season 2.

Table 16 Energy and protein intake by seasons

Category of:	season1	season2
Energy intake	(%)	(%)
<80%	50.0	73.3
80-99%	20.0	13.4
≥100%	30.0	13.3
Protein intake		
<80%	23.3	30.0
80-99%	10.0	26.7
≥100%	66.7	43.3

N=30 for both energy and protein intake

4.10 Nutritional Status and Seasons

4.10.1 Children below five years

Nutritional status of children (aged 6-59 months) was assessed by the weight-for-age, height-for-age and Body mass index–for-age z-scores. Mid upper arm circumference (MUAC) was also used. In season 1, a total of 162 children were assessed of which 48.8% were boys and 51.2% were girls. Season 2, had slightly more children (222) of which 50.9% were boys and 49.1% girls. After computing the anthropometric measurements using AnthroPlus, 5 children were flagged in season1 leaving 157 for the analysis and 3 in season2 leaving 219. The study was carried out at a time when the residents were harvesting their food crops referred to as season1 or the long rains harvest and season2, the short rains harvest. Figure 13 shows the prevalence of underweight, stunting and wasting among the children in the households that were surveyed in the two seasons.

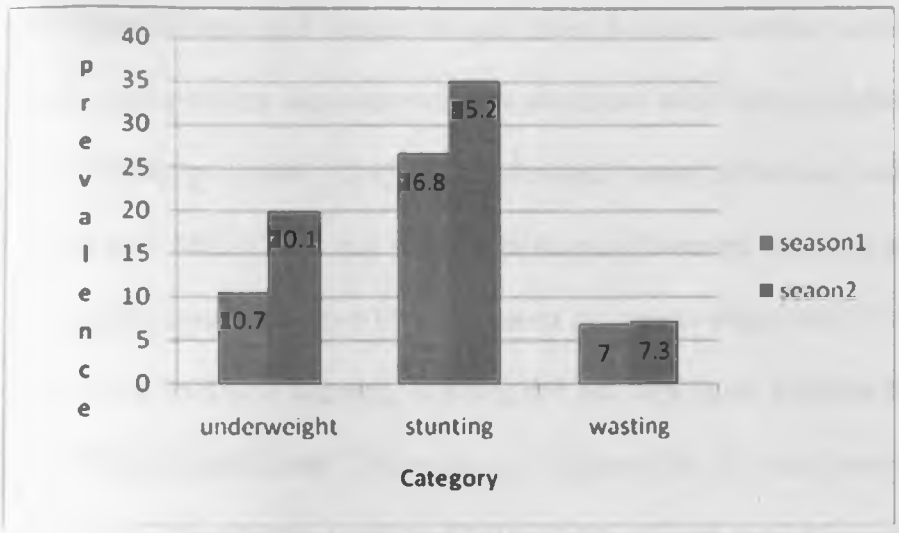


Figure 13 Malnutrition levels of the children 6-59months by seasons

Table 17 gives the mean z-scores of the nutrition indicators of the children, the standard deviation and the confidence intervals for the two seasons. Generally the mean Z-scores and the confidence intervals for season2 were lower than season1 while the standard deviation does not show variation meaning that the distribution curve for season2 shifted slightly to the negative.

Table 17 Results of the mean z-scores nutrition indicators for the two seasons

Nutrition indicator	mean z-scores	standard deviation	95%confidence interval	
Season 1 (long rains harvest)				
Weight-for-age	-0.7692	1.1348	-0.9481 : -0.5903	(0.09)*
Height-for-age	-1.1978	1.3658	-1.4231 : -0.9525	(0.11)*
BMI-for-age	-0.0285	1.3816	-0.2426 : 0.1930	(0.11)*
MUAC	14.3869	1.1797	14.3869 : 14.5711	(0.10)*
Season2 (short rains harvest)				
Weight-for-age	-1.1271	1.1304	-1.2801 : -0.9740	(0.08)*
Height-for-age	-1.5680	1.3861	-1.7556 : -1.3803	(0.09)*
BMI-for-age	-0.2026	1.3710	-0.3883 : -0.0170	(0.09)*
MUAC	14.6212	1.2180	14.4563 : 14.7861	(0.08)*

*Standard error of the mean

The weight-for-age and height-for-age mean z-scores showed significant difference between seasons, independent samples t-test for the mean difference, weight-for-age; mean difference was 0.3958, p- value <0.05, height-for-age; mean difference was 0.4105, p-value <0.05. Wasting and MUAC did not show significant differences between seasons. In season 1, the underweight children were 10.7% compared to season2 which had 20.1%. Stunting was 25.8% in season1 and 35.2% in season2. Wasting did not vary much between the two study periods as it was 7.0% in season1 and 7.3% in season2 (figure 13). No child was found with oedema in the entire study. The children who had MUAC (Mid Upper Arm Circumference) less than 12.5cm cut-off were 4.4% in season1 and 2.8% in season2. MUAC is also a measure of wasting which did not vary significantly with seasons.

4.10.2 Nutritional status by sex

On the overall, a higher proportion of boys compared to girls had severe malnutrition such that in season 2 the proportion of boys who were found stunted was significantly higher compared to season 1 (chi-square value, 14.084 df=2 p=0.001), table 18.

Table 18 Distribution of Children by Nutritional status and sex in season1 and 2

		Season1(long rains harvest) N=157			Season2(short rains harvest) N=219		
Nutrition index	sex	Severe %	Moderate %	Normal %	Severe %	Moderate %	Normal %
Weight-for-Age (underweight)	Boys	2.5	3.8	42.0	3.7	4.6	42.5
	Girls	1.3	3.2	47.1	2.7	8.2	38.4
	Total	**3.8**	**7.0**	**89.1**	**6.4**	**12.8**	**80.9**
Height-for-Age* (stunting)	Boys	4.5	6.0	38.2	11.0	12.3	27.4
	Girls	3.8	10.9	36.9	3.2	8.7	37.4
	Total	**8.3**	**16.9**	**75.2**	**14.2**	**21.0**	**64.8**
BMI-for-Age (wasting)	Boys	2.5	2.0	44.6	2.3	2.0	45.7
	Girls	0.6	1.9	48.4	1.4	1.6	47.0
	Total	**3.1**	**3.9**	**93.0**	**3.7**	**3.6**	**92.7**

*significant chi-square p value=0.001

4.10.3 Nutritional status by Age

The number of malnourished children increased with age in both seasons as can be seen in tables 19 and 20. During season1, of the 21 children below 1year, 2 two were wasted and 1 stunted. It was also found that children above 36 months had significantly high levels of malnutrition and their mean z-scores were lower than the other age groups. This is demonstrated in figures 14 ,15 and 16.

Table 19 Distribution of children by nutritional status and age in season1.

Season1 (long rains harvest)							
		Weight-for-Age		**Height-for-Age**		**BMI-for-Age**	
Age groups in months	N	Severe %	Moderate %	Severe %	Moderate %	Severe %	Moderate %
6-12	21	0	0	0	0.6	0.6	0.6
13-24	49	0	2.5	4.5	3.8	0	1.3
25-36	30	0.6	2.0	0.6	4.2	0.9	1.4
>36	57	3.2	2.5	3.2	8.3	1.6	0.6
Total	**157**	**3.8**	**7.0**	**8.3**	**16.9**	**3.1**	**3.9**

Table 20 Distribution of children by nutritional status and age in season2.

Season2 (short rains harvest)							
		Weight-for-Age		Height-for-Age		BMI-for-Age	
Age groups in months	N	severe %	Moderate %	Severe %	moderate %	Severe %	moderate %
6-12	43	1.8	0.9	1.8	2.3	1.3	0.9
13-24	55	0.9	2.3	3.7	5.9	0.6	0.5
25-36	51	1.4	3.2	4.6	4.1	0.9	0
>36	70	2.3	6.4	4.1	8.7	0.9	2.2
Total	**219**	**6.4**	**12.8**	**14.2**	**21.0**	**3.7**	**3.6**

The mean Z-scores of the main nutrition indicators generally decreased with age which means that within the age group (6-59months) the older children suffered more from malnutrition than the younger ones. This was the case in both seasons and z-scores were found to be lowest at age group 36-59. By one way independent ANOVA, the weight-for-age, showed significant difference in the mean z-scores between the age groups $F(3,153)=8.95$ $p<0.05$, $r=0.28$ for

season1 and $F(3,215)=5.014$ $p<0.05$, $r=0.14$ for season2. The trend in mean z-scores for the weight-for-age within the age groups was significantly linear ($p<0.05$) and decreased with age in both seasons which means that as the age of children increased , the mean z-scores decreased proportionally, (figure14)

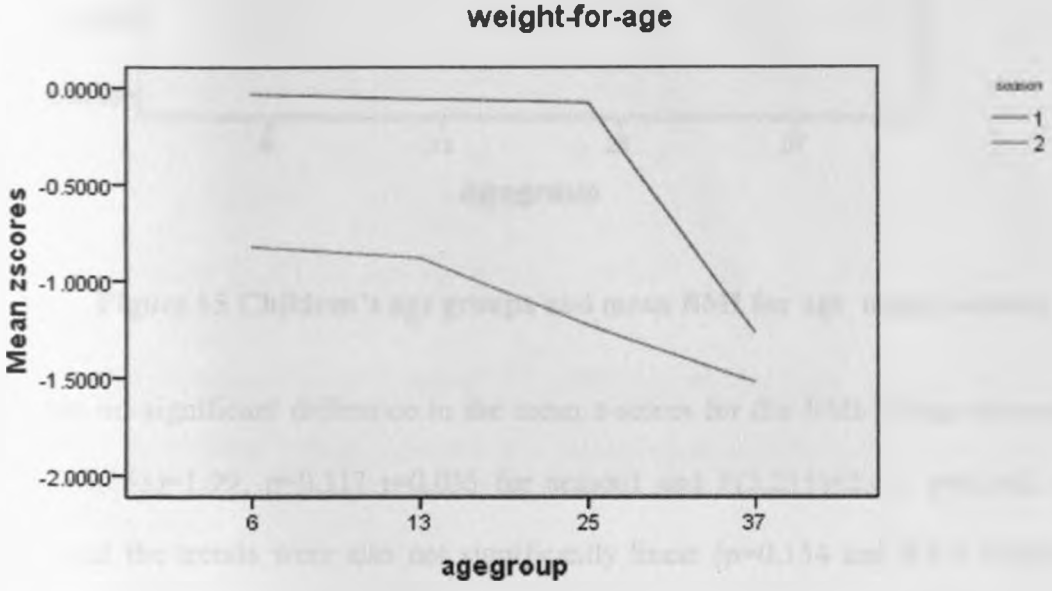


Figure 14 Children's age groups and mean weight for age z-scores

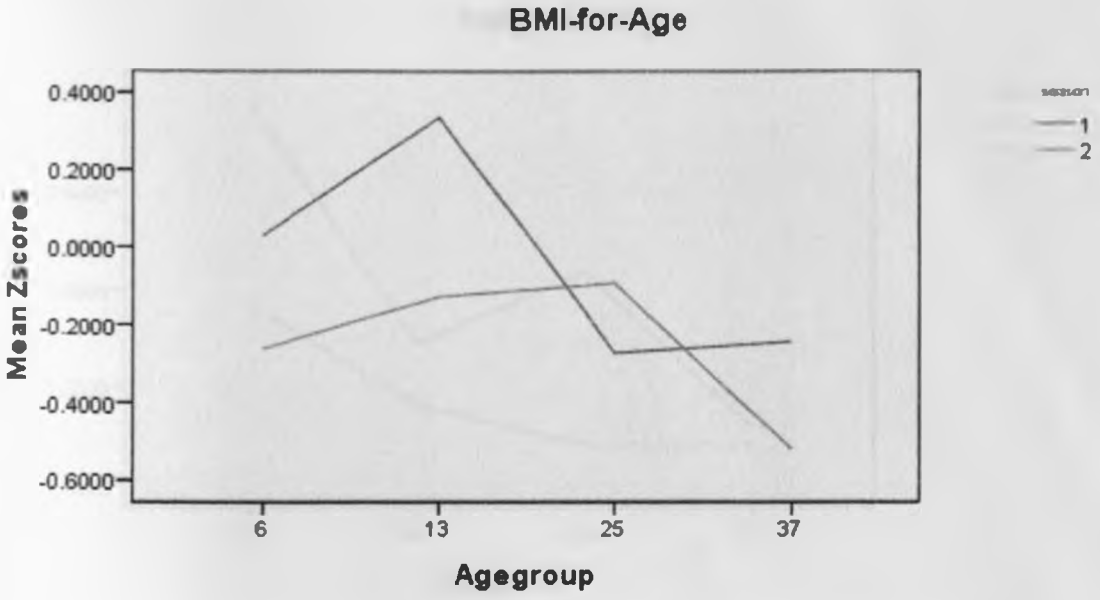


Figure 15 Children's age groups and mean BMI for age mean z-scores

There was no significant difference in the mean z-scores for the BMI-for-age between the age groups F(3,153)=1.99, p=0.117 r=0.035 for season1 and F(3,215)=2.48 p=0.062 r=0.03 for season2 and the trends were also not significantly linear (p=0.154 and 0.217 season 1 and 2 respectively) as can be seen from figure15

Figure 16 Children's age groups and height for age mean z-scores

For the height-for-age, there was significant difference in the mean z-scores between the age groups $F(3, 153)=9.56$ $p<0.05$ $r=0.32$ for season1 and $F(3,215)=2.84$ $p=0.039$ $r=0.16$ for season2 (Figure 16)

4.10.4 Nutritional status of women

On the whole, 3.9% women in season1 and 5.1 % in season 2 were found to be severely underweight, having a BMI below 17.0. The total underweight women, both severe and moderately wasted, in season1 were 11.3% while season2 had 16.0% as indicated in figure 17. In both seasons, most of the underweight women were in the age groups 20-29 years and 30-39 years. Over, 80% in both seasons were of normal or above 18.5 BMI. About 20% in both seasons were obese or tending to obesity. Although the number of women who were both severe and moderately underweight in season 2 were higher than season1, the overall difference in mean BMI (0.0404), between season 1 and 2 was not significant, t-test for the mean difference, $p>0.05$.

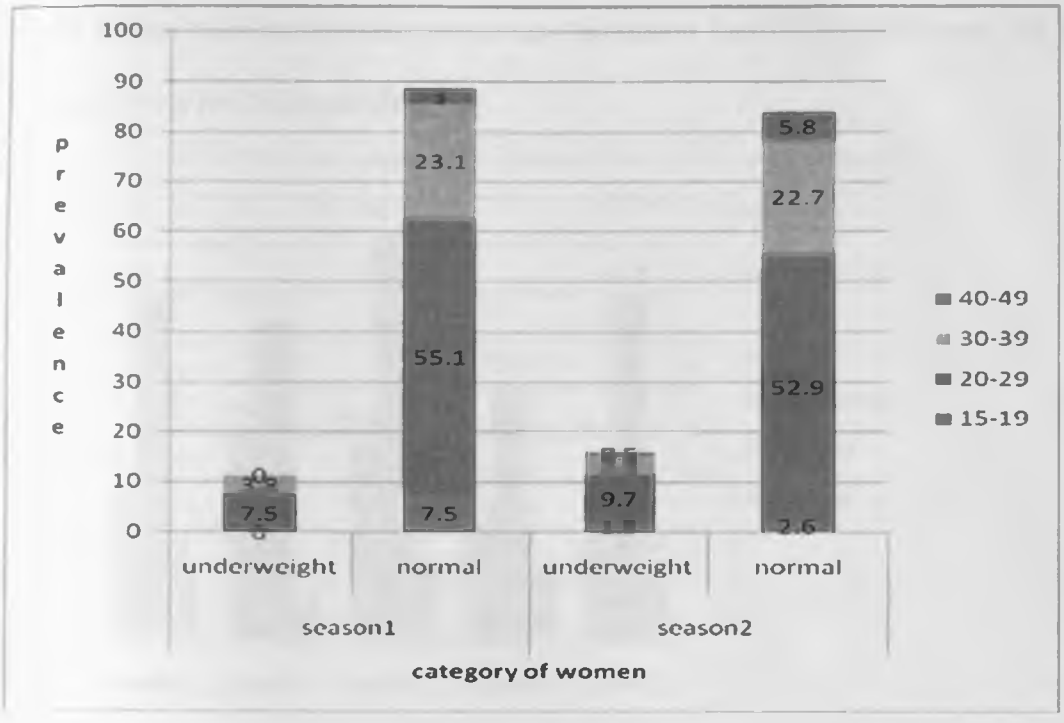
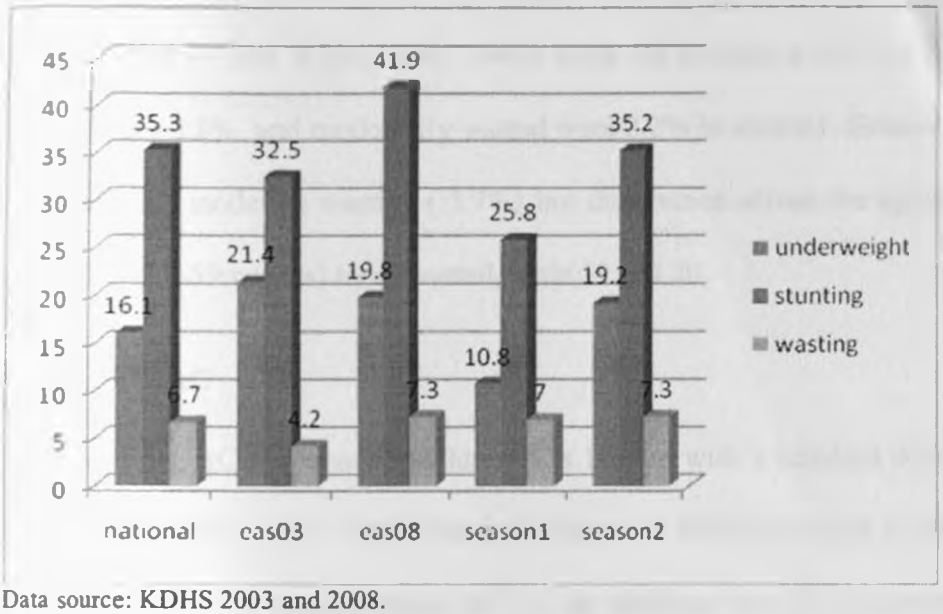


Figure 17 BMI women season1 and 2 (Nutritional Status of Women by BMI)

4.10.5 Association Nutritional Status with Seasons

Figure 18 illustrates malnutrition prevalence for season 1and 2, National levels for 2008, Eastern province levels for 2003 and 2008.



Data source: KDHS 2003 and 2008.

Figure 18 Prevalence of malnutrition of children 6-59 months in season 1 and 2, National and Eastern province

4.10.5.1 Underweight (WAZ)

The prevalence of underweight among children in season1 was 10.7% while in season2 it was 19.2%. There was significant difference in mean weight-for-age z-scores, between season1 (mean=-0.7692) and season 2 (mean=-1.1271), independent t-test $p<0.05$. Odds ratio for underweight between seasons was : =2.1, 95% CI 1.1 - 3.8, meaning that the children were 2.1 more likely to become underweight in season2 compared to season1, Table 21. The severely underweight were 3.8% and moderately underweight were 7.0% in season1. Season2 had 6.4% severely underweight and 12.8% moderately underweight, tables 19 and 20.

4.10.5.2 Wasting (BMI- for- age or BAZ)

The study found that prevalence of wasting or excessively thin children was 7.0% in season 1 and 7.4% in season 2. There was no significant difference in the BMI-for-age mean z-scores between season1 and 2 (p=0.189). Odds Ratio for wasting was 1.0, CI 0.5; 2.4. The severely wasted were 3.8% and moderately wasted were 3.2% in season1. Season2 had the same number of severe and moderate wasting (3.7%) but distribution across the age groups shows the older age group (36-59months) more wasted, table 19 and 20.

4.10.5.3 MUAC

The mean MUAC for season1 children was 14.4cm with a standard deviation 1.17, confidence interval of 14.20: 14.57. The moderately thin were 6.9% and those at risk were 15.0%, (that is below 13.5cm). In season2 mean MUAC for children was 14.16cm with a standard deviation 1.37, confidence interval of 14.45: 14.78. The moderately thin were 4.2% and those at risk were 16.7% (that is below 13.5cm). The mean difference (0.2138) between the seasons was not significant (p>0.05).

4.10.5.4 Stunting (HAZ)

Stunting was 25.8% in season 1 and 35.2% in season 2. The difference between the mean z-scores in season1 (mean-1.1978) and season 2 (mean-1.5680) was significant, independent t-test, p<0.05. Odds ratio for stunting was 1.6, 95% CI; 1.04: 2.59 (Table 21). Those who were severely stunted were 8.3% and moderately stunted were 15.9% in season1. In season 2, the severely stunted were 14.2% and moderately were 21%, tables 19 and 20.The computed odds ratio indicates the probability risk of becoming stunted in season2 compared to season1 and that children were 1.6 times more likely to become stunted in season2 than in season1. The confidence interval gives the range in which the population odds ratio would fall.

Table 21 shows that the prevalence of underweight and stunting among children was significantly higher in season 2 compared to season1 (χ^2 $p<0.05$), but not wasting in children and underweight women.

Table 21 Association of nutritional status and seasons

Nutrition indices	Season1	Season2	χ^2 p-value	Odds ratio Season2/season1	Pearson chi-square χ^2
WAZ ≥ -2	89.2	79.9	0.016	2.1	5.773
< -2	10.8	19.2		95% CI: 1.1 - 3.8	df=1
HAZ ≥ -2	75.2	64.8	0.033	1.6	4.564
< -2	24.8	35.2		95% CI: 1.0 -2.6	df=1
BAZ ≥ -2	93.0	92.7	0.912	1.0	0.012
< -2	7.0	7.3		95% CI: 0.5 - 2.3	df=1
Women	% N=134	% N=154	-	-	-
BMI ≥ 18.5	88.8	84.4	0.277	1.5	1.180
< 18.5	11.2	15.6		95% CI: 0.7 - 2.9	df=1

The prevalence of children in season1 who were underweight was 10.7, and in season2, 20.1,. Underweight was significantly higher both in prevalence and mean z-scores in season2 compared to season1, $p<0.05$, odds ratio: 2.1. Children below 12months were found well nourished while children above 36 months were significantly more of malnourished. Women who were underweight by BMI<18.5, were 11.5% in season1 and 15.6 in season2 and these prevalence levels were not significantly different.

4.10.6 Nutritional status and Coping strategies

The diet based coping strategies that were found significantly higher in season2 compared to season1, ($p<0.05$), were, reduction in the size of meals, restricting adults consumption to allow more for the children, using less preferred or cheaper food, borrowing food, reduction in the

number of meals (not significant),and skipped food consumption for an entire day, and they were cross-tabulated with the main nutrition indicators, weight-for-age, height-for-age, BMI-for-age to evaluate the association these measures, could have on the children's nutrition, Tables 22 and 23.

Table 22 Some diet based coping strategies and malnutrition prevalence of in season1 (long rains harvest).

Coping strategy	% households N=147	%children underweight N=157	χ^2 p-value	% children stunted N=157	χ^2 p-value	% children wasted N=157	χ^2 p-value
Reduced the size of meals	Yes 59.0 No 41.0	4.2 5.6	0.853	14.4 11.0	0.851	3.5 2.8	.980
Restricted adult consumption to allow more for children	Yes 33.6 No 66.5	1.4 8.3	.237	9.6 15.8	.702	0.7 5.6	.306
Used less preferred or cheaper food	Yes 49.3 No 50.7	4.9 4.9	1.000	12.3 13	.925	4.2 2.1	.306
Borrowed food from friend or relative	Yes 67.1 No 32.9	4.9 4.9	.228	18.5 6.8	.424	3.5 2.8	.474
Reduced number of meals	Yes 78.8 No 21.2	6.3 3.5	.169	19.9 5.5	1.000	5.6 0.7	.685
Skipped food consumption for an entire day	Yes 49.7 No 50.3	4.9 4.2	.780	13.1 12.4	.851	2.1 4.2	.497

Association of prevalence of malnutrition with households practising or not practising the diet based coping strategies generally was not significant in both seasons. (appendix 11) .

Table 23 some coping strategies and prevalence of malnutrition in season2 (short rains harvest).

Coping strategy	%age households N=171	%age underweight N=219	χ^2 p-value	%age stunted N=219	χ^2 p-value	%age wasted N=219	χ^2 p-value
Reduced the size of meals	Yes 79.2 No 20.8	13.7 3.6	.983	27.2 7.1	.888	5.4 0.6	.690
Restricted adult consumption to allow more for children	Yes 61.9 No 38.1	9.5 7.7	.410	18.3 16.0	.135	3.6 2.4	.898
Used less preferred or cheaper food	Yes 86.3 No 13.7	14.9 2.4	.986	29 5.3	.640	6.0 0	.361
Borrowed food from friend or relative	Yes 53.0 No 47.0	10.1 7.1	.545	18.9 15.4	.748	3.0 3.0	.846
Reduced number of meals	Yes 76.6 No 23.4	12.4 4.1	.084	26.5 7.6	.378	5.3 0.6	.596
Skipped food consumption for an entire day	Yes 44.5 No 55.5	6.0 11.3	.220	15.4 18.9	.890	2.4 3.6	.755

Although the diet based coping strategies came out like the routine system of everyday life among the study community, they became more widely applied during periods of food scarcity like season2. Generally there was no significant association ($p>0.05$) with the nutritional status of women and children.

4.10.7 Nutritional status and household income

The household income was cross-tabulated with the nutrition indices of both women and children. From table 24, it can be seen that the household income was not associated significantly with the nutritional status of children and women χ^2 p value >0.05. However the women BMI correlated positively with total household income, and more specific with husbands salary and livestock income (r-value=0.296, 0.314, 0.719, respectively) $p<0.05$ appendix 15

Table 24 Association between total annual household income and nutritional status of children and women

Seasons	income	Underweight %	χ^2p-value	Stunting %	χ^2p-value	Wasting %	χ^2p-value
1 N=111	Below median 52.3%	5.5	0.866	17.1	0.096	2.8	0.605
	Above median 47.7%	5.5		9.0		3.7	
2 N=141	Below median 51.1%	9.9	0.199	19.9	0.105	3.5	0.505
	Above median 48.9%	5.7		12.9		2.1	
1 BMI	Below median Above median	5.9 5.9	0.800				
2 BMI	Below median Above median	7.3 7.3	0.930				

4.11. Assessing the Contribution of Some Variables as Predictors of Nutritional Status of the Children

The following variables, season, household income, household expenditure, income from cereals, beans yield, pigeon pea yield, maize yield, size of land, livestock keeping, frequency of consumption of maize, beans, pigeon peas, sorghum, and beef per week, and the coping strategies were subjected to a multivariate analysis (Binary logistic regression analysis). The results showed that the variables, season, yield of beans, protein and calorie intake per day, household size, daily food expenditure, consumption of beans per week and size of land were associated with the weight- for- age height-for-age and BMI-for-age z-scores at the bivariate analysis level as they were retained in the model indicating that they influence or contribute to variation in the nutrition indices of the children. The retained variables may be used as predictors of the children's nutritional status. Table 25, B represents the change in the outcome associated with a unit change in the predictor variable. Wald statistic has a chi square distribution and p-value indicates whether the B coefficient for the predictor is significantly different from zero. If

significant, the predictor has a significant contribution to the outcome. Exponential B is an indicator of the change in odds resulting from a unit change in the predictor.

Table 25 Association of some variables with nutritional status

Variable	B	S.E	Wald	p-value	expB	95% CI	
Underweight (weight-for-age)						**Lower**	**upper**
season	0.720	0.356	4.086	0.043	2.055	1.022	4.130
Beans yield	0.051	0.043	1.373	0.241	1.052	0.967	1.145
Protein intake in gm/day	0.022	0.029	0.569	0.451	1.023	0.965	1.083
Kcal/day	0.004	0.003	1.638	0.201	1.004	0.998	1.010
No.of hh members	-0.080	0.078	1.052	0.305	0.923	0.791	1.076
Stunting (Height-for-age)							
Daily food expenditure	-0.002	0.002	1.904	0.168	0.998	0.994	1.001
Consumption of beans per week	0.146	0.077	3.617	0.057	1.158	.996	1.346
Wasting (BMI-for-age)							
No. Of hh members	-0.209	0.103	4.146	0.042	0.811	0.663	0.992
Land owned	0.280	0.257	1.184	0.276	1.323	0.799	2.189

4.11 Summary of Results

Social Demographic

The mean household size was 4.8 in season1 and 5.2 in season2. The mean difference was significant, p=0.01 though the median was the same in both seasons. The male to female ratio was 1:1.1 in both seasons while children below five years were 27.3% in season1 and 30.3% in season2. Women aged 15-49 years were 27.6% in season1 and 24.0% in season2. The majority of study household members (two thirds) had level 8 education. About 20% of caretakers or mothers had secondary or above secondary education in both seasons.

Employment and Housing

There was a negative shift in the level of employment from season1 to season2 amounting to 13.2% except for male casual labour which showed a slight increase. The level of unemployment rose significantly in season2 compared to season1, (χ^2 df6 = 55.178 $p<0.001$).

Seasonal pattern of incomes and Expenditures

There was no significant difference in median monthly incomes between season1 and 2.There was significant difference in the median monthly expenditures between seasons, higher in seson2. In season1 64.1% of the households were spending over 70% of the monthly budget on food while in season2 they were 75.9%.

Farming and seasonal food production

The median production of major food crops, maize and beans, was significantly higher in season1 than season2. Over 60% households kept livestock and there was no significant difference in the number of animals per household between the seasons.

Adaptation methods and coping strategies

There were slightly more households in season2 (28.3%) having small scale irrigation than season1(25.3%). There was a significant difference in the number of households that reduced the size of meals, restricted adult consumption to allow more for the children, used less preferred or cheaper food, borrowed food from friend or relative, engaged in degrading jobs or begged, sent household members to eat elsewhere and sold farm implements or livestock in season2 compared to season1 (χ^2 $p<0.05$).

Seasonal dietary sources

The main sources of household diets were subsistence farming and purchasing. In season 1, 89.7% of the households had food stocks to last between 1-10 months but in season2, 85.8 of the households were food insecure, without stocks.

Dietary intakes and adequacy

Maize was the most frequently consumed food in both seasons, by over 70% households on a daily basis in both seasons. The mean energy and protein consumption per day and dietary diversity were significantly higher in season1 than season 2, (t-test $p<0.05$). The children getting less than 80% of their daily energy requirement were 50% in season1 and 73.3% in season2. For protein intake per day, the children taking less than 80% of the daily requirement were 26.7% in season1 and 36.7% in season2.

Seasonal variation in nutritional status

In season 1, the prevalence of underweight children was 10.7% , stunting was 26.8% and wasting was 7.0%. In season 2, the prevalence of underweight children was 20.1%, stunting 35.2% and wasting 7.4%. There was significant difference in the prevalence of underweight and stunting between season1 and 2, χ^2 $p<0.05$, OR=2.1 and 1.6 respectively. There was significant difference in mean z-scores between age groups for the weight-for-age and height-for-age in both seasons ($p<0.05$). The mean z-scores scores for all the 3 nutrition indicators decreased with age which meant older children (36-59months suffered more malnutrition than the younger ones. There was significant difference in weight-for-age and height-for-age mean z-scores, between season1 and 2 ($p<0.05$) but not BMI-for-age z-scores and women BMI.

Nutritional status and coping strategies

The diet based coping strategies were not significantly associated with nutritional status.

Nutritional status and household income

There was no significant association of household income and children's nutritional status. There was a positive significant correlation ($p<0.05$) between women BMI and total household income, husbands salary and livestock income.

Seasonal and non-seasonal variables that contributed to variations in nutritional status

Seasons, yields in beans, protein intake in gms/day, consumption frequency of beans per week, energy intake in kcal. per day, daily food expenditure, household size, and size of land are the variables that were found to contribute to variations in underweight, stunting and wasting on a multivariate binary logistic regression analysis. The number of household members and the size of land owned by the household were also found to correlate with nutritional status of children.

CHAPTER 5

5.0 Discussion

5.1 Demographic and Social Economic Characteristics of the Households

Although the median household size was the same for season1 and season2, (5.0), the study registered households with more members in season 2 than season1 as portrayed by the mean, and this could be attributed to more grandchildren and other relatives in season 2. There was also a slight increase in the children below one year from 7.9% in season1 to 9.4%, in season 2 indicating possible new births. Coupled with food scarcity in season2, the household size was found to correlate negatively with the children's nutritional status. The household size reflects population fertility according to KDHS and the mean household size for the two seasons (4.9 and 5.3) was higher than the Eastern Province mean 4.7, (CBS, MOH, and ORC macro 2003). The average household size for Kitui District is given as 5.3 (GOK, 2002), which compares well with the mean household size in season 2.

Education level is regarded as an enabling factor giving people choices in life especially against poverty, and this may affect children mainly through nutrition. In both seasons education levels showed the same trends. The introduced free secondary education may have reduced the number of persons reported with level 8 education in season2. Kitui district has 18.3% primary school dropout rates according to government development report (GOK, 2002-2008), The mothers or caretakers with secondary education generally remained the same in both seasons but was slightly lower than the national level of 25% for the rural areas (GOK, UNICEF, 2000). T he study found no significant association between the level of education of the household heads and nutritional status of the children.

5.2 Seasonal Occupation trends

The main occupation for the residents was self employment in both seasons taking 18.0% in season1 and 12.6% in season 2 of the total population. The differences in employment rate between seasons was significant (chi-square p-value<0.05), indicating more job opportunities in season1 and consequently a higher total household income. Although the study does not find a significant association of income with children's nutritional status, there is a significant association of stunting rates and the employment status of the household head, higher among the unemployed ones.

Unemployment increases by 6% in season2. The regular and temporary employment reduced in season 2 probably due to the onset of the economic recession where most businesses and factories went down. The self employed jobs that required water availability like brick making, sand harvesting and production of vegetables were not available due to water scarcity. This is an indication of a seasonal effect on the social economic dynamics that leads to employment opportunities and household income in the study area.

5.3 Seasonal Patterns of Incomes and Expenditures

Though the total household income does not vary significantly betweens seasons but there is significant difference in total household expenditures per month ($p<0.05$) higher in season2. The total monthly incomes correlate significantly with expenditures ($r=0.230$).Total expenditures correlated with daily food expenditures($r=0.520$, $p<0.01$)

Non-farm incomes like salaries, business and casual labour did not fluctuate significantly between the seasons. These contributed about 80% of the total household incomes in season1 and 2. Studies by Mwadime(1996) have also shown that non-farm incomes contribute more than 80% of the total household income. However it was not easy to separate activities that were not dependent on seasons since businesses like sand harvesting and brick making depended on seasonal rivers. Since most of the non-farm incomes were not affected by seasons, they remained an important source of purchasing power for food and services to ensure adequate nutrition throughout the year. A household where one or more members are formally employed or have a regular income may remain stable during drought when food from the farms has been depleted.

Farm based incomes were found to be the most diverse sources of income for the resident farmers but were affected by seasonal variability. Season 2 was drier than season1 and fewer crops were harvested due to the failure of the short rains. The income from crops (cereals, fruits, vegetables and root crops) varied significantly between the seasons, and so is the contribution to total income. Most households practiced subsistence farming, with a purpose of growing enough staple foods to last the season and it was only when a seasonal harvest was good enough that a household was able to sell some of the produce for income indicating why the incomes from agriculture contributed very low to total income. This may explain why Kitui district report (GOK, 2002-2008) indicating that Agriculture forms the major income earner may only hold for the large scale farmers. Businesses in Kitui town ensured some regular incomes especially from vegetables. Livestock income was slightly higher in season2 than season1 and it generated some income to subsidize the lacking foods and other utilities in season 2.

Food expenditure in both seasons contributed highest to total expenditures giving an indication of the food insecure households in both seasons. A significant high number of households (75.9)

in season2 were spending over 70% of the total expenditure (χ^2 p=0.023) as a result of the poor crop harvest compared to season 1 (64.1). The results also indicated that other costs like clothing, transport, medical and leisure were cut down in season 2 maybe to supplement on the food budget. Food prices were also higher in season 2 compared to season1 and this may have impacted on the total expenditure and the difference between the seasons, (appendix 16 for food prices).

5.4 Climate and seasonal food production

Subsistence farming in Kitui is dependent on seasonal rainfall. This is when everybody plants their crops and harvesting follows at the same period for all the farmers. Though the smallholder farmer may not understand the dynamics of climate variability and or climate change, they are quite aware of negative or positive effects climate has on food production patterns through the changing seasons. The response was that climatic seasonal fluctuations has not been getting better over the past years in terms of farm food production and this is confounded by factors like soil fertility , proper seeds and to a lesser extent farm sizes. Over the years annual rainfall in a year has been fluctuating as can be seen from figure 4 chapter 3. Over 50% of the total years, total annual rainfall is below the mean 800mm distributed over two seasons in a year making it inadequate for growing sufficient food. There is positive correlation (though not significant) between the total annual rainfall and production per hectare of staple foods in Kitui namely, maize, beans, sorghum, millet, cowpeas, pigeon peas, and green grams for 11years (1996 to 2007) and figure 11 illustrates this (figure 11 and appendix 11).

5.5 Seasonal food production, dietary intakes and nutritional status

The food produced in the farms was mainly for household consumption to ensure some food security status. More than 80% of the households in season2 have critical food insecurity, without food stocks and even the majority of the households with food stocks, the food only last for about 3 months. The other major source of household food is purchasing which depends on whether a household had sufficient income. As was seen earlier majority of the households (more in season2) spend more than the median daily income on food alone, which means that the incomes are not sufficient for food alone. However the study does not establish the daily minimum expenditure required by a household for food in the area.

The dietary intakes are mainly determined by what is produced in the farms. The frequency of consumption of certain foods in both seasons indicates their availability. Pigeon peas is consumed daily by majority of households in season 1 as it was being harvested, after which consumption frequency declines in season 2. Beans were harvested dry in season1 but the consumption is more in season 2 due to availability of pigeon peas in season1. There is a positive significant correlation between height-for-age and consumption frequency of pigeon peas in season1($r=0.167, p<0.05$). In season 2, HAZ correlates with consumption of beans, cowpeas, and VitA. ($r=0.188$, 0.248, 0.374, <0.05). These foods were locally produced which means food production is linked to the children's nutritional status.

Maize production correlates positively with calorie intake in children ($r=0.409$, $p=0.043$). This is in season1 but not season2 as there is more production of maize in season1 compared to season2 ($p<0.05$). This indicates that food production is a determinant of caloric intake in children. From figure 1, food production is regarded as a secondary determinant of nutritional status through food consumption which is the underlying cause. Since the number of children not meeting

adequate nutrition in terms of calories and nutrients is higher in season2 than season1, and the mean calorie and protein intake is significantly more in season1 than season2 ($p<0.05$ for both) it can be deduced that this is partly attributed to the poor harvests in season2 which consequently contributes to the poor nutritional status in season2. There is a positive significant correlation between the kale yields and Height-for-age and BMI-for-age but this relationship is not clear whether it is through direct consumption or income generated from sales.

The poor harvest, in addition to compromising the nutrition of the residents, contributes to an increase in the food budget to a significant level in season2 (t-test $p<0.05$). There was also a general countrywide increase in food prices which may also have partly contributed to this effect. The households whose children were taking less than 80% of the calorie requirements can be considered food insecure (Riely et. al., 1999).

5.6 Incomes, Expenditures and Nutritional status

Household income stands as one of the factors that enable a household access to sufficient food. The income which mainly comes from non-farm sources could be used both directly to improve the quantity and quality of the diets and or indirectly to boost food production by buying farm inputs like fertilizers, seeds, and farm implements. In these two pathways, incomes could have contributed to the nutritional status of the residents.

Livestock sales are higher in season2 than season1 and this appears to offset the low income from crops in season2. On short term basis like seasons, livestock keeping may absorb climate shocks that are not favourable to crop since the effects of seasonal variability, due to elevated

temperatures may favour indigenous fowls and goats that thrive better in hot weather, (Boko et al, 2007) and these are able to supplement nutrition and incomes for the local small scale farmer.

During season 2 when production of the local farm foods falls drastically, consumption of energy and protein declined and the mean daily food budget rises by 22%. More households resulted to purchasing food including the staples in season 2. It is also noted that more households in season2 than season1 spent more on food than the daily income and this is an indication that these households are food insecure. Income from casual labour jobs by male gender and husbands' salary correlated with total income, ($p<0.05$). These incomes do not change significantly with seasons yet there is no significant relationship with food consumption and nutritional status of the children.

BMI for women does not change significantly between the seasons, (t-test $p=0.902$). However there is a significant correlation between BMI and total household income in season1 ($r=0.296$), livestock sales ($r=0.719$), and husbands salary ($r=0.314$), $p<0.05$. These are the stable incomes which do not change significantly with seasons. The important thing to note is that while the children's nutritional status fluctuates significantly with seasons and show a weak relationship with household incomes, the women BMI remained stable over the seasons and is associated significantly with the 'stable' incomes. This observation leads to the belief that there is a gap between the household nutrition and the care and practices for the children. Generally the household income and food expenditure were therefore found weak determinants of nutritional status of the children less than five years. This means that to a certain extent, a good income or a high expenditure on food, does not necessarily improve the children's nutrition. This fact was also found by Mwandime (1992) in Mwea irrigation scheme where incomes from the sale of rice

significantly increased the purchasing power of the residents but the nutrient intake and nutritional status of the residents remained unaffected.

5.7 Seasonal Variation of Dietary intakes

According to the results, dietary intakes are predominantly dictated by what is grown in the farms. Maize, sorghum, and millet do not show any significant difference in consumption frequency between seasons. These staples we re locally produced or purchased. Consumption of most vegetables, beans, pigeon peas, and locally grown fruits like mangoes and oranges show significant differences between the seasons ($p<0.05$). This means that in season2 the household diets were more likely lacking in protein and micronutrients which could lead to not only protein-energy malnutrition but also micronutrient deficiencies.

The individual Dietary Diversity score (IDDS) calculated for the children in the 24 hour recall, is significantly higher in season 1 than season2 (t-test, $p=0.009$). It is positively correlated with energy and protein intake with a significance ($r=0.390$ $p<0.05$ and $r=0.649$ $p<0.01$) respectively). A high diversity score implies having varied diets and consequently better nutrition. The children in season2 are more likely to suffer from deficiencies not only in energy and protein but also in micronutrients. There is no significant association of IDDS with the children's nutritional status. A study in India found that Dietary diversity score and energy consumption diminished during drought in the year 2000, whereby energy and several vitamin deficiencies were reported (Confalonieri et al 2007).

From season1 results, consumption of pigeon peas is positively correlated with HAZ ($r=0.167$, $p<0.05$). By then, about half the households were harvesting pigeon peas and consuming it daily.

In season2 consumption of beans is correlated positively with WAZ and HAZ (r=0.152 and 0.188) and $p< 0.05$). Only 21% of the households had harvested beans but 50.9% were consuming it daily. This meant that most of the beans consumed in season2 was obtained from r sources other than farming. Beans and pigeon peas alternated seasonally as sources of protein and energy in the household's diets.

5.8 Nutritional Status and Seasonality

There is significant high levels of underweight children in season2 compared to season1(χ^2 p=0.016, OR=2.1) as well as stunting (χ^2 p=0.033, OR 1.6). There is no significant difference in the levels of wasted children between the seasons. From figure 16, the nutritional status of children below five years in Eastern province as a whole, has deteriorated since 2003 especially the stunting levels. The study area portrays lower levels of stunting and underweight in both seasons compared to the rest of the Eastern province which can be attributed to the better food security status in Kitui central and its environs compared to the rest of the province.

In both seasons food insecurity is recorded but is more severe in season2. The levels of stunting in both seasons indicate long standing or chronic malnutrition. Although the study is comparing all aspects of the study subjects, the two seasonal groups are regarded as independent samples. It is therefore important to note that some of the observations like stunting in children would be an ongoing problem in the many cycles of drought and chronic food insecurity in the area. Nevertheless it is quite likely that some of the children fell into stunted status within the 8 months period between the surveys since a healthy child is expected to grow linearly at a peak rate of 0.78cm per month for children 6-24months of age and 0.8cm per month for children of 25-60 months (Niemeijer et. al., 1991).

The mean z-scores decrease with age for both underweight and stunting in both seasons which means that the children of 36-59 months had poorer nutrition than the children in the younger age groups. Appendix 10 shows that a bigger number of the children between 36 and 59 months were not meeting the RDAs for energy and protein in both seasons. This is probably the reason why their mean z-scores are lower than the other age groups. This age also spends a good part of the day away from home as they start preschool and are deprived of necessary feeding and care. BMI-for-age z-score or wasting is an indication of a recent depletion of body tissues due to inadequate food intake as a result of food scarcity or illness. Although there is no significant difference ($p=0.114$) in BMI-for-age between the seasons, a child could remain wasted for a long time depending on how long food deprivation persisted. Wasting levels for season 1 and 2 are higher than the National levels but generally the same as those of Eastern province. There is also no significant difference in the number of children found wasted by MUAC index between season1 and 2. ALRMP, (2008) gives MUAC levels for Kitui District as15.5% in 2006, 8.3% in 2007 and 7.7% in 2008, which are lower than for season1 and 2.

Though there is no significant difference in the mean BMI values for women between season 1 and 2, ($p=0.902$) more underweight women are found in seasom2 than season1. The women having a BMI below 18.5 in both seasons are mainly between age 20-39 years of age. This age group had young families to take care of, were mostly home makers or self employed. Although the data collection was during the post-harvest periods, women still provided most of the farm labour besides the household chores. Culturally, they are also known to eat last after feeding the men and the children. In times of food shortage, this may precipitate under-nutrition, lowering the BMI values of the active members of the household notably the women. Majority of women have normal BMI in both seasons while 20% are tending to obesity. However, the fact that the

women BMI is significantly correlated with caloric and protein intake ($r=0.375$ and 0.411, $p<0.05$ respectively) which is not the case with the children's nutritional status, it is most likely that young children's diet is compromised in quality and quantity by the child minders as mothers are out working.

5.9 Adaptation Methods, Coping strategies, and Nutritional status

Since climate change is now no longer a speculative academic endeavour, the impacts are being felt and some adaptations taking place. These measures whether planned or autonomous are in response to environmental changes affecting the capacity expected to be realised (Easterling et. al., 2007). The major threat to the small scale farmer in the study area and the entire district is the frequent droughts. In both seasons some households had irrigation gardens along river beds and near wells or boreholes though in small scale and manually operated. Foods produced were kale, tomatoes, spinach, onions and cabbage. These were mostly for sale or home consumption and reduced the vulnerability of the residents from climate conditions that aggravated food insecurity in the region. The choice of crops was left to the farmers' decision.

The study found significant differences in the number of households engaged in the diet based coping strategies between seasons due to the food insecurity experienced in season 2. Higher sales of livestock reflected in season2 are maybe to subsidise the food scarcity. A study in Ethiopia by Ferro-Luzzi et.al.,(2001) showed that households with livestock were less vulnerable in nutrition to seasonal shocks than those without. More borrowing of food in season1 suggests that inter-house food exchange is common with better harvests. Consumption of seed stock is also likely to contribute to a cycle of food scarcity whereby lack of seeds at the proper time contributes to little or no harvests.

Although the coping strategies were widely practiced in both seasons, the study found no significant association between the households who practiced the coping strategy and the nutrition condition of the study children. However in season2, more underweight children are found in households who reduced the number of meals per day (chi square p=0.084) and also more underweight women in households who acknowledged borrowing food (chi square p=0.082) though the observations are not significant.

5.10 Nutritional status predictor parameters

The variation in seasons is the key predictor of underweight children. This meant that seasonal variability may affect weight-for-age z-scores by 0.720 z-score points. Maize production fluctuates significantly between seasons yet a significant positive correlation is observed between maize yield and caloric intake. From table 30, a decrease in caloric intake per day by one unit reduces WAZ–scores by 0.004z-score points. Hence maize yield may be used to predict nutritional status in the event of falling production yields due to climate variability and change.

Pigeon peas and beans were a major source of household protein in that 46.9% of the households consumed pigeon peas daily in season1, and 50.9% of the of the households consumed beans daily in season2. An increase in the consumption of 1 gm protein/day would raise weight-for-age z-scores by 0.022 score points. Consumption frequency of beans correlates significantly with long term nutritional status or stunting and has been shown to be a predictor variable for stunting. When the frequency of beans consumption is reduced by one unit, the height-for-age z-scores reduces by 0.146 z-score points, table 26.

The size of land owned by a household positively correlates with food production (maize and beans) and from table 32, it predicts wasting in that an increase of one unit of land raises the

BMI-for-age z-scores by 0.280 z-score points. An addition of one person to the household would reduce the BMI-for-Age z-scores by 0.209 z-score points ($p=0.042$). A large household size during food poor seasons impacts negatively on nutrition where maternal care and food distribution is not adequately addressed.

CHAPTER 6

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study investigated variability in food security, dietary intakes and nutritional status in two climatic seasons, namely, the long rains season, as season1 and the short rains season as season 2. Data was collected soon after the harvests in both seasons. The investigation was done by comparing variables that directly or indirectly affected nutrition of the study households which were represented by children and women. The two groups were selected as they are the more vulnerable members in a household.

The study also tested the hypothesis that seasonal variability has significant contribution to the food insecurity status of the households in Kitui against the null hypothesis of no significant contribution. The results from the study allows the conclusion that seasonal variability, a common phenomenon in the ASALs significantly contributes to the household food insecurity in the rural areas mainly through the farm production of food whereby households suffer many consequences when seasons fail or the harvested food does not last till the next harvest. Coupled with loss of employment or high unemployment rates, incomes, especially those generated from farming like sale of food crops, and related activities like brick making, are negatively affected reducing the purchasing power of the households. Due to food shortfalls arising from crop failure or similar events, food access is compromised which is indicated by an increase not only of the household food budget but also the number of households spending a larger proportion of the total expenditure on food as was the case during season2.

The seasons have a significant contribution on the fluctuation of the dietary intakes of the children. This is evidenced by the significant difference in calorie and protein intake, dietary diversity and the increase in the number of children not meeting the Recommended Dietary Allowance in season2. The null hypothesis of no significant fluctuation in dietary intakes with seasons is therefore rejected.

Seasonality has a significant impact on the nutritional status of the children but not of the mothers. Children below 5 years portray greater vulnerability in nutritional status during periods of food insecurity as indicated by the significant high level of underweight children in season2.

Seasonal variability contributes to significant high number of households practising diet based coping strategies during times of food scarcity. The diet based coping strategies were hypothesised that they impact significantly on the nutrition of the children which was tested against the null hypothesis of no impact. It may be concluded that no definite significant association was found between the practise of diet based coping strategies and the nutritional status of the households.

6.2 Recommendations

In order to build the resilience of vulnerable communities, against seasonal climate shocks which threaten household food security, interventions or measures can be taken at the household level in the following:

- Measures to boost household food production to create self sufficiency in staple foods that may last preferably to the next season. This can be done by empowering the

households in making use of the underutilised land, water preservation, irrigation, soil improvement and seed acquisition.

- To mitigate and reduce the children's vulnerability to seasonal impacts on nutritional status, mothers and caretakers need to be sensitised on their care especially the under fives.

At the national level,

- The unemployment levels in the rural areas needs to be addressed through job creation to improve food access and mitigate climate shocks on food security.
- Relevant research that reduces vulnerability of crops to climate shocks.

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APPENDICES

Appendix 1 Questionnaire

Form no. 1: demography
House hold no.----------
Village----------
Sub-location ----------

Date of interview ----------
Name of interviewer ----------
Name of respondent ----------
Location----------

Household Profile: Nuclear family members and those people the respondent considers to be household members

Pers no	Name	Age yrs	sex	Resd type	reas	freq	Rel to hhh	Marit sta.	Educ	occp

Legend: pers. No=person number, **yrs**=years, **typ**=type of residence, **rea**=reason for not being full-time Resident, **freq**=frequency of visits for non-full-time residents, **rel. to hhh**=relation to household head, **marit. Stat**.=marital status, **educ**.=years of formal education, occup=occupation

code	Resid.typ	reason	Freq.	Rel to hhh	Marital sta	Educ	occup
1	Fulltime	Farming elsewhere	Several times	Hh head	Single	None	Regularly employed
2	Regularly absent	Working elsewhere	Weekly	Spouse	Monogamous	1-4years	Temporarily employed
3	Non resident	Looking for work	At least once a month	Son	Polygamous	5-8years	Self employed
4	other	Taken to streets	Between terms	Daughter	Divorced	Secondary school	Casual laborer
5		Schooling	Once a year	Grand child	windowed	Above secondary	Unemployed
6		With relative	Less frequent	Other relative			None
7				Friend			other
8				other			
9		other					

Comments.

Form no. 2: Social economic
Housing

1 Do you own this house [ ] 1—yes 2—no

Ownership	Roof	Walls	Floor	Rent/month

Ownership: owned=1, Rented=2
Roof: grass/thatch=1, makuti=2, iron sheets=3, bricks=4
Walls: mud=1, plaster=2, wood=3, iron sheets=4, brick/block/stone=5

Floor: mud=1, cemented=2, wood=3 brick/tiles/stone=4, others(specify)

Land and source of livelihood

2 What is the approximate size of land used by the household?

Land	Acreage	Employment	
Owned		Business	
Rented		Farming	
Others		Donations	
Total Land		Others(specify)	

Which fuel do you use for cooking? ---------- 1=firewood, 2=paraffin, 3=charcoal, 4=gas, 5=others(specify)----------

What is the main source of lighting? ----------1=tin and wick, 2=hurricane, 3=gas, 4=lamp, 5=electricity, 5= candle.

Other properties owned by household

Property owned	quantity	Property owned	quantity
Motor vehicle		Sofa set	
Motor cycle		Bicycle	
Hand cart		Plough	
TV		Wheelbarrow	
Radio		Oxen	
Cellphone		Farm implements	
Fridge		Others(specify)	

Household income and expenditure.

Income activity	Estimate income Last one year		Expenditure items	Amounts ksh. Per year
Sale of cash crops			Food	
Sale of root crops			Housing	
Sale of livestock			Education	
Sale of hand craft			Medical	
Husband's salary			Clothing	
Wife's salary			Transport	
Business			Loans	
Casual labour			Leisure	
Remittance			Miscellaneous	
Others				

Farming Activities

7. Do you keep any livestock? ---------- yes=1 no=2 (if no skip table).

Type.....	Nunber of animals	Purpose	Annual Production kg	Amount sold Per year kg	Amount Purchased/yr	Amount Consumed/yr
1. Cattle		Milk				
		Meat				
2.Goat		Milk				
		Meat				

3Chicken		Meat				
		Eggs				
4 Rabbit						
5. Sheep						
6						
7						
8						

Agriculture

8. Do you grow any crops ?---------- yes=1, no=2 (if no skip table)
9. If yes , what portion of land acreage do you grow crop?----------
10. What crops did you grow in the last one year? (write all)

Crops grown	Annual yield (kg)	Estimated food consumed/yr kg	Amount sold/yr kg	Amount purc hased/yr kg	Does produce last to next harvest? 1=yes 2=no	
					Short rain	Long rain
1.maize						
2.beans						
3.irish potatoes						
4.tomatos						
5.mangoes						
6.oranges						
7.Sukuma wiki						
8.Sweet potatoes						
9.cassava						
10.cowpeas						
11.						
12.						
13						
14.						

11. Did you store any food after harvest in the last one year?

12. In the previous two years was the harvest better or worse than the current and why?
    2007---------- Reason ----------
    2006 ---------- Reason----------
13. In the last 5 years, have you experienced a change in the rainfall pattern?[ ] 1=yes 2= no
14. Has the seasonal rainfall been getting less, more or the same [ ]

Form no3. Food Frequency
15. Indicate the type of food consumed by the household within the week and how many times it is consumed.

Food	Frequency Per week	Per month	Never	Food	Frequency per week	Per month	never
Cereals roots and tubers				Legumes and meats			
Maize				Beans			
Sorghum (muhia)				Njahi			
Rice				Pigeon peas			
Irish potatoes				Green grams (ndengu)			
Wheat				Peas			
Yams				Lentils			
Cassava				Beef			

Arrowroots				Chicken			
Sweetpotatos				Pork			
Finger millet				Rabbit			
Raw bananas(matoke)				Eggs			
				Fish			
				Milk			
Fruits and vegetables				Fats oils and sugars			
Sukuma wiki (kale)				Cooking fat			
Cabbages				Cooking oil			
Carrots				Sugar			
Amaranth (terere)							
Black nightshade(managu)							
Cowpea leaves(mathoroko)							
Ripe bananas							
Paw paw							
Mangoes							
Oranges							

16. Apart from farming and purchases, how else do you obtain food for the household consumption? (can have multiple responses)----------1=relief, 2=food gifts, 3=food for work, 4=beg, 5=borrow, 6=none, 7=others (specify)

17. Have you experienced any food shortage in the last one year? ---------- 1=yes, 2=no.

18. If yes when? ---------- .

19. What are the three main problems that affect food availability in the household? (probe for ranking)

1----------

2----------

3----------

20. What measures do you take to cope with food unavailability?

1----------

2----------

3----------

21. Do you grow any food during the dry season? ----------1=yes, 2= no

22. If yes, state which ones and how you water .

1----------

2----------

3----------

23. In the last, three months has your household done any of the following due to lack of food ? circle all answers.

1 Reduction in the number of meals.
2 Skip food consumption for an entire day.
3 Reduction in the size of meals.
4 Restrict adult consumption to allow more for children.
5 Feed working members at the expense of the non working.

6 Use less preferred or cheaper food.
7 Borrow food from friend or relative.
8 Purchased food on credit.
9 Consumed wild foods or toxic or taboo foods.
10 Consumed immature crop.
11 Consumed rotten maize.
12 Consumed seed stock as food.
13 Send household members to eat elsewhere.
14 Withdraw children from school.
15 Begging or engaging in degrading jobs.
16 Individual or household migration from the area.
17 Sale of household goods or farm implements.
18 Sale of milking livestock.

Water and sanitation

24 What are the two main sources of water used [ ], [ ]
1=river, 2=piped water, 3=borehole, 4=spring, 5=roof catchments, 6=wells, 7=others---------
25 How long does it take to to get to the source of water?----------mins, hours.
During dry season ----------mins, hours.
During wet season----------mins , hours,
26 How frequently is water available from this source? [ ]
1-always 2-once or twice a week. 3-several hours perday. 4-not frequently
27. Do you buy water from this source? [ ] 1-yes 2-no

28. How much do you pay for a 20litre jerrycan? [ ]
29. Do you treat your drinking water? [ ] 1=yes, 2= no
30. If yes which of the following methods do you use? [ ] 1=boiling,2=filtering
3=chemicals, 4=others----------
31. Do you have any latrines?----------.1=yes, 2=no,
32. Observe the following and indicate1=yes, if condition exists or 2=no, if it does not.
Animal dung visible in the house
Animals in living room
Heaps of garbage within 10m of the house,
Human feaces within 10m of the house.

Morbidity

33 Do you know about worms? ----------1=yes, 2=no.
34. Have you ever dewormed your child? ----------1=yes, 2=no.
35. If yes when did you last deworm your child?----------
36. What do you think are the causes of worm infestation?
1----------
2----------
37. Have you heard of aflatoxins?----------1=yes, 2=no
38. If yes, how does it get into man?----------
39. What illnesses has your child experienced in the last two weeks ?

Diseases.	
Diarrhea	
Cough/cold	
Stomach ache	
Fever	
Tonsils	
Skin rashes	
Bronchitis	
Malaria	
Others, specify	

40. Where do you treat your child when sick?----------
1=home care, 2=dispensary, 3=MCH, 4 =hospital, 5=herbalist,6=traditional healers,

7= others specify----------

41. How long does it take to reach the nearest health centre?----------mins,hours.

Mortality

42. How many people live with you in this household?----------

43. How many are under five years?----------

44. Did any one die in the last one year?----------1=yes, 2=no.(if no, end mortality interview)

45. How many were under five years of age?----------

46. How many were over five years of age?----------

47. What was the causes of death of the under five years?----------

Name of child	Cause of death

Nutritional status of children 6-59 months and women 15-49 years of age

I would like to take your height and weight and those of the children.

Mother/woman

Name,	Age,	Height in meters	Weight in kgs	Muac

Children

Name	sex	Age in months	Weight in kgs	Height in cm	Muac cm

Examine whether the child has oedema----------1=yes 2=no

Household food intake : 24hour recall for the child

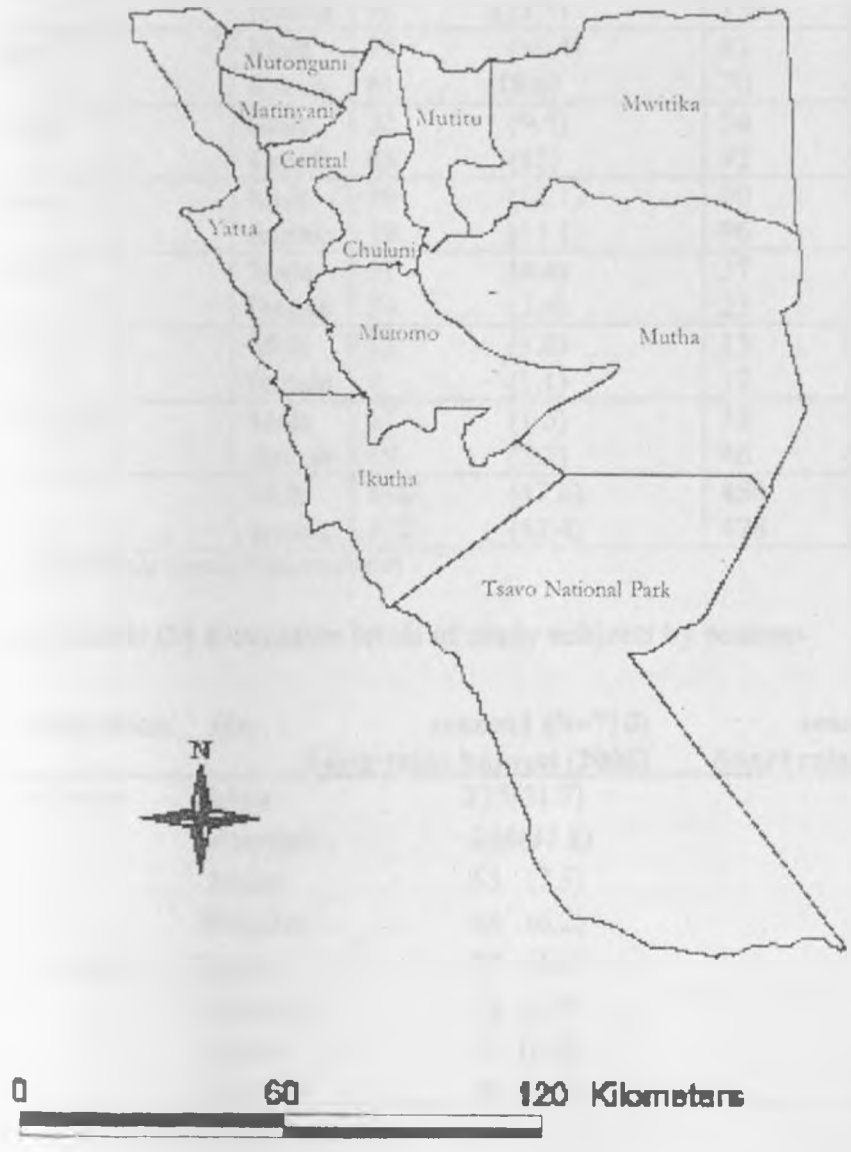
Can you please tell me what the child ate since yesterday?

Period	Dish	Name of Ingredients	Amount of Ingredients in Household Measures	Amount in Standard Units grams	Amount Served to Index child volume in ml	Amount Consumed By index Child Vol in ml	Amount Leftover By Index Child Vol in ml
B/fast							
Mid Morning							
lunch							
After Noon							
Supper							
After Supper							

Focus group discussions

Focus group discussions were held to collect qualitative data on relevant topics based on the following questions:

1) In the last five to ten years what has been changing in terms of the weather?(to probe on temperatures, rainfall regularity, and generally weather conditions)
2) What major events have taken place like droughts, floods and epidemics?
3) How did the community go through it in terms of coping strategies?
4) What traditional food crops have been phased out within the last 5-10 years and what is currently?
5) What food crops are preferred by the community and why?



Appendix 2 Figure (a) Kitui District in Kenya

Appendix 3 Table (a) Distribution of study population by age groups by seasons

Age group	sex	Season 1		Season 2	
Below 5years	Male	98	(13.8)	142	(15.3)
	female	96	(13.5)	139	(15.0)
6-14years	Male	74	(10.4)	82	(8.8)
	female	61	(8.6)	70	(7.5)
15-24years	Male	32	(9.5)	54	(5.8)
	female	85	(12)	92	(9.9)
25-34years	Male	79	(11.1)	90	(9.7)
	female	79	(11.1)	96	(10.3)
35-44years	Male	31	(4.4)	37	(4.0)
	female	24	(3.4)	23	(2.5)
45-49years	Male	13	(1.8)	13	(1.4)
	female	8	(1.1)	12	(1.3)
Above 50years	Male	11	(1.5)	32	(3.4)
	female	19	(2.7)	46	(5.0)
Totals	Male	338	(47.6)	450	(48.5)
	female	372	(52.4)	478	(51.5)

(figures in parenthesis represent percentages)

Appendix4Table (b) Education levels of study subjects by seasons

Level of education	sex	season1 (N=710) Long rains harvest (2008)	season 2 (N=928) Short rains harvest(2009)
8 years or lower	Male	225(31.7)	285(30.7)
	Females	268(37.8)	324(34.9)
Secondary	Males	53 (7.5)	62 (6.7)
	Females	44 (6.2)	74 (8.0)
Above secondary	Males	13 (1.8)	29 (3.1)
	Females	11 (1.5)	23 (2.5)
None	Males	47 (6.6)	74 (8.0)
	Females	49 (6.9)	57 (6.1)

(Figures in parenthesis represent percentages)

Appendix 5 Table (c) Distribution of study subjects by occupation by seasons

Type of employment		season 1 n=710		season 2 n=928	
Regularly employed	males	40	(5.6)	34	(3.7)
	Female	34	(4.8)	12	(1.3)
Temporary employed	males	32	(4.5)	21	(2.3)
	Females	15	(2.1)	8	(0.9)
Self employed	males	44	(6.2)	53	(5.7)
	Females	84	(11.8)	64	(6.9)
Casual labour	males	24	(3.4)	43	(4.6)
	Females	5	(0.7)	5	(0.5)
Unemployed	males	14	(2.0)	51	(5.5)
	Females	66	(9.3)	136	(14.7)
Children/students/elderly	males	184	(25.9)	248	(26.7)
	Females	168	(23.7)	253	(27.3)

(figures in parenthesis represent percentages)

Chisquire-test,df5=55.178, p-value<0.05

Appendix 6Table (d) Distribution of households by land ownership and cultivated land

	Season1 (long rains harvest)		Season2 (short rains harvest)	
Acreage	Households Owning as total land in % N=146	Households with land under crop in % N=134	Households owning as total land in % N=169	Households with land under crop in% N=163
< or =1	48.6	59.7	47.9	55.2
1.1-2.5	26.7	23.9	24.3	22.7
2.6-5.0	20.6	14.9	20.8	18.3
5.1-10	3.5	1.4	4.2	3.0
Above 10.1	0.7	-	1.2	0.6

Appendix 7 Table(e) Livestock keeping by season

Season	1	2
Keep livestock	89 (61.8%)	108 (63.5%)
Keep no livestock	55 (38.2%)	62 (36.5%)
N	144	170

Significance p-value =0.929 (t-test for the mean difference.

Appendix 8 Table (f) Household monthly expenditures by season

Season 1 n=147				season2 n=171		
Expenditure Type in ksh	Hh	seas on	Mean	median	IQR	Significance p-value
Food	145	1	4621	4500	3000-6000	0.001
	170	2	5624	6000	3000-6000	
Education	109	1	841	200	150-500	0.221
	129	2	870	200	100-500	
Medical	133	1	562	350	150-500	0.001
	159	2	393	150	53-388	
Clothing	133	1	375	250	200-400	0.001
	164	2	268	180	125-350	
Transport	113	1	829	500	200-1100	0.001
	119	2	559	240	120-525	
Loans	7	1	2314	2000	800-5000	0.905
	11	2	3003	2400	900-4000	
Leisure/mis llaneous	8	1	525	400	225-950	0.107
	40	2	410	1125	250-2000	
Daily food	145	1	155	150	100-200	0.001
	170	2	189	200	100-200	
Total p/m	146	1	6453	5738	3905-7964	0.007
	170	2	8112	6516	4858-8550	

(IQR is inter quartile range)

Appendix 9Table (g) Training manual for the enumerators

Topic	Study contents
Purpose of research	The survey was a research for the university education. This meant that the data was to be for research only and would be handled confidentially. The enumerators were not to promise the subjects rewards, any type of interventions or relief food.
Sampling	The trainees were briefed on the sampling procedure, how the villages and selected. Random selection of the direction while starting the survey as well as sample size.
Collecting information and data	Emphasis on the accuracy of the data and correct information. This was to avoid excessive flagging during data entry and cleaning. Confidentiality of the information and data.
Questionnaire	The questionnaire was rehearsed, going through it one section at a time to make sure the trainees understood the contents and meaning, interpreting in the local language and the expected answers.
Nutrition data	The trainees were instructed on who would provide the nutrition data, namely the children and the mothers/caretakers within the required age. Exclusion and inclusion criteria for women and children was carefully discussed. How to get the correct age of the child and the records to ask for, like birth/clinic records or events to consider if mother is not certain. To identify a child with nutritional oedema. Taking the weight of the child using the hanging salter scale and the mothers using the step-on balance. Taking the height and length of the children using the height board and the mothers/caretakers using a vertical surface and a tape measure. Taking of measurements including MUAC was demonstrated in the field and the importance of taking at least two measurements, averaging and rounding off the figures correctly.
Pretesting of the questionnaire	The team was involved in pretesting of the questionnaire with the supervision of the researcher in both administering of the questionnaire and taking anthropometric measurements.
Discipline/ethics	The trainees were couched on how to interact with the subjects, introduce themselves, their mission to the households, and the person to provide the research information namely household head, mothers or caretakers or a responsible member of the household. They were to conduct themselves in a respectable manner and treat each household likewise.

Appendix10 Table(h) The individual Dietary Diversity Score list of foods

The groups of foods that were used to construct the individual dietary diversity score(IDDS) from the 24hour recall.

1.Cereals
2.VitaminA rich vegetables and tubers
3.White tubers
4.Dark green leafy vegetables
5.Other vegetables
6.Vitamim rich fruits
7.Other fruit
8 organ meat
9Flesh meat
10Eggs
11Fish
12 Legumes,nuts and seeds
13milk and milk products
14oils and fats

Appendix11 Table (i) BMI for women with coping strategies in season1 and 2

Coping strategy	Seson1 N=147 %	%underweight	χ^2p-value	Season2 N=171 %	% underweight	χ^2p-value
Reduced the size of meals	Yes59 No 41	4.5 6.7	.489	76.8 23.2	10.8 3.6	.648
Restricted adult consumption to allow more for children	Yes 34 No 66	6.0 5.2	.169	60.1 39.9	9.0 5.4	.672
Used less preferred or cheaper food	Yes48.7 No51.3	4.5 6.7	.676	84.4 15.6	11.7 2.7	.851
Borrowed food from friend or relative	Yes 66.2 No33.8	6.0 5.2	.286	52.2 47.8	10.8 3.6	.082
Reduced number of meals	Yes79.2 No 20.8	9.0 2.2	.814	75.7 24.3	11.9 2.7	.696
Skipped food consumption for an entire day	Yes48.7 No51.3	6.0 11.3	.220	44.5 55.5	.890	2.4 3.6

Appendix 12 Table (j) Food consumption by age groups by seasons

Age group in months		% children consuming Less than 80% RDA in season1			% children consuming Less than 80%RDA in season2	
	N	kcal	protein	N	kcal	protein
6-12	3	0	0	5	0	0
13-24	5	6.7	3.3	6	20	10
25-36	8	23.3	10	11	33.3	16.7
>36	14	20	10	9	20	6.7
Total	30	50	23.3	30	73.3	33.4

Appendix 13Table (k) Correlation coefficients for annual rainfall and food production

	rainfall	MAIZE_HA	BEANS_HA	CPEAS_HA	GGRAMS_H	PPEAS_HA	MILLET_H	SORGHUM_
Rainfall	1	.094	.538	.553	.567	.362	.405	.264
		.784	.088	.078	.069	.304	.216	.433
Maize_HA	.094	1	.642*	.320	.610*	.636*	.639*	.623*
	.784		.018	.286	.046	.026	.034	.030
BEAN_HA	.538	.642*	1	.807**	.927**	.771**	.683*	.573
	.088	.018		.001	.000	.003	.021	.051
CPEAS_HA	.553	.320	.807**	1	.716*	.689*	.694*	.590*
	.078	.286	.001		.013	.013	.018	.043
GGRAMS_HA	.567	.610*	.927**	.716*	1	.751*	.572	.259
	.069	.046	.000	.013		.012	.066	.442
	.362	.636*	.771**	.689*	.751*	1	.725*	.493
PPEAS_HA	.304	.026	.003	.013	.012		.018	.123
	.405	.639*	.683*	.694*	.572	.725*	1	.813**
MILLET_HA	.216	.034	.021	.018	.066	.018		.002
	.264	.623*	.573	.590*	.259	.493	.813**	1
SORGHUM_HA	.433	.030	.051	.043	.442	.123	.002	
	11	12	12	12	11	11	11	12

*. Correlation is significant at the 0.05 level
**Correlation is significant at the 0.01 level

Source; Kitui district agriculture office

Appendix14Table (l) Pearson correlation coefficients for the nutrition indicator, frequency of consumption of foods and 24 hour nutrient intake season1

	WAZ	HAZ	BAZ	BMI	Maize	Beans	PigeonP	Beef	Sorghum	KCAL	Protein	VITA	DVS	Cassava
WAZ	1	.467(**)	.655(**)	.147	-.101	-.203(*)	.080	.125	-.081	-.148	-.127	.132	.062	-.034
HAZ	.467(**)	1	-.357(**)	.162	-.100	-.053	.167(*)	.115	-.114	-.049	-.086	.124	-.037	-.087
BAZ	.655(**)	-.357(**)	1	-.012	-.021	-.160	-.075	.020	.039	-.146	-.071	.085	.152	-.009
BMI	.147	.162	-.012	1	-.025	.018	-.026	.082	-.011	.375(*)	.411(*)	-.062	.138	.157
Maize	-.101	-.100	-.021	-.025	1	-.068	-.084	-.389(**)	-.270(**)	.067	-.039	-.009	.159	.056
Beans	-.203(*)	-.053	-.160	.018	-.068	1	.089	.176	.227(*)	.122	.170	.504(**)	.490(**)	-.191
PigeonP	.080	.167(*)	-.075	-.026	-.084	.089	1	.094	.105	-.122	-.107	.096	.208	.153
Beef	.125	.115	.020	.082	-.389(**)	.176	.094	1	.073	.143	.241	.448(*)	.478(*)	-.138
Sorghum	-.081	-.114	.039	-.011	-.270(**)	.227(*)	.105	.073	1	-.241	-.154	-.202	-.091	.017
KCAL	-.148	-.049	-.146	.375(*)	.067	.122	-.122	.143	-.241	1	.954(**)	.196	.390(*)	.140
Protein	-.127	-.086	-.071	.411(*)	-.039	.170	-.107	.241	-.154	.954(**)	1	.189	.431(*)	.119
VitaminA	.132	.124	.085	-.062	-.009	.504(**)	.096	.448(*)	-.202	.196	.189	1	.649(**)	-.235
DVS	.062	-.037	.152	.138	.159	.490(**)	.208	.478(*)	-.091	.390(*)	.431(*)	.649(**)	1	-.047
Cassava	-.034	-.087	-.009	.157	.056	-.191	.153	-.138	.017	.140	.119	-.235	-.047	1

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).DVS..DietaryDiversity Score for the 24 hour food intake by the children

Appendix 14 Table (m) Pearson correlation coefficients nutrition indicators, frequency consumption of Foods, 24 hour nutrient intake

Season2

	WAZ	HAZ	BAZ	BMI	Maize	Sorghum	Beans	Beef	Cassava	Cowpeas	KCAL	Protein	VitaminA	DVS
WAZ	1	.586(**)	.599(**)	.123	-.049	.023	.152(*)	.050	.055	.200	.053	.024	.036	.041
HAZ	.586(**)	1	-.273(**)	.135	.094	.106	.188(*)	-.151	.043	.248(*)	.194	.219	.374(*)	-.188
BAZ	.599(**)	-.273(**)	1	.037	-.154(*)	-.072	-.013	.205(*)	.009	-.021	-.144	-.202	-.415(*)	.258
BMI	.123	.135	.037	1	.005	.143	.113	.001	-.086	-.149	-.159	-.129	.291	-.089
Maize	-.049	.094	-.154(*)	.005	1	-.264(**)	.437(**)	-.228(**)	-.331(*)	.051	.276	.300	.001	-.002
Sorghum	.023	.106	-.072	.143	-.264(**)	1	-.002	-.031	-.066	-.026	.107	.202	.191	.169
Beef	.050	-.151	.205(*)	.001	-.228(**)	-.031	-.116	1	-.097	-.249	-.138	-.200	.115	-.194
Cassava	.055	.043	.009	-.086	-.331(*)	-.066	.014	-.097	1	.058	-.505	-.359	.394	.478
Cowpeas	.200	.248(*)	-.021	-.149	.051	-.026	-.003	-.249	.058	1	.137	-.029	-.018	-.579(*)
KCAL	.053	.194	-.144	-.159	.276	.107	.317	-.138	-.505	.137	1	.907(**)	-.129	.048
Protein	.024	.219	-.202	-.129	.300	.202	.299	-.200	-.359	-.029	.907(**)	1	-.094	.141
VitaminA	.036	.374(*)	-.415(*)	.291	.001	.191	-.035	.115	.394	-.018	-.129	-.094	1	.108
DVS	.041	-.188	.258	-.089	-.002	.169	-.051	-.194	.478	-.579(*)	.048	.141	.108	1

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed). DVS..Dietary Diversity Score for the 24 hour food intake by the children

Appendix15 Table (m) Pearson correlation coefficients for nutrition indicators, food production, incomes and nutrient intake over 24hour season1

	WAZ	HAZ	BAZ	BMI	HHincome	Daily food exp	Land on crop	Maize yield	Beans yield	Pigeonpeasyield	Cassava yield	Kale yield	Cereals income	Livestock income	Husband salary	KCAL	Protein	Vitamin A	DVS ***
WAZ	1	.467(**)	.655(**)	.147	-.033	-.135	-.076	-.052	-.104	.020	-.077	.066	-.070	.345	.069	-.148	-.127	.132	.062
HAZ	.467(**)	1	-.357(**)	.162	.081	-.087	-.038	-.008	-.059	.011	-.275	.506(**)	.028	.521	.056	-.049	-.086	.124	-.037
BAZ	.655(**)	-.357(**)	1	-.012	-.114	-.074	-.041	-.061	-.047	.033	.144	-.557(**)	-.081	.014	.005	-.146	-.071	.085	.152
BMI	.147	.162	-.012	1	.296(**)	.028	.093	.163	.038	.001	.002	.155	.281	.719(**)	.314(*)	.375(*)	.411(*)	-.062	.138
HHincome	-.033	.081	-.114	.296(**)	1	.108	-.075	.093	.140	.076	-.136	-.252	.164	.491	.814(**)	.160	.194	.269	.389
Daily food exp.	-.135	-.087	-.074	.028	.108	1	.006	-.033	-.073	.050	-.181	-.136	.027	-.452	-.059	-.017	.082	.061	-.015
Land on crop	-.076	-.038	-.041	.093	-.075	.006	1	.570(**)	.662(**)	.533(**)	-.084	.415(*)	.481(**)	.364	.043	.036	.015	.019	.203
Maizeyield	-.052	-.008	-.061	.163	.093	-.033	.570(**)	1	.823(**)	.603(**)	-.054	.475(*)	.697(**)	.330	.132	.409(*)	.389	.359	.344
Beansyield	-.104	-.059	-.047	.038	.140	-.073	.662(**)	.823(**)	1	.769(**)	-.097	-.007	.633(**)	.605	-.036	.217	.300	.022	.249

Pigeonpea syield	-.020	011	-.033	-.001	076	050	.553(**)	.603(**)	.769(**)	1	-.220	.470	.806(**)	.184	.183	.122	.173	.143	-.046
Cassava yield	-.077	-.275	.144	.002	-.136	-.181	-.084	-.054	-.097	-.220	1	-.074	-.205	.278	-.118	-.519(*)	-.462	-.279	.137
Kale yield	.066	.506(**)	-.557(**)	.155	-.252	-.136	.415(*)	.475(*)	-.007	.470	-.074	1	.155	.627	.430	.447	.494	-.526	-.224
Cereals income	-.070	.028	-.081	.281	.164	.027	.481(**)	.697(**)	.633(**)	.805(**)	-.205	.155	1	.683	.630(**)	.233	.260	.703(*)	.482
Livestock income	.345	.521	.014	.719(**)	.491	-.452	.364	.330	.605	.184	.278	.627	.683	1	.158	.425	.545	.039	.537
husbands alary	.069	.056	.005	.314(*)	.814(**)	-.059	.043	.132	-.036	.183	-.118	.430	.630(**)	.158	1	-.060	-.226	.220	-.024
KCAL	-.148	-.049	-.146	.375(*)	.160	-.017	.036	.409(*)	.217	.122	-.519(*)	.447	.233	.425	-.060	1	.954(**)	.196	.390(*)
Protein	-.127	-.086	-.071	.411(*)	.194	.082	.015	.389	.300	.173	-.462	.494	.260	.545	-.226	.954(**)	1	.189	.431(*)
Vitamin A	.132	.124	.085	-.062	.269	.061	.019	.359	.022	.143	-.279	-.526	.703(*)	.039	.220	.196	.189	1	.649(**)
DVS	.062	-.037	.152	.138	.389	-.015	.203	.344	.249	.045	.137	-.224	.482	.537	-.024	.390(*)	.431(*)	.649(**)	1

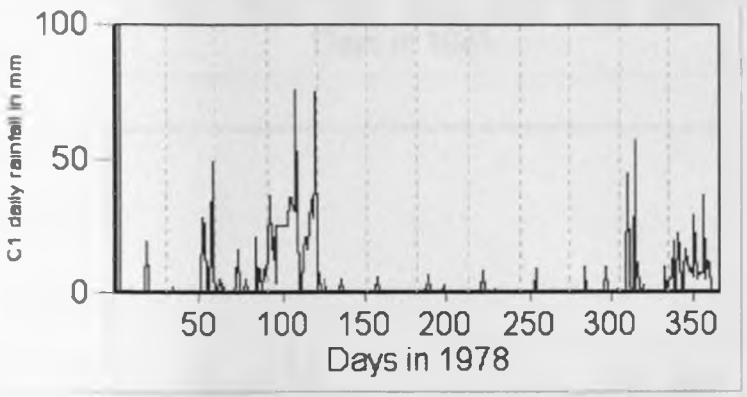
** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Dvs. dietary diversity score

Appendix16Table (o) Prices of common foods during the two survey periods in Kitui Town

Food	Quantity	price in 2008	price in 2009
Potatoes	1kg	40.00	50.00
	20	350.00	700.00
Cabbage	small	15.00	40.00
	Big	30.00	60.00
Tomato	4	20.00	20.00
Onions	1kg	60.00	80.00
Cooking bananas	4	20.00	20.00
Ripe bananas	bunch	250.00	250.00
Carrots	1kg	40.00	40.00
Avocado	3	20.00	20.00
Pawpaws	big	50.00	50.00
pigeonpeas (green)	1kg	20.00	80.00
(dry)		50.00	70.00
Mangoes (apple)	1	25.00	25.00
Mangoes (local)	3	20.00	20.00
Kale	1	0.5	1.00
Spinach	4	5.00	5.00
Maize (dry)	1kg	22.00	32.00
Beans (dry)	1kg	55.00	70.00
Muthokoi	1kg	30.00	50.00
Sorghum	1kg	40.00	70.00
Millet flour	1kg	50.00	80.00
Maize flour	1kg	30.00	50.00
Greengrams	1kg	50.00	70.00
Cowpeas	1kg	60.00	90.00
Splitpeas	1kg	50.00	70.00
Dry greenpeas	1kg	50.00	80.00

Appendix 17 Figures 1-34 Daily rainfall trends in mm for matinyani area in Kitui district for the years indicated.

The bimodal nature of the rainfall which is an indicator of the food productive seasons.(Data source was the metrological department Nairobi.



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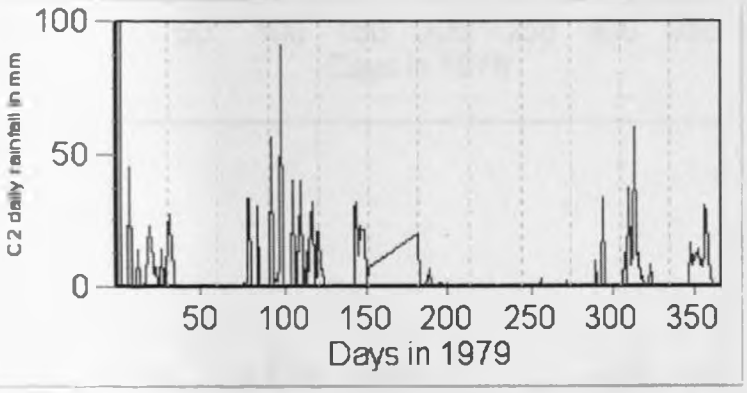

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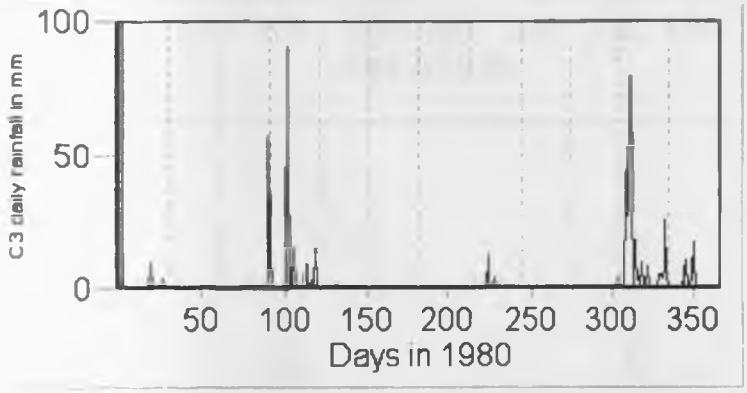

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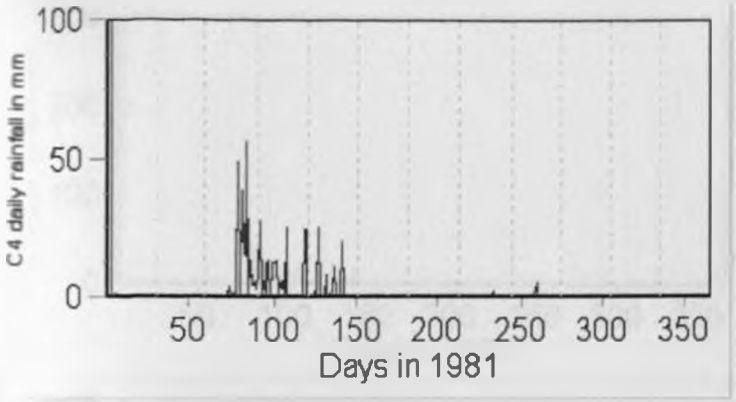
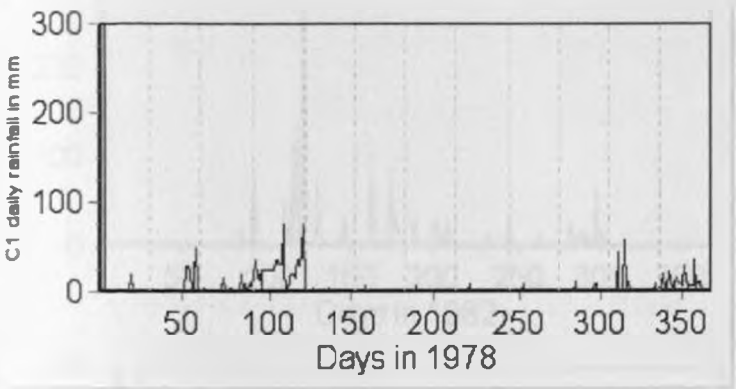
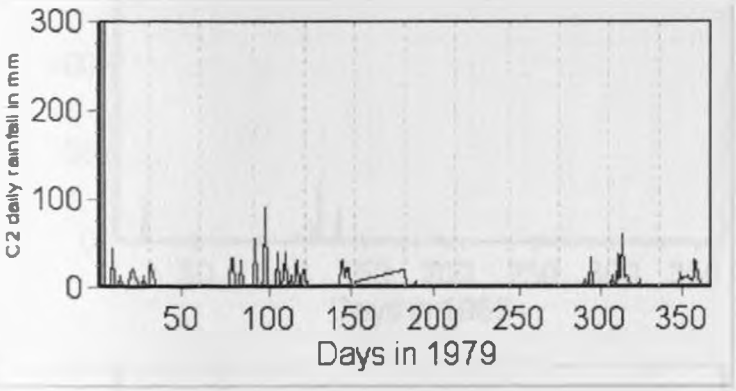

C 4 daily rainfall in mm
100
50
0
50 100 150 200 250 300 350
Days in 1981

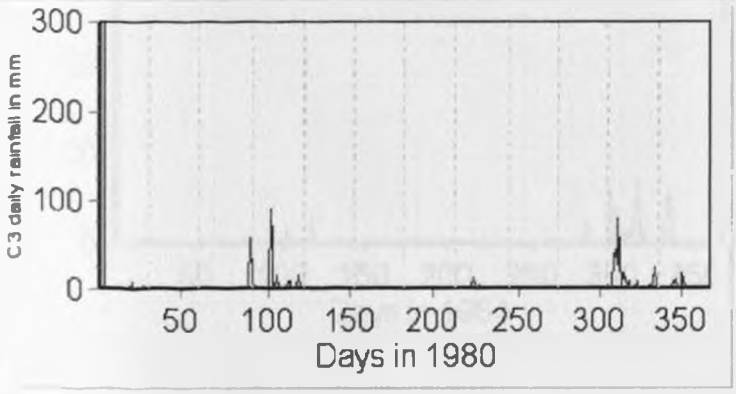
4


C1 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1978

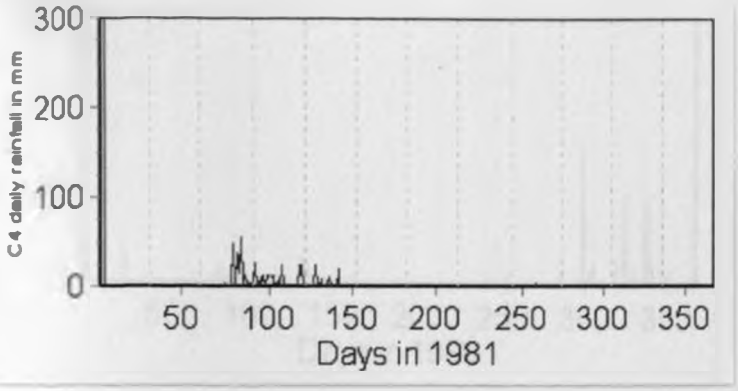
5


C2 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1979

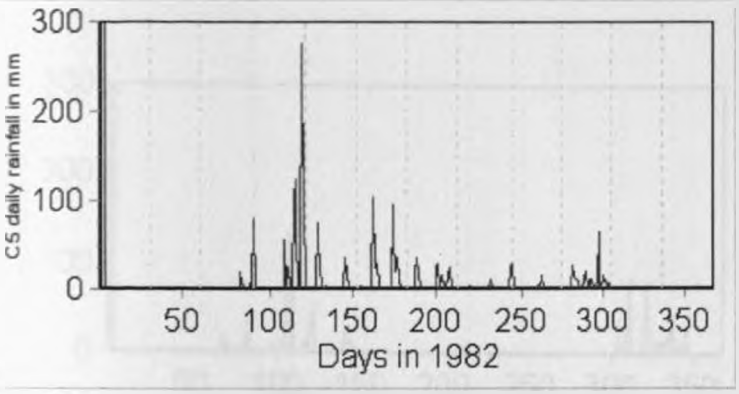
6


C3 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1980

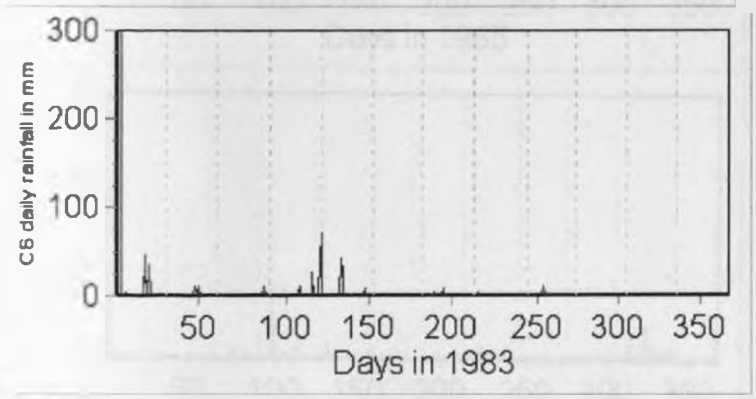
7


C4 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1981

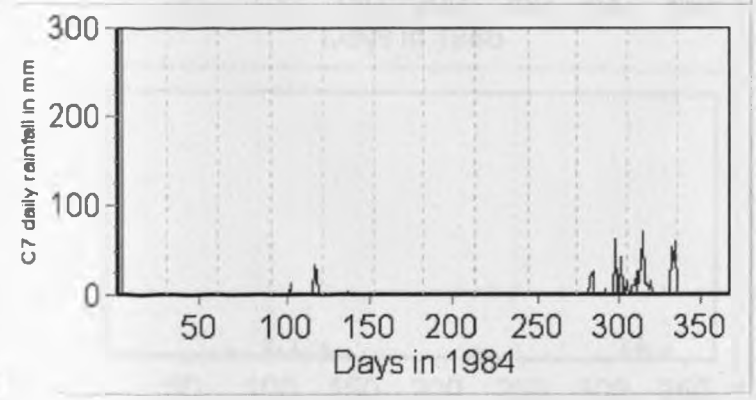
8


C5 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1982

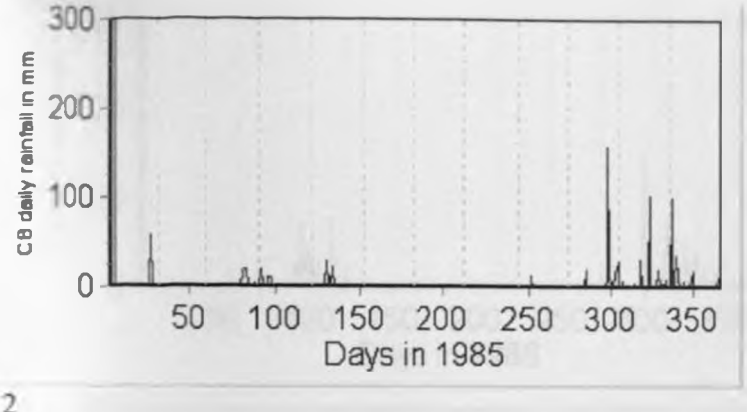
9


C6 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1983

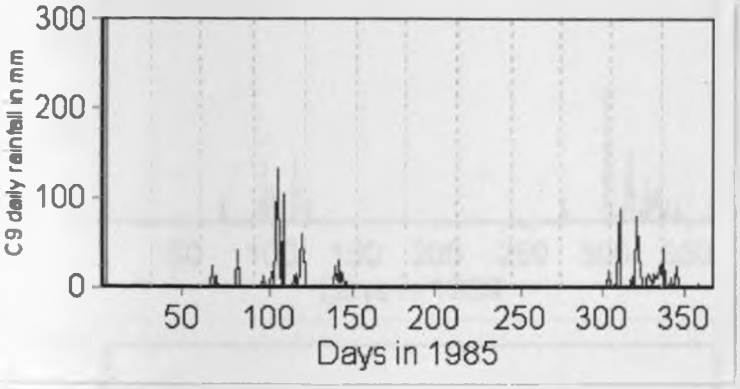
10


C7 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1984

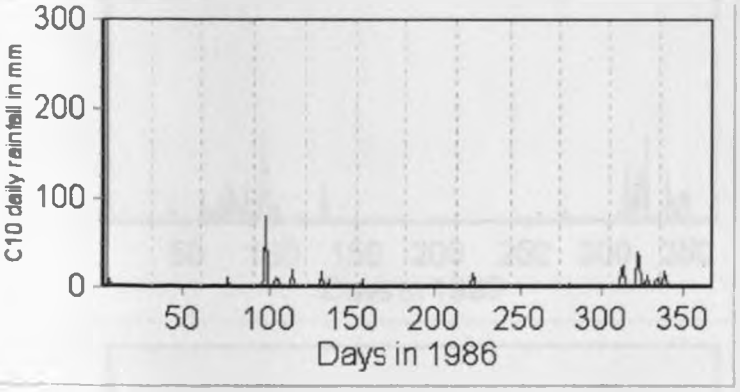
11


C8 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1985

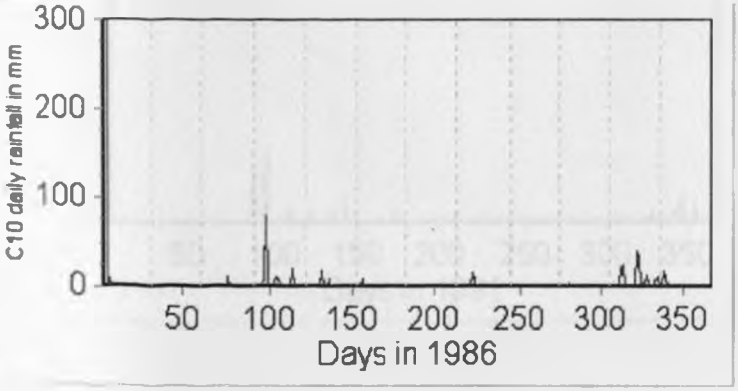
12


C9 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1985

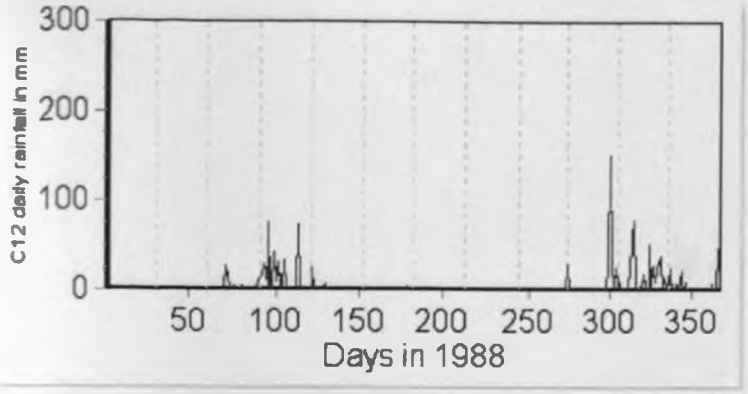
13


C10 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1986

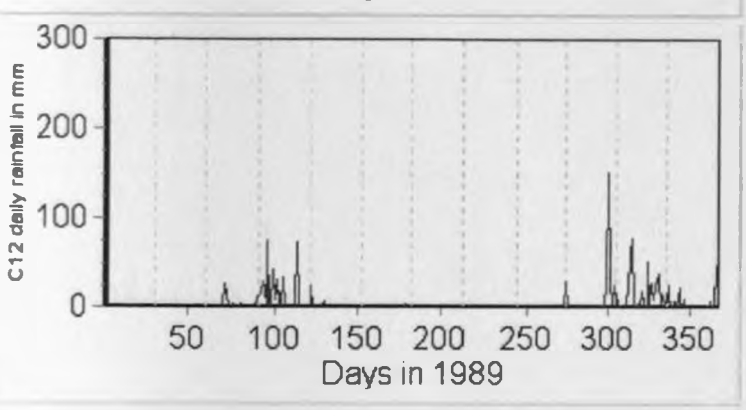
14


C10 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1986

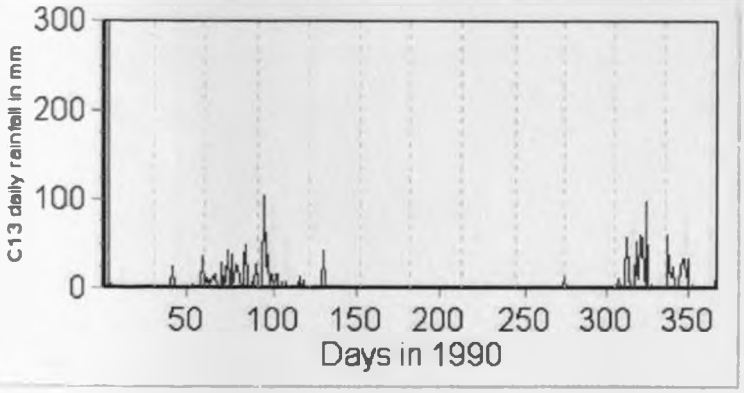
15


C12 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1988

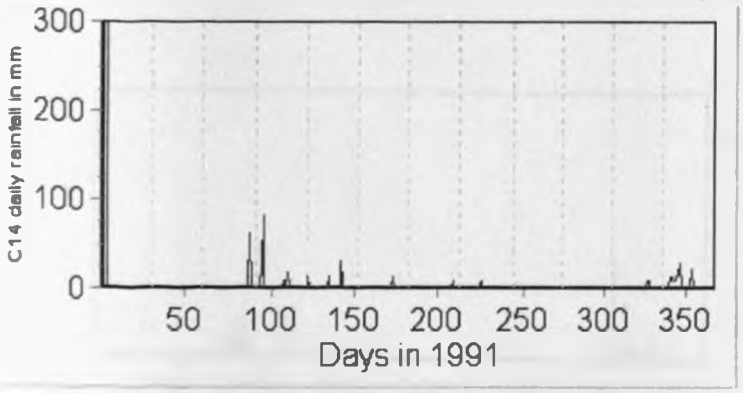
16


C12 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1989

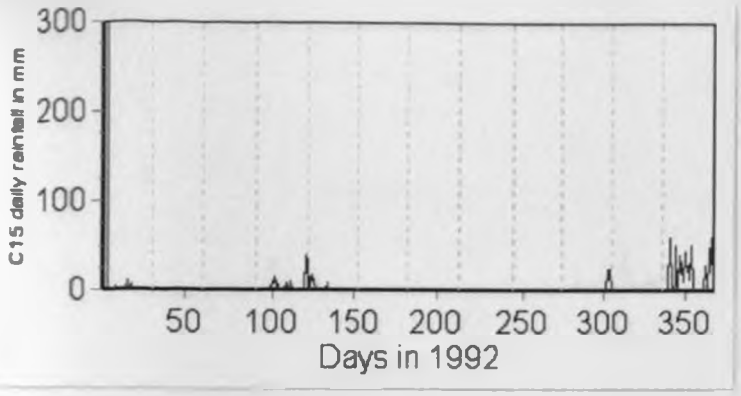
17


C13 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1990

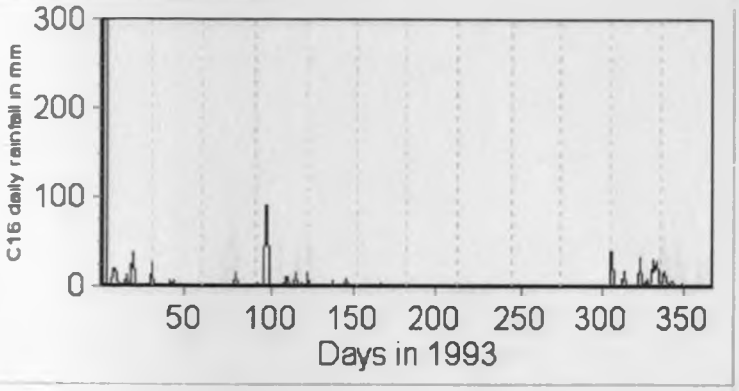
18


C14 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1991

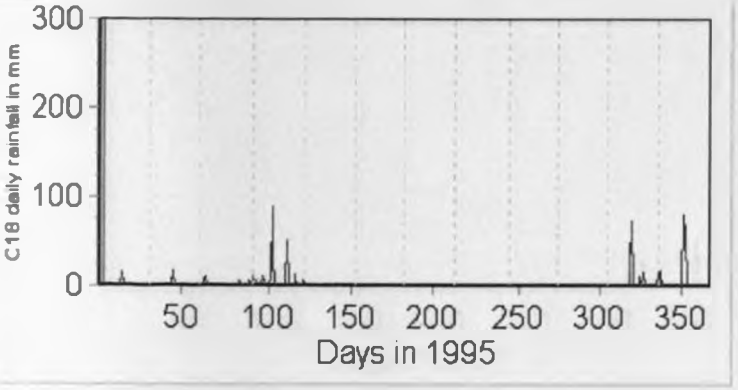
19


C15 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1992

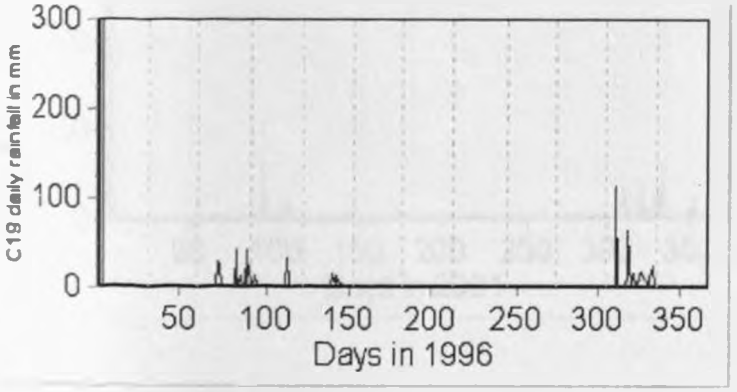
20


C16 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1993

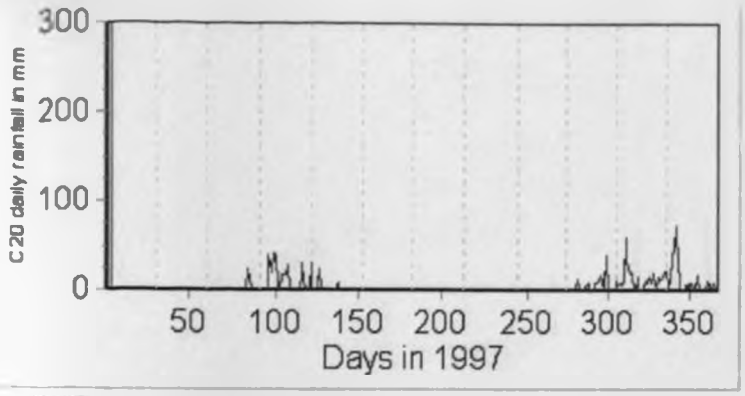
21


C18 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1995

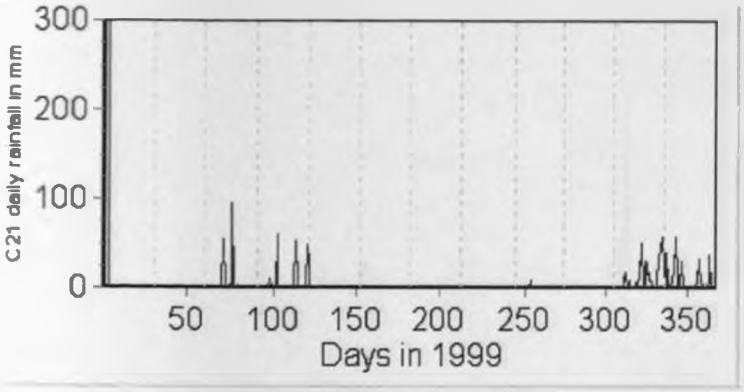
22


C19 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1996

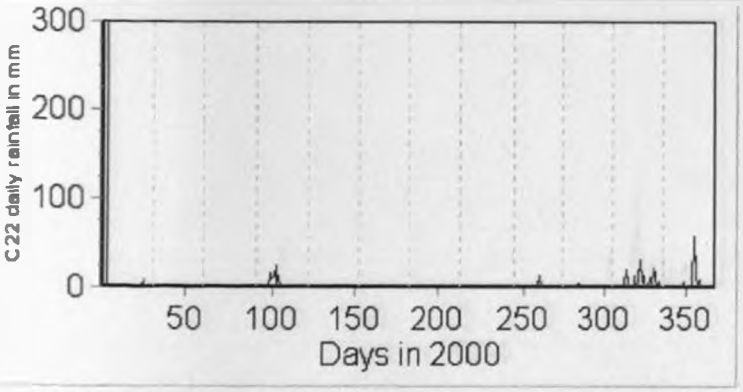
23


C20 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1997

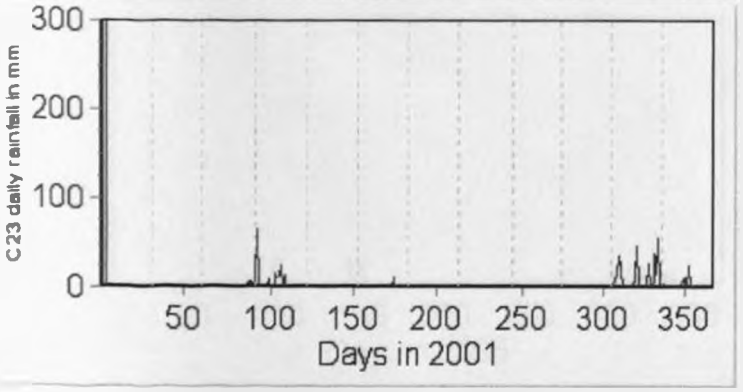
24


C21 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 1999

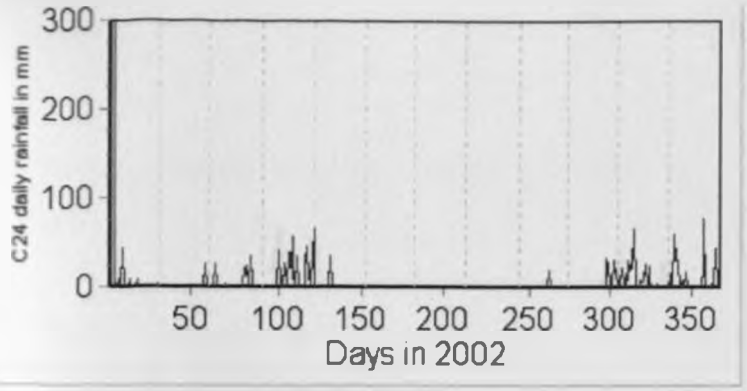
25


C22 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2000

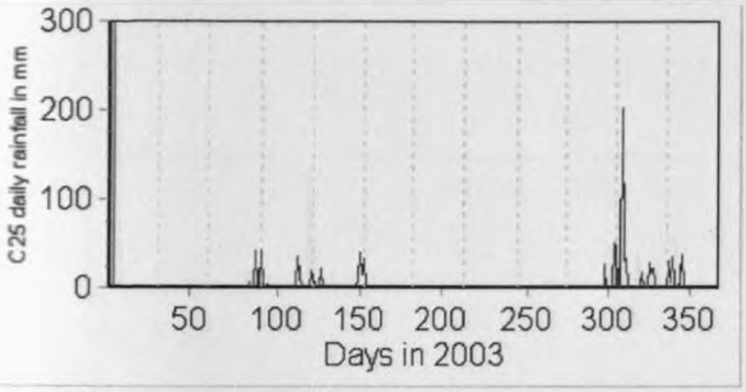
26


C23 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2001

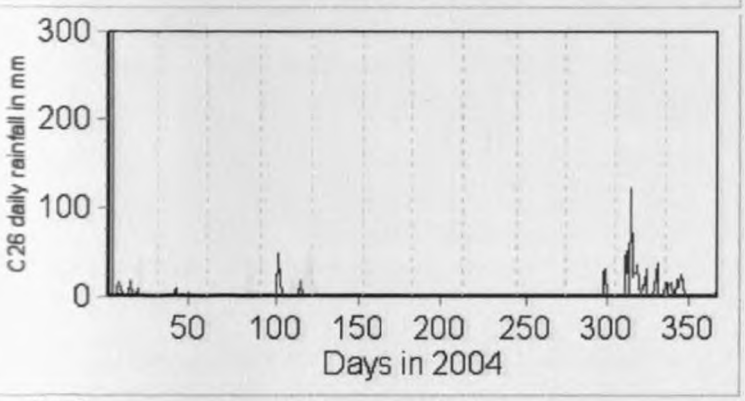
27


C24 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2002

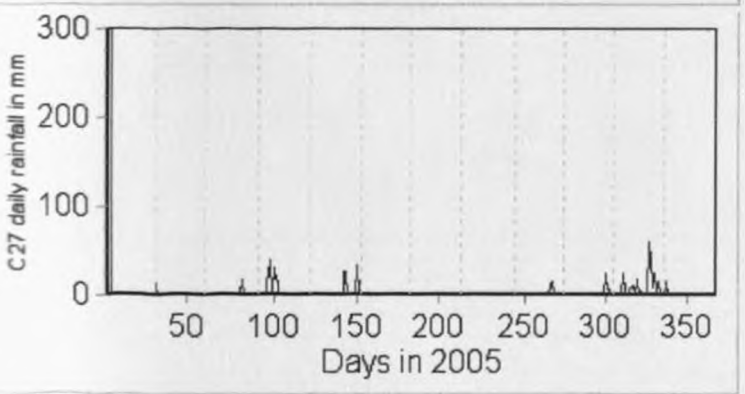
28


C25 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2003

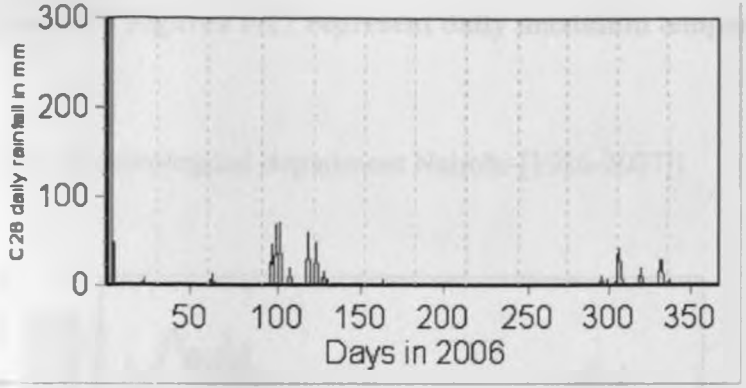
29


C26 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2004

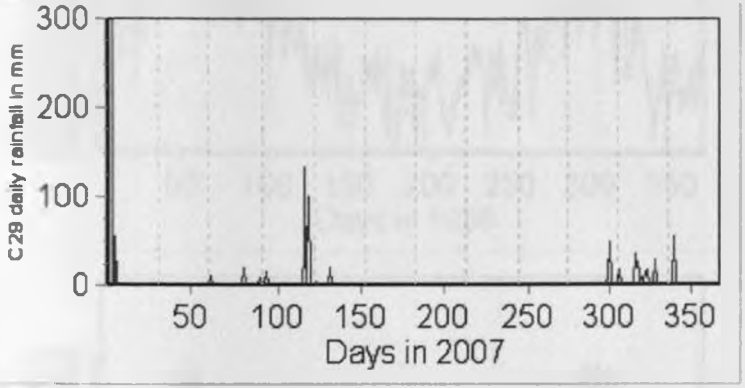
30


C27 daily rainfall in mm
300
200
100
0
50 100 150 200 250 300 350
Days in 2005

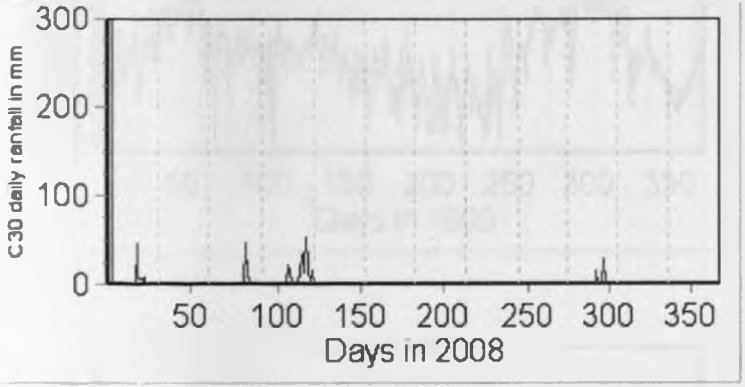
31


C28 daily rainfall in mm
300
200
100
0
50
100
150
200
250
300
350
Days in 2006

32


C29 daily rainfall in mm
300
200
100
0
50
100
150
200
250
300
350
Days in 2007

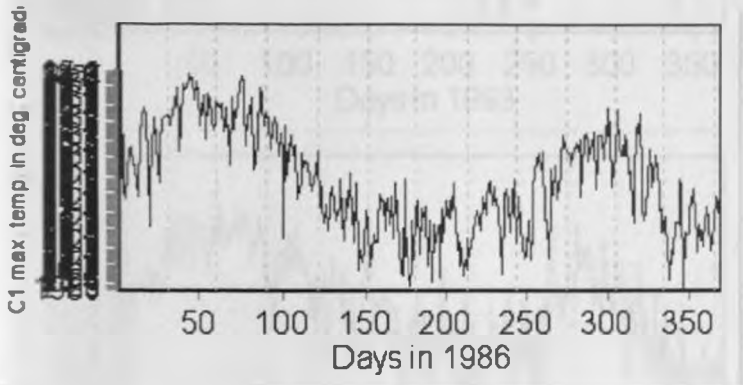
33


C30 daily rainfall in mm
300
200
100
0
50
100
150
200
250
300
350
Days in 2008

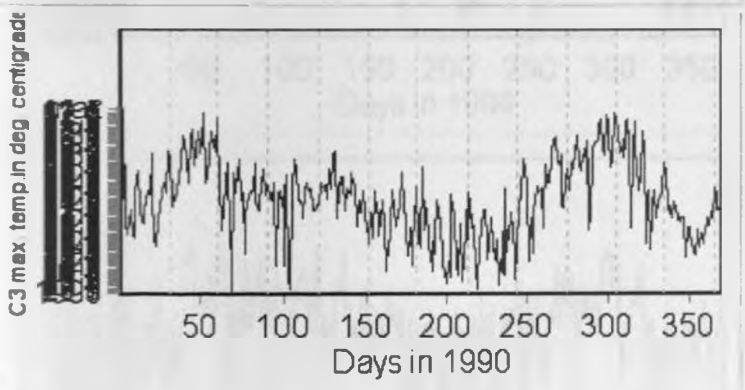
34

Appendix 18 Figures 1-17 represent daily maximum temperatures for Makindu

(Source: meteorological department Nairobi-[1986-2007])



1



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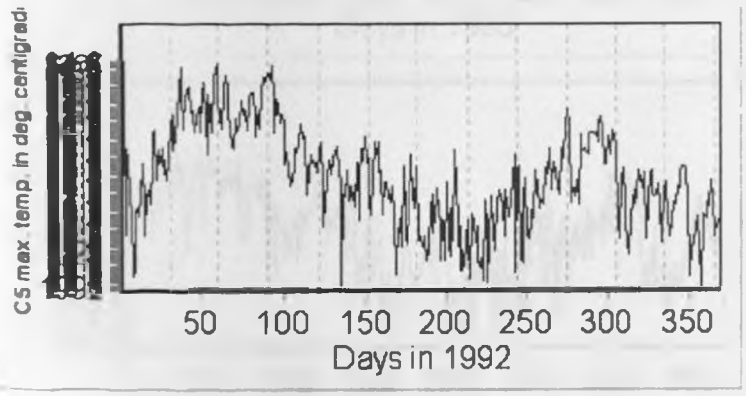

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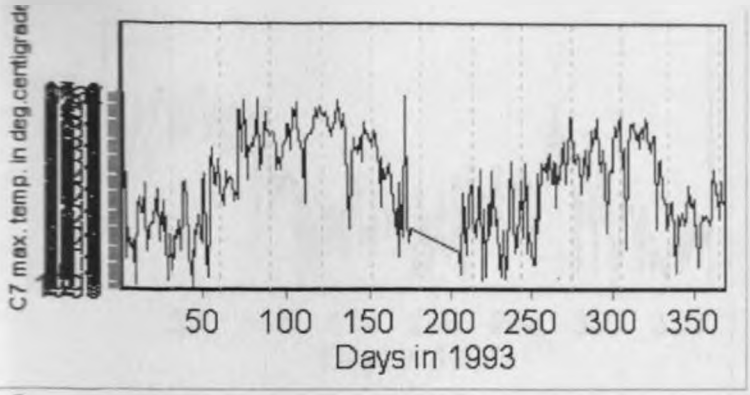
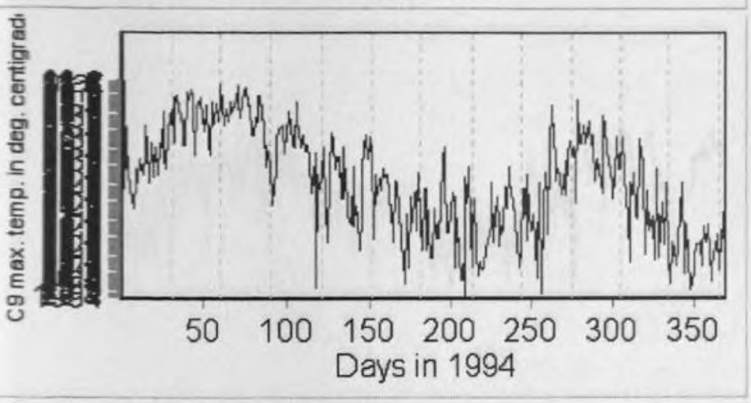
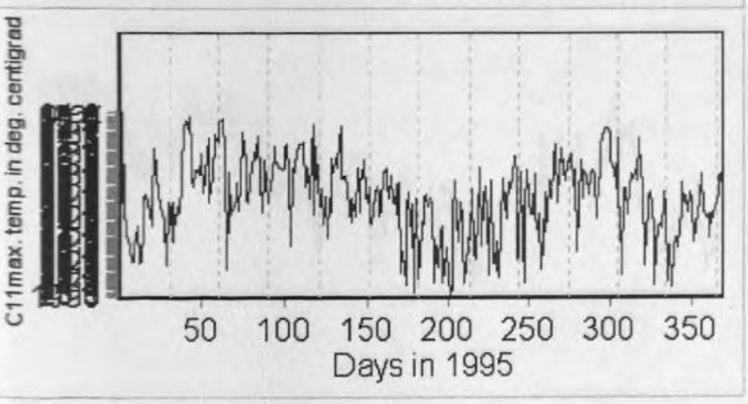

C7 max. temp. in deg.centigrade
50 100 150 200 250 300 350
Days in 1993

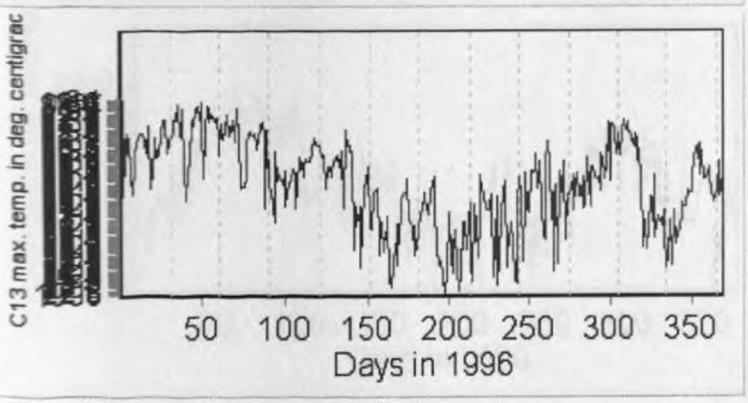
4


C9 max. temp. in deg. centigrade
50 100 150 200 250 300 350
Days in 1994

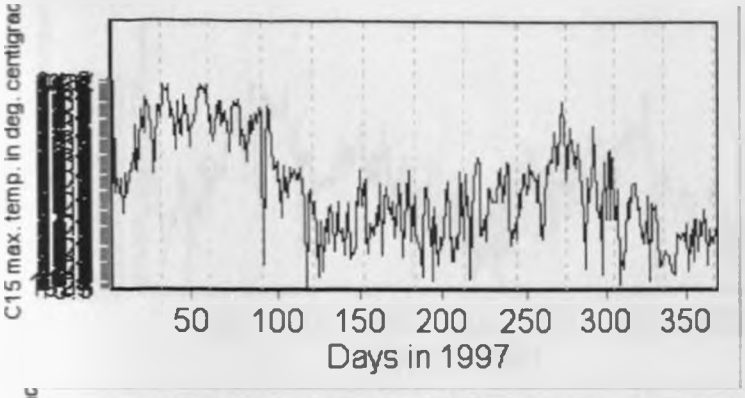
5

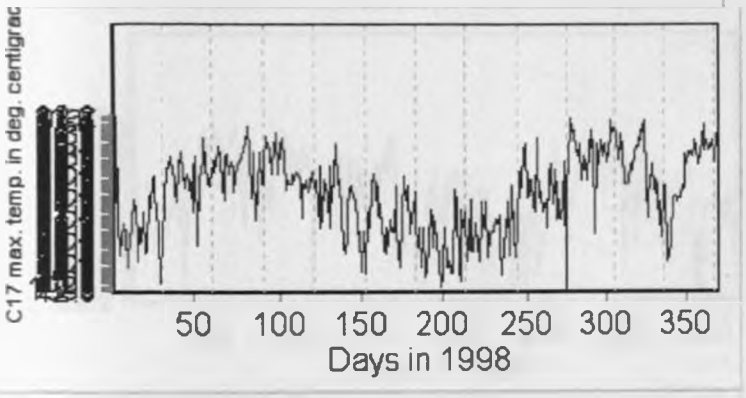

C11max. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1995

6

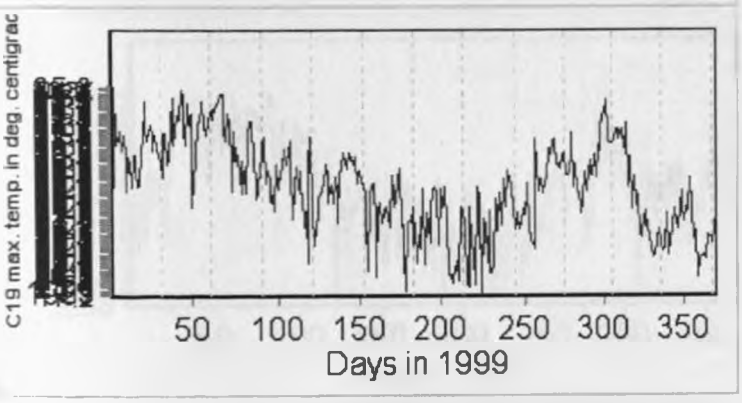

C13 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 1996

7

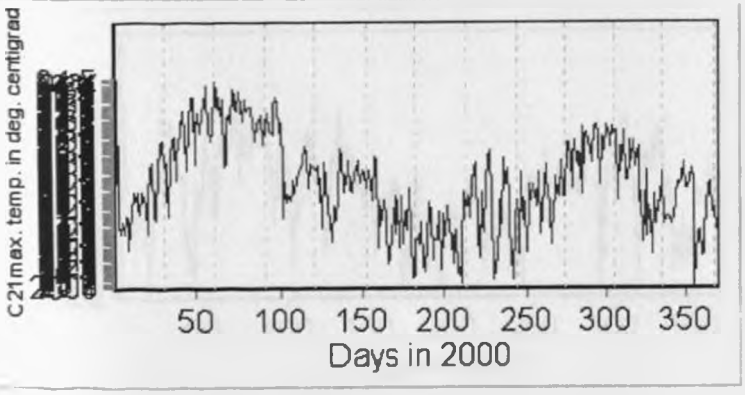

C15 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 1997


C17 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 1998

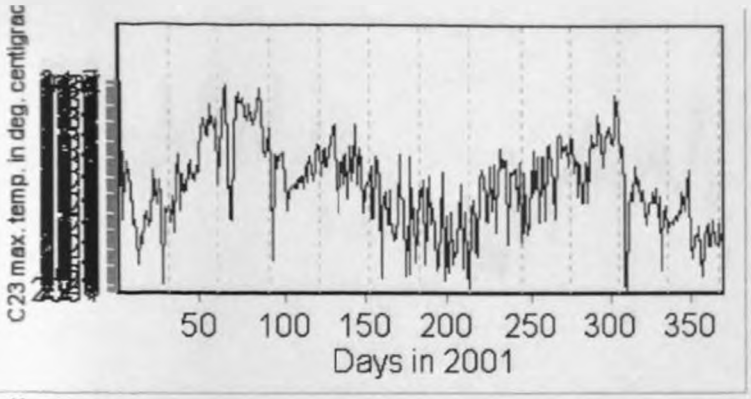
8


C19 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 1999

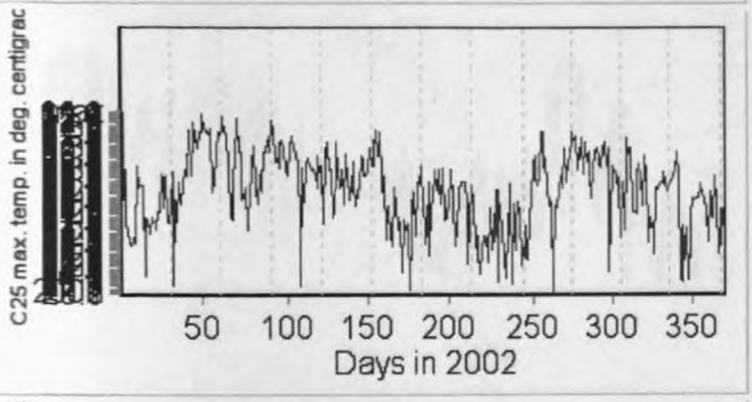
9


C21 max. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 2000

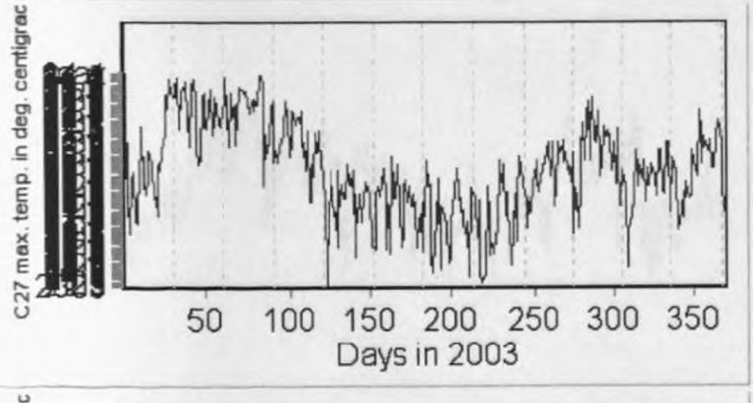
10


C23 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 2001

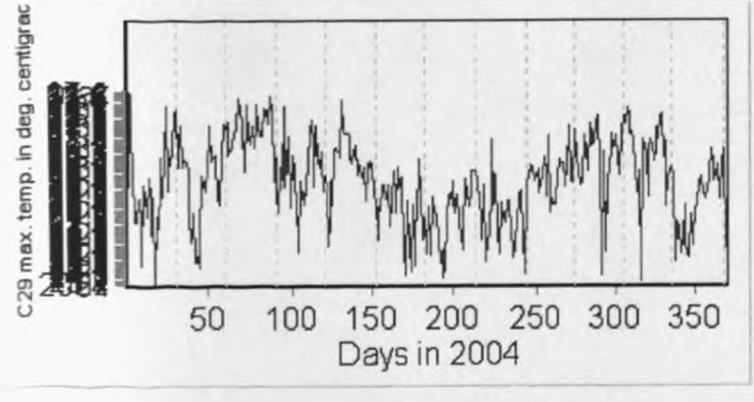
11


C25 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 2002

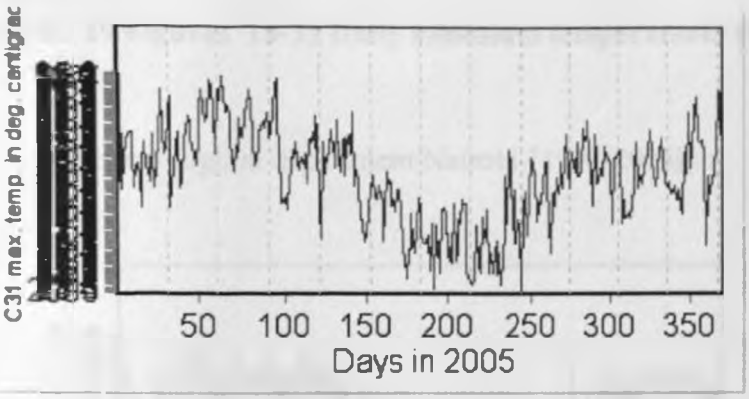
12


C27 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 2003

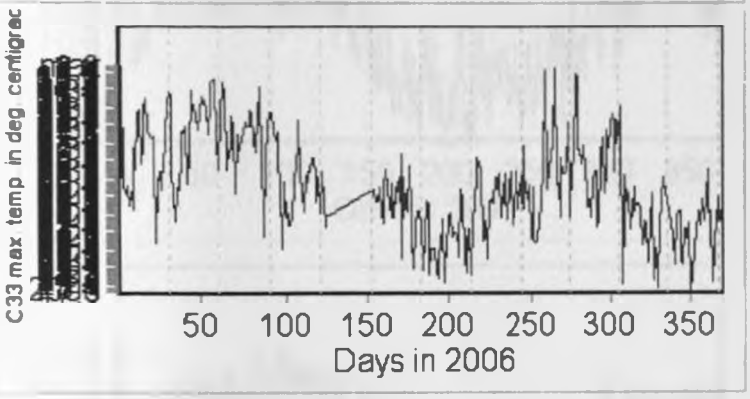
13


C29 max. temp. in deg. centigrac
50 100 150 200 250 300 350
Days in 2004

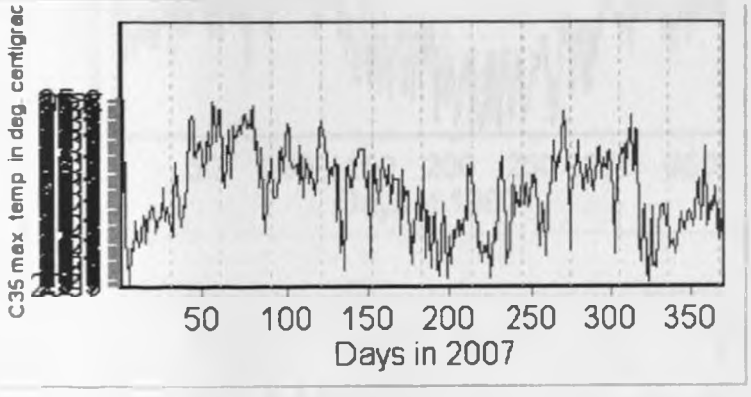
14


C31 max. temp. in deg. centigrac
50
100
150
200
250
300
350
Days in 2005

15


C33 max. temp. in deg. centigrac
50
100
150
200
250
300
350
Days in 2006

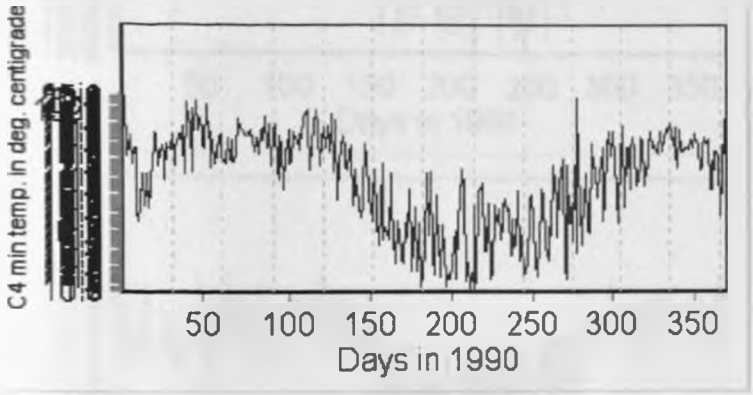
16


C35 max. temp. in deg. centigrac
50
100
150
200
250
300
350
Days in 2007

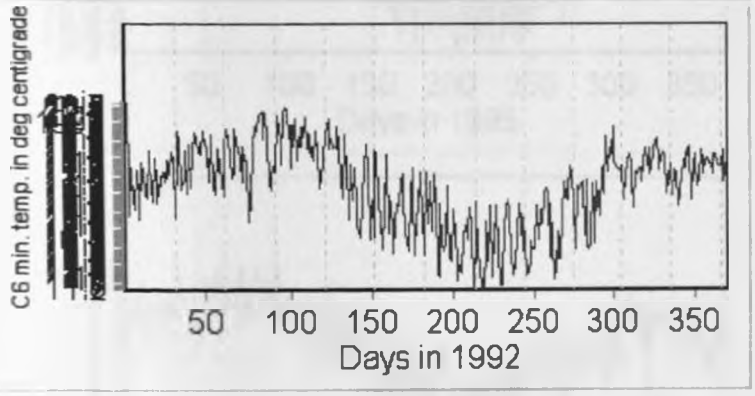
17

Appendix 19 Figures 18-33 Daily minimum temperatures for Makindu

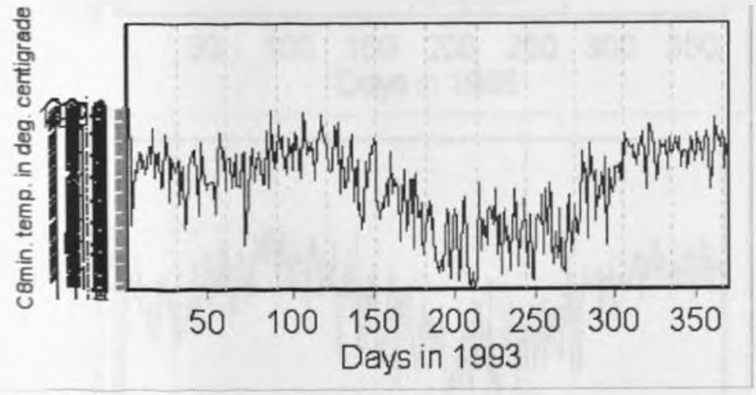
(Source: meteorological department Nairobi-[1990-2006])



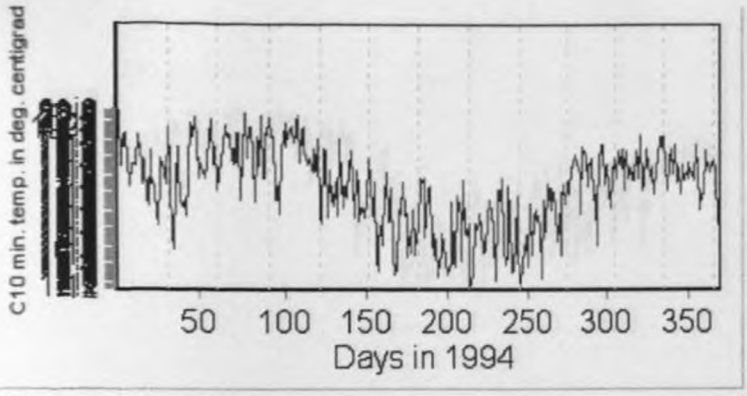
18



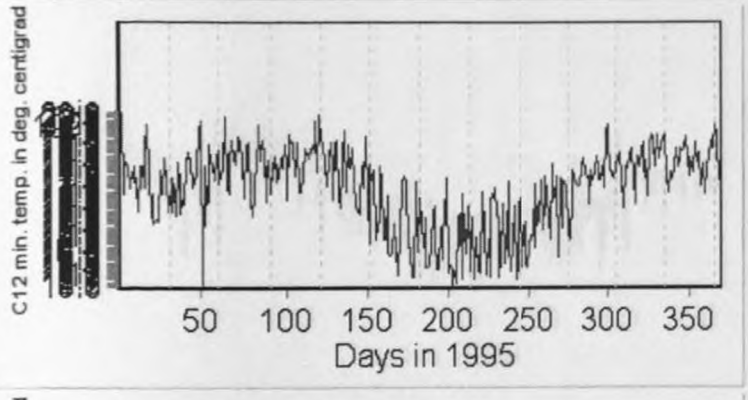
19



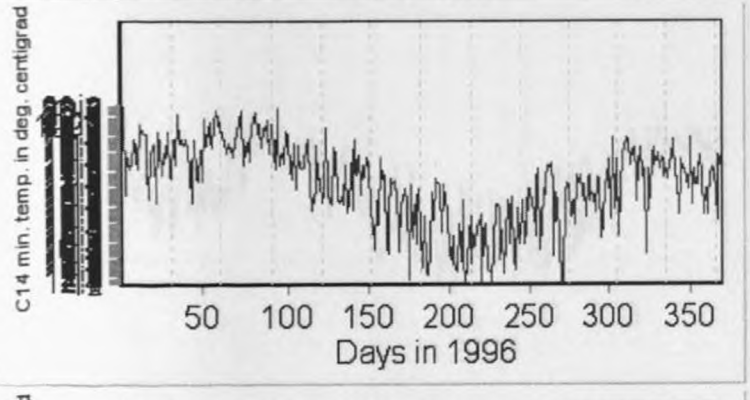
20


C10 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1994

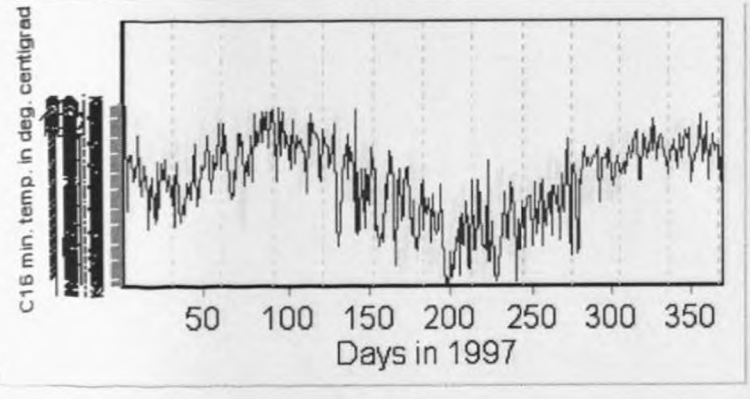
21


C12 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1995

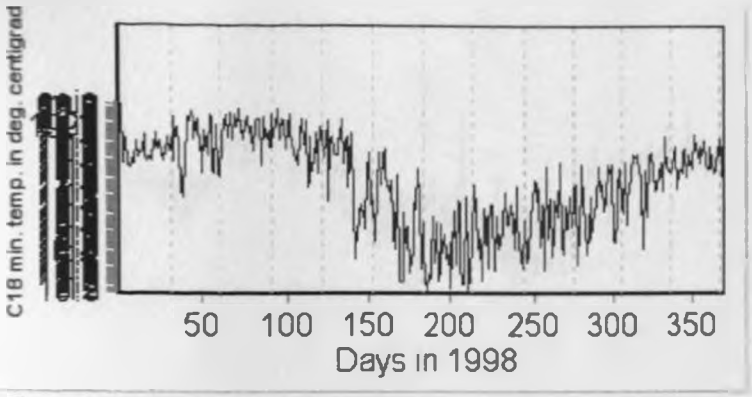
22


C14 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1996

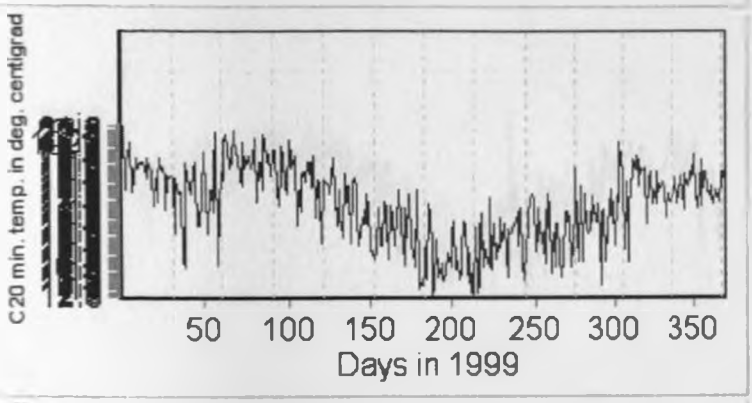
23


C16 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1997

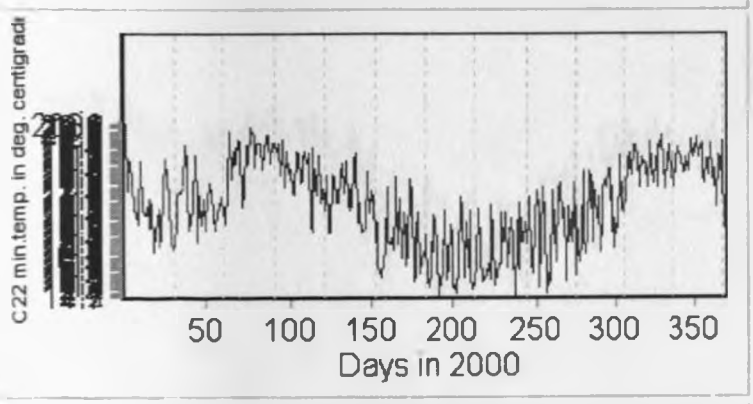
24


C18 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1998

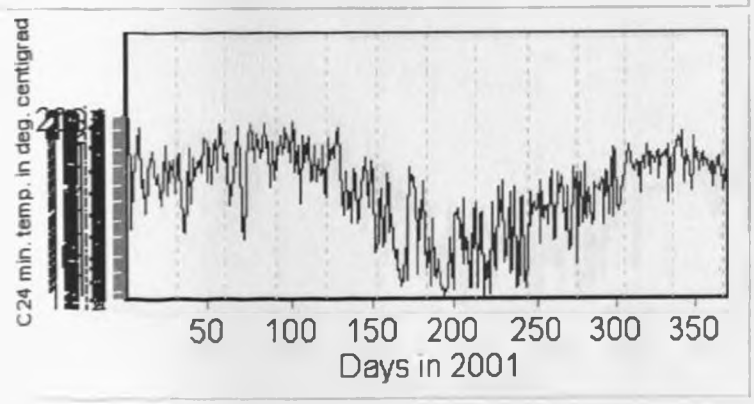
25


C20 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 1999

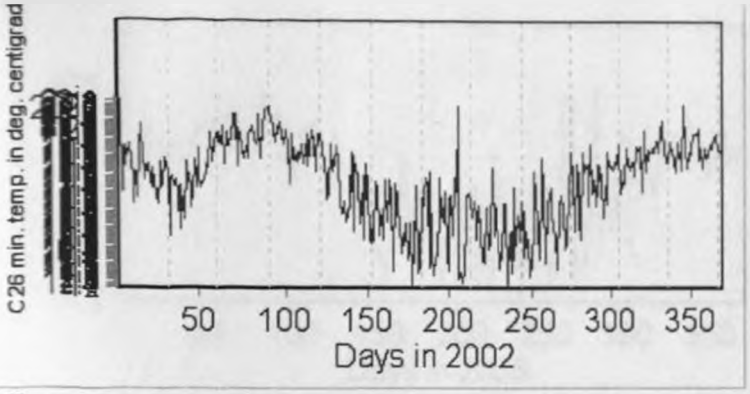
26


C22 min.temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 2000

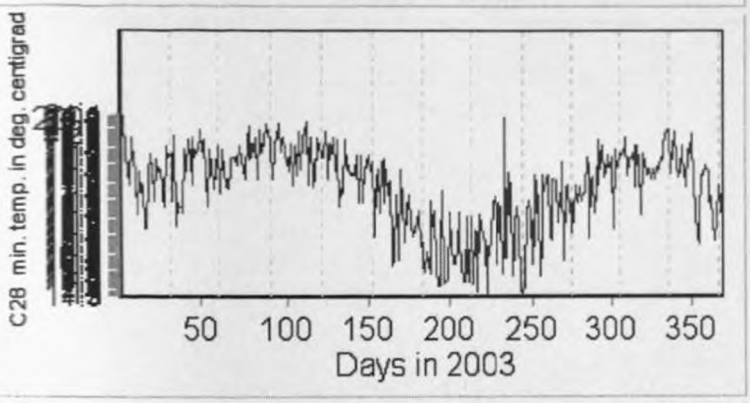
27


C24 min. temp. in deg. centigrad
50 100 150 200 250 300 350
Days in 2001

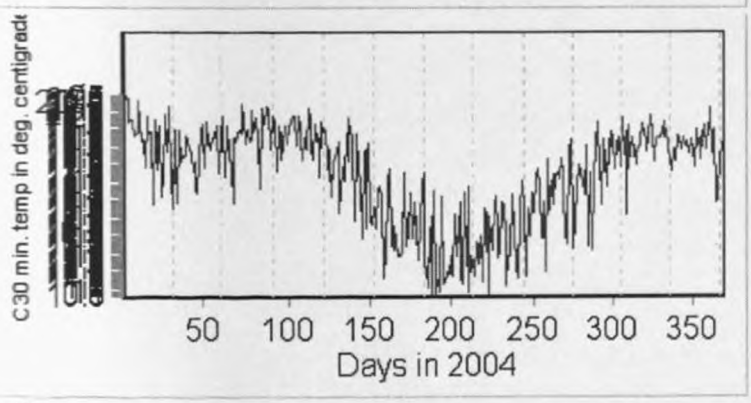
28



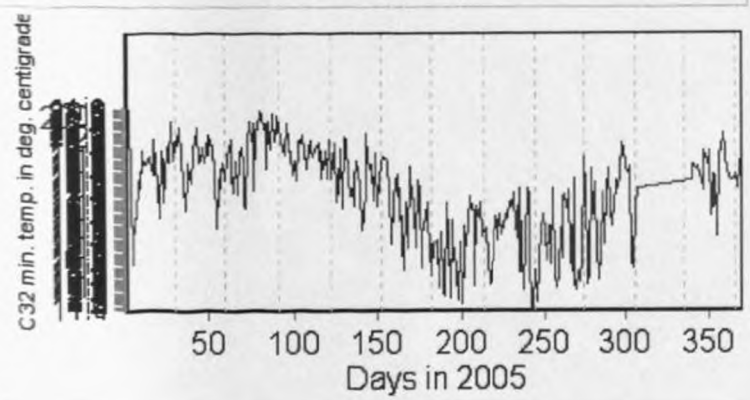
29



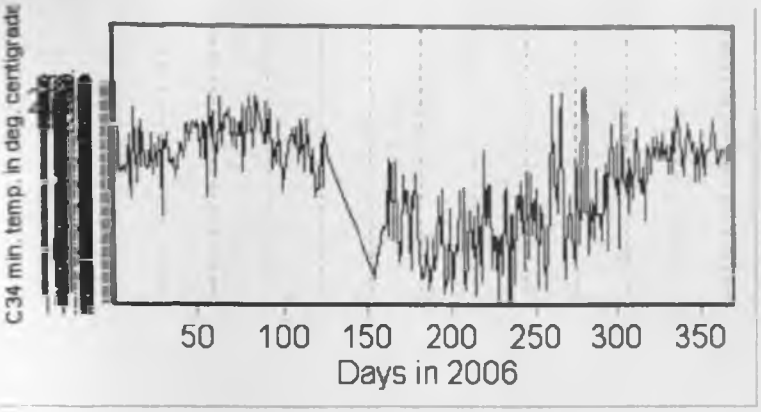
30



31



32


C34 min. temp. in deg. centigrade
50
100
150
200
250
300
350
Days in 2006

33