THE ROLE OF IRRIGATION ON IMPROVEMENT OF FOOD AVAILABILITY AND NUTRITION STATUS OF CHILDREN AGED 6 – 59 MONTHS: A case study of Kieni East Division of Nyeri District, Kenya.

By

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Declaration

I, Veronica Wanjiru Kirogo, hereby declare that this thesis is my original work and has not been presented for a degree in any other university.

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Dedication

This work is dedicated to my husband Kirogo Mwangi, children Gichui and Cici, for their encouragement and support and to my mother Shelmith Wanjiku for her parental guidance that moulded me to whom I am today.

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Abstract

Over dependence on rain-fed agriculture is one of the major problems in Kenya's agricultural sector. Irrigation, use of fertiliser and improved crop varieties have been identified as the key inputs for increasing crop yields. Given that about 80 percent of the country's land surface falls under arid and semi-arid areas and majority of the population living in rural areas depend on agriculture for their livelihood, irrigation is inevitable. However, what is not clear is the role of irrigation water on household food security and nutritional status per se. This study investigated the role of irrigation on improvement of household food security and nutritional status. The study was conducted in Kieni East division of Nyeri district; an area of high agricultural potential but aridity hinders its exploitation. The Nyeri Dry Area Smallholder Community Services Development Project has been involved in provision of irrigation water in the study area with the aim of raising food production and improving the nutritional status of the target population.

Two random sub-samples that consisted of 59 households each were selected. They comprised of project households (those with access to irrigation water) and non-project households (those without access to irrigation water). Agricultural production data was based on production figures of the year 2000, while the 24-hour dietary recall determined dietary energy and nutrient intake. Food security was assessed in terms of household dietary energy adequacy ratio and proportion

of income spent on food. Households whose energy adequacy ratio was below 0.8 or who spent more than 60 percent of income on food were considered food insecure. Anthropometric measurements were used to assess the nutritional status of children aged 6 – 59 months.

Provision of irrigation water increased crop yields such that the average maize yield in the project households (141.1kg/acre) was 3.2 times more than that of non-project, which was 44.2kg/acre; the difference was significant. It can be concluded that irrigation has led to a shift from subsistence to commercial farming since significantly more project households than non-project households engaged in commercial farming. Commercial farming was found to have a positive effect on income levels. The number of non-commercial farming households below the rural poverty line (KSh. 1240) was three times significantly more that of commercial farming households. However, improvement of income in commercial farming does not appear to have a significant influence on household food security.

Although the prevalence of underweight and stunting in the project households (3% and 10% respectively) was lower than in non-project households, which was 10% and 17%, there was no significant difference. This implies that provision of water in Kieni East division has not lead to a significant improvement of nutritional status of young children. However, since children from the project

households were better off, it can be concluded that irrigation has contributed to protection of nutritional status. There is need for further research because the impact of irrigation could have been misrepresented, since the reference period was characterised by drought, which subsequently affected availability of water.

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Abbreviation and acronyms

ACC/SCN	Administrative Committee on Co-ordination and Subcommittee on Nutrition
BSF	Belgium Survival Fund
CBS	Central Bureau of Statistics
CU	Consumer Unit
FAO	Food and Agriculture Organisation
GoK	Government of Kenya
HAZ	Z-score for height-for-age
HDEAR	Household Dietary Energy Adequacy Ratio
HH	Household
IFAD	International Fund for Agriculture Development
IFPRI	International Food Policy Research Institute
JICA	Japan International Co-operation Agency
Kcal	Kilocalories
KDHS	Kenya Demographic and Health Survey
KSh	Kenya shilling (one US dollar is equivalent to Ksh. 79)
KWMS	Kenya Welfare Monitoring Survey
MI	Macro International
MOALD	Ministry of Agriculture and Livestock Development
MOARD	Ministry of Agriculture and Rural Development

MOFP	Ministry of Finance and Planning
MSc	Master of Science
MUAC	Mid-Upper Arm Circumference
NCHS	National Centre for Health Statistics
NCPD	National Council for Population Development
NDAP	Nyeri Dry Area Smallholder Community Services Development Project
RDA	Recommended Daily Allowance
RDI	Recommended Dietary Intake
RE	Retinol equivalent
SD	Standard Deviation
UoN	University of Nairobi
UN	United Nations
UNICEF	United Nations Children's Fund
WAZ	Z-score for weight-for-age
WHO	World Health Organisation
WHZ	Z-score for weight-for-height

Operational Definitions

Consumer unit is the nutrient requirement (mainly used for energy) of an individual expressed as a ratio of the recommended daily intake for sex and age.

Family dish refers to meal prepared for the whole family.

Food insecure households are those that do not satisfy 80 percent of their total dietary requirements or those that allocate more than 60 percent of the total income on food.

Food security refers to access to food by households, assessed by the degree of adequacy of dietary energy intake or the proportion of household income spent on food.

Household dietary energy adequacy ratio is the total dietary energy intake of a household divided by the total energy required by the household based on sex and age.

Household refers to a person or group of related and unrelated persons who live together in the same dwelling unit(s), who acknowledge one adult male or female

as the head of household, who share the same housekeeping arrangement and are considered as one unit.

Index child is the youngest child in the household whose age is between 6 – 59 months.

Jua Kali refers to informal small-scale business.

Non-project households are households in the study area that have no access irrigation water.

Nutritional status refers to the nutritional state of the body as expressed according to anthropometric indices namely height-for-age, weight-for-age and weight-for-height.

Project households refer to households in the study area that have access to irrigation water.

Rural poverty line refers to monthly household income of KSh.1240, which is the minimum amount necessary to afford an adult equivalent their basic minimum food and non-food requirements in the rural area in Kenya.

Study households comprise of both households with and without access to irrigation water that were selected for the purpose of this study.

Stunting measures linear growth and indicates chronic malnutrition that is usually associated with long-term factors such as poverty, frequent infections and poor feeding practices.

Underweight is a composite measure of both stunting and wasting.

Wasting describes a recent and severe process that has produced a substantial weight loss, usually as a consequence of acute shortage of food and/or severe disease.

Chapter 1

1.0 Introduction

1.1 General Background

In Africa, malnutrition continues to kill millions of children, predisposes children to various diseases, and impedes overall social-economic progress (Ntiru, Diene and Ndure, 1999). Many studies have consistently shown that the highest incidence of malnutrition is usually found among those with the lowest purchasing power (Caliendo, 1979; Alderman and Garcia, 1993; Bouis and Haddad, 1990; Martorell, 1985). Over the last decade, the rate of malnutrition in many countries in sub-Saharan Africa has remained high.

During the period 1980-1995 no progress was made in reducing stunting in Sub-Saharan Africa. The number of children who were stunted increased by an alarming 62% (ACC/SCN, 1997). In Kenya, the estimate of stunting as reported in 1998 Kenya Demographic and Health Survey (KDHS) is parallel to that of 1993 KDHS, suggesting no improvement in the nutritional status of young children over the past five years (NCPD, CBS and MI, 1994 and NCPD, CBS and MI, 1999). The prevalence of stunting reported in the 1998 survey was 33 percent as compared to 32.7 percent in 1993. Factors that have been identified as causes of malnutrition include: food insecurity, which is as a result of inadequate food

supply leading to poor/low nutrient intake, limited purchasing power, poor environmental conditions, and inadequate knowledge on nutrition (Harper, 1984).

Much effort has been made to improve the nutrition situation in Africa, yet malnutrition continues to affect large proportions of the population in the continent. Multisectoral intervention strategies that take into consideration the linkages between agriculture, education, economic status, environmental health, sanitation, and nutrition have been introduced. Nyeri Dry Area Smallholder and Community Services Development Project (NDAP) funded by Belgium Survival Fund (BSF) through the International Fund for Agriculture Development (IFAD) in Kieni East and Kieni West divisions of Nyeri district (1991-1998) is one such intervention. The primary objective of the project was to improve the welfare and standard of living of the community in the two divisions (MOARD, 1998). The project aims were: to raise food production, the income and well being of the target population through increase in agricultural production; to improve the health of the population through cost-effective primary health care, the provision of safe drinking water and the promotion of an improved diet; and to promote agricultural techniques that would protect the environment.

The Home Economics sector in the Ministry of Agriculture was charged with the responsibility of implementing the nutrition component of the NDAP through the following strategies that targeted formal women groups:

- Diversification of food production and consumption through promotion of kitchen gardens and rearing of small livestock such as rabbit and poultry.
- Promotion of increased production of indigenous, drought tolerant and under-utilised foods such as sorghum, millet, sweet potatoes, soybeans, and cassava.
- Food preservation, in particular vegetables and grains.
- Nutrition education and cookery demonstrations utilising the locally available foodstuffs.
- Promotion of women friendly, time saving, and energy efficient technologies and practices.
- Population education – planning families in relation to resources available to households.
- Promotion of rural income generating activities.

1.2 Statement of the Problem

The unreliability of rain experienced in Kieni East division has made the area vulnerable to food insecurity and under nutrition. The Nyeri District Development Plan 1997-2001 noted that despite the low level of malnutrition in the district, Kieni East and West divisions continue to report comparatively high levels of malnutrition, mainly because of drought and low income levels (GoK, 1997). This area mostly relies on drought relief food aid.

At the end of the project (1998), the NDAP reported that it achieved most of its objectives particularly in improving the nutritional situation of the beneficiaries and provision of water (MOALD, 1998). However, impact on nutritional status could not be quantified due to non-availability of baseline data. The report also noted that provision of water led to the shift from subsistence to commercial agriculture whose effect on households' nutrition and food security situation has not been determined. It could be assumed that this may lead to deterioration of the nutrition situation but since this may not be the case, a survey is needed to establish the true situation.

1.3 Main objective of the study

The main objective of this study was to determine the effects of provision of irrigation water on nutrition and food availability in NDAP area.

1.4 Immediate Objectives

1.4.1 To compare agricultural production between project and non-project households.

1.4.2 To investigate whether differences exists in income expenditure patterns in the project and non-project households.

1.4.3 To compare energy adequacy of diets consumed by project and non-project households.

1.4.4 To compare dietary intake of children aged 6-59 months in the project and non-project households.

1.4.5 To compare nutritional status of children aged 6 – 59 months in the project and non-project households.

1.5 Hypotheses

1.5.1 There is no significant difference in nutritional status between project and non-project households.

1.5.2 There is no significant difference in food security between project and non-project households

1.6 Justification of the Study

Provision of irrigation water is more often accompanied by increased level of crop production, which may lead to improved household food and nutrition security. This study aimed at establishing the role of irrigation on improvement of household food security and nutritional status of children in the study area. More often, provision of irrigation water encourages shift from subsistence to commercial farming. Therefore, it was of interest to confirm and also establish the effect of commercial farming on nutritional status, since several studies have conflicting findings, with some suggesting deterioration while others indicate that it has no effect. The study will also provide baseline data on nutrition and food

security situation of the study population, which in future may be, used as a benchmark in designing intervention strategies.

Chapter 2

2.0 Literature Review

2.1 Malnutrition

Malnutrition is defined as the human pathological condition brought about by the inadequacy of one or more of the essential nutrients that the body cannot make but that are necessary for growth and reproduction, capacity to work, learn and function in the society (Berg, 1988). Malnutrition can present itself as primary or secondary malnutrition. Primary malnutrition refers to inadequacies and imbalances in the diet, in either the quantity or quality of foods consumed and it is the major concern in developing countries. Secondary malnutrition on the other hand refers to increased risk of malnutrition from disease and disability e.g. cardio vascular disease, diabetes mellitus etc. (Simko and Cowell, 1984).

The ACC/SCN (2000) report estimated that 32.5 percent of children under five years of age in the developing countries are stunted. Africa had the highest level of stunting (35.2%), followed by Asia (34.4%) and lastly Latin America and the Caribbean (12.6%). The report estimated that of the 182 million pre-school children in the world who are stunted, more than two-thirds (70%) lived in Asia while close to a quarter (24%) lived in Sub-Saharan Africa. There has been no progress in reducing stunting in Eastern Africa during the period 1980 – 2000. The prevalence of stunting in the region increased from 46.5% in 1980 to 47.3% in

1990 and 48.1% in 2000. On the contrary there has been dramatic gains in reducing child malnutrition in South East Asia; where the prevalence of stunting reduced from 52.4% in 1980 to 42.6% in 1990 and further to 32.8% in 2000. A study on child malnutrition in developing countries established that the deteriorating trend in Sub-Saharan Africa is associated with declines in women's relative status, slow progress in improving women's educational attainment, and low per capita food availability and income (Smith and Haddad, 1999).

Similar deteriorating trend was observed in Kenya where the level of stunting slightly increased from 32.7 percent in 1993 to 33 percent in 1998 (NCPD, CBS and MI, 1999). The level of stunting, wasting and underweight in 1998 was reported as 27.5 percent, 5.6 percent and 14.3 percent respectively for Central Province in which the study area is located. This was lower than the national average for stunting (33%), wasting (6.1%) and underweight (22.1%), which could be attributed to a number of factors such as high levels of maternal and paternal education and low poverty levels in the province. The KDHS (1998) report noted that among the rural-based provinces, Central Province had the largest proportion of men and women who have attended secondary school or above. It has been established that maternal and paternal education level has positive effect on child nutritional status (MI, CBS and UoN, 1996). Children of fathers with no education are more likely to be stunted than children of fathers who obtained at least a secondary school education. Although maternal education level is highly

correlated with household income, which also positively affects child nutritional status, it has also been shown that even after holding household income constant, maternal education had a positive effect on child nutritional status (Moore and Favin, 1990). The province is also the least poor in the country, with poverty level estimated at 31.4 percent compared to the national average of 52.3 percent (MOFP, 2000). According to the report, over three quarters (77%) of the population in the province were able to meet the recommended daily allowance of 2250 Kcal per adult equivalent and this could have contributed to low prevalence of stunting.

Nutritional status reflects health of an individual as it results from consumption and utilisation of food in the body. The type and amount of nutrient that is taken into the body and how complete they are used to meet the body needs determine the nutritional status. Nutritional status is influenced by several factors among which, dietary intake, social and economic variables are the most significant predictors of nutritional status. Harper (1984) identified food availability, income levels, education, and food utilisation as the major determinants of nutritional status.

Malnutrition leads to increased susceptibility to infection, higher morbidity and mortality rates, greater demand for health services, and increased medical

expenditures. Other effects of obvious economic importance include low work productivity and diminished intellectual and social competence. Growth failure is mainly due to malnutrition, which may be caused by inadequate food/nutrient intake or by disease state. Thus, results of anthropometry are appropriately used to indicate nutritional status (Alderman and Garcia, 1993). The prevalence of malnutrition in children in the 6-59 months age group is usually used as an indicator for nutritional status of the entire population because this sub-group is more sensitive to nutritional stress.

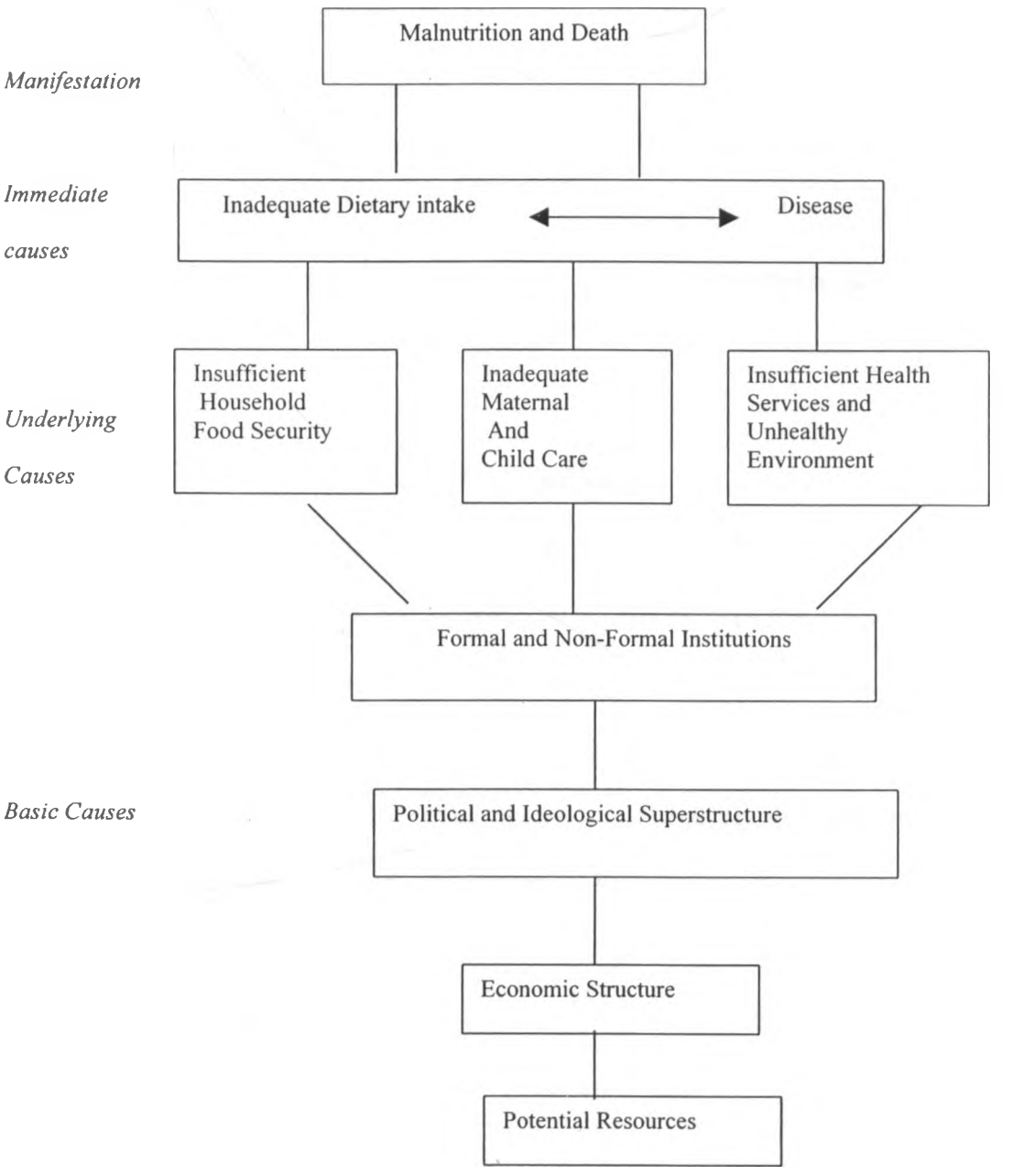
Three anthropometric indices are used in assessment of nutritional status namely height-for-age, weight-for-age and weight-for-height. These use the WHO recommended reference standards, which are based on National Centre for Health Statistics (NCHS) reference children (UN, 1986).

- Stunting refers to shortness that is a deficit in height for a given age. It indicates chronic malnutrition, which is usually associated with long-term factors such as poverty, frequent infections and poor feeding practices. It is defined as low height-for-age at < -2 standard deviations (SD) of the median value of the NCHS/WHO international growth reference.
- Wasting describes a recent and severe process that has produced a substantial weight loss, usually as a consequence of acute shortage of food and/or severe disease. It refers to low weight-for-height at < -2SD of the median value of the NCHS/WHO international weight-for-height reference.

- Underweight is a composite measure of both stunting and wasting, and applies to all children below minus two standard deviation of the NCHS/WHO international reference median weight for age.

The UNICEF conceptual framework as illustrated in Figure 2.1 identifies the immediate causes of malnutrition as poor diet and disease, which result from the underlying causes such as food insecurity, inadequate maternal and childcare, and poor health services and environment (GoK/UNICEF, 1998). The basic causes are social structures and institutions, political systems and ideology, economic distribution, and political resources (Figure 2.1). The problem of malnutrition is thus a multifaceted one and not just a problem of food shortage. Poverty is a primary cause of malnutrition in many countries, hence increasing individual income and purchasing power is regarded as an important prerequisite for improved nutritional status of a community.

Figure 2. 1 The complex causal pattern of malnutrition



Source: GoK/UNICEF (1998)

2.2 Food Security

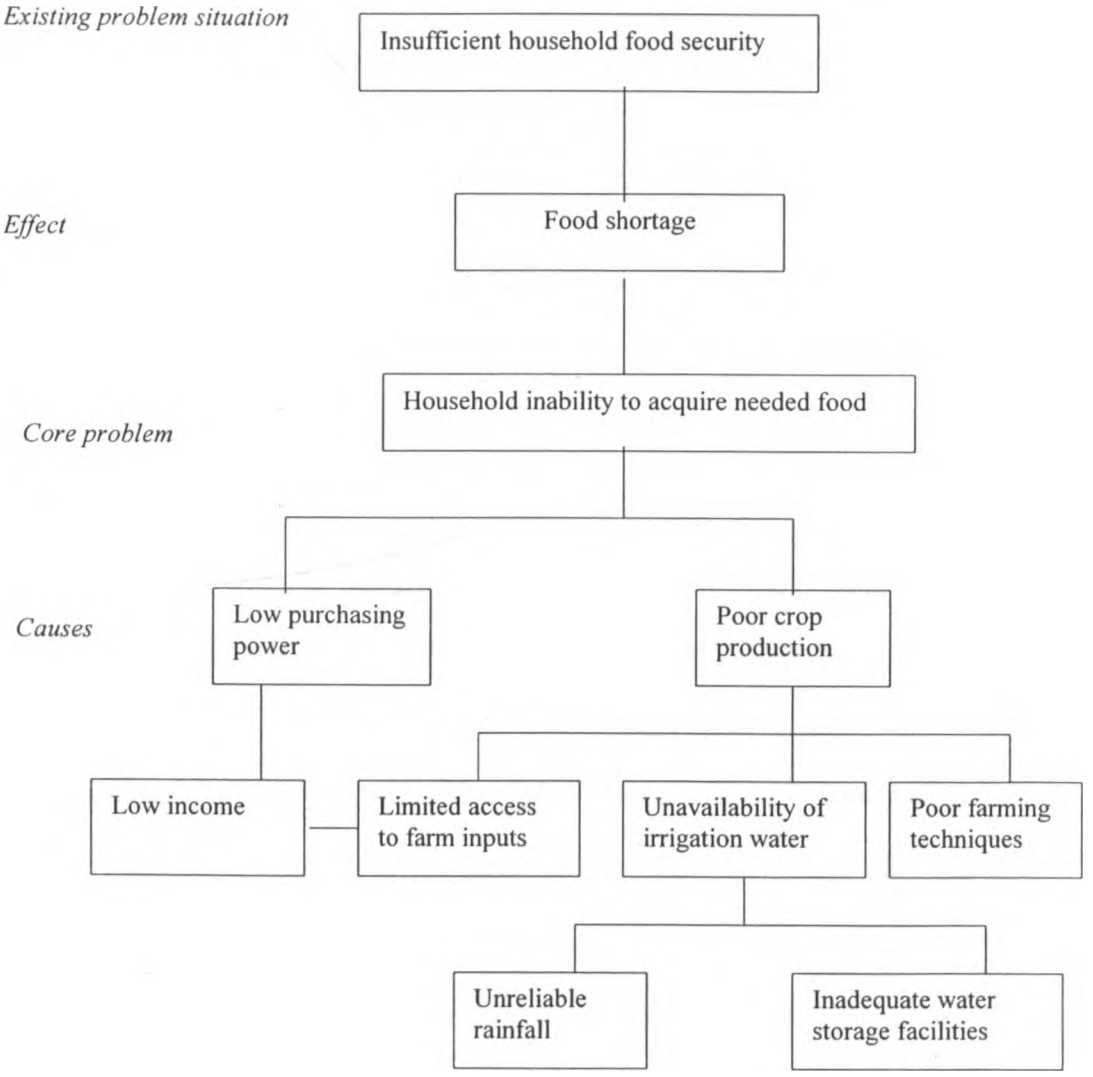
Food security has been defined as access to food that is adequate in quality, quantity, and safety to ensure healthy and active lives for all household members (FAO and WHO, 1992). However, global or national food security does not necessarily ensure household or individual food security. Thus it is the access to food or the household's ability to obtain food that is critical to ensuring household food security.

Food security can be assessed by the degree of adequacy of dietary energy intake (in comparison with appropriate norms) for the health, growth, and activity of all individual members (Gillespie and Mason, 1991). Households that do not satisfy 80 percent of their total dietary energy requirements are considered food insecure, while households whose household dietary energy adequacy ratio (HDEAR) is 0.8 or above are food secure. The other method is based on the proportion of household income spent on food. According to *Engel's law,* the proportion of a household's budget devoted to food declines as household's income rises. Therefore, households which allocate more than 60 percent of the total income on food are considered food insecure while households whose budget allocation on food is less than 60 percent are food secure (GoK, 2000).

Basically there are two types of household food insecurity: Transitory food insecurity results from a temporary decline in household's access to food, due to

instability in production, food prices, or income. Chronic food insecurity on the other hand results from inadequate dietary intake arising from continual inability of households to acquire needed food either through production or purchases. Figure 2.2 presents a problem analysis framework of household food insecurity.

Figure 2. 2 Causes of Household Food Insecurity



Food security though seen as a necessary input for adequate nutritional status is not on its own a sufficient input. It is possible to be malnourished in a food secure household as a result of a disease, inadequate care, or inequitable allocation of food. A household may be food secure in terms of calories, but insecure in terms of micronutrients, thereby rendering its members vulnerable to micronutrient deficiencies. It is also possible for some individual in a food insecure household to be well nourished if they receive preferential food allocation and care at the expense of other members of that household. This is evident in most African communities where the head of the household, usually the man, is served first and with the best portion of the meal at the expense of the other members of the household including the children.

Households may access food through own food production, purchase or remittances. For the rural population, majority of the households depend mainly on their own production for food supply for better part of the year. Therefore, not only is availability of land an important factor in food production but also accessibility of good farmland. The link between access to land and nutritional status is well established (Biswas and Pinstrup-Andersen, 1985). Several studies show that gross consumption of calories and protein intake increase with rising farm size and that most food insecure groups are mainly the low-income

smallholder farmers who have limited access to land, finances and farm inputs (Martorell, 1985; Alderman and Garcia, 1993).

A study on child malnutrition and land ownership in Southern Brazil established that the prevalence of stunting and underweight was higher among children of landless families than children of landed families (Victoria et al, 1986). Similar studies carried out in Sri Lanka (Abeyrathnes and Poleman, 1983) and rural Kenya (Haaga et al., 1986) concurred with the above findings. A study on determinants of child nutritional status in Nepal showed a positive correlation between land ownership and nutritional status (Martorell, Leslie and Moock, 1984).

The nutritional status of the rural population can sometimes be directly linked to the availability of and accessibility of good farmland (UNICEF, 1989). Evidence from Kenya and a number of developing countries indicates that malnutrition tends to be higher in areas with poor soils (Biswas and Pinstrup-Andersen, 1985). This is because in developing countries majority of the population lives in the rural areas, depending directly on agriculture for their food supply, employment and income. Therefore, problems in agriculture and food production have a direct bearing on the household's ability to have sufficient income and consume an adequately balanced diet. The problems could emanate from ecological constraints; rapid population increase, inefficient methods of farming, imbalances between cash and food crops, uneconomical systems of land ownership, poor

transport systems, undeveloped marketing systems, unequal distribution of farm produce and inadequate male contribution to household labour (UNICEF, 1989). Biswas and Pinstrup-Andersen (1985) established that in areas where land is of high quality and can be irrigated or receives adequate rainfall, a farm of less than one hectare can provide (directly or indirectly) an adequate diet for a farm family. On the other hand, where soil quality is low and rainfall erratic even 10 – 50 hectares may be insufficient to guarantee an adequate diet throughout the year. The key inputs of raising land productivity include fertiliser, irrigation and improved crop varieties.

As aforementioned most food insecure groups are mainly the low-income smallholder farmers and consequently have the highest incidence of malnutrition due to their low purchasing power. This is mainly because low income levels limit the kinds and amounts of food available for consumption and increase the likelihood of infection through mechanisms such as inadequate shelter and housing, limited facilities and supplies for personal hygiene, and poor sanitation (Martorell, 1985). For the poorest members of the society the immediate impact of rise in income is increased consumption of food, which helps in overcoming malnutrition particularly where protein and calories are limiting.

In a study carried out in rural Pakistan, Alderman and Garcia (1993) found out that malnutrition in children tends to be more severe in households with lower average

income per capita, and that it would take a thirty- percent increase in income to achieve a ten- percent rise in calories intakes. Bouis and Haddad (1990) in a survey on corn and sugar producing households in Philippines concluded that raising income appears to be a necessary but not sufficient condition for substantially improving nutritional status of pre-school children. This is mainly because increased cash income is not translated into increased food production or consumption or other health benefits.

Three trends are relevant to the relationship between income and diet (Caliendo, 1979). The first trend termed as *Engel's law* observes that as income increases, the proportion of total income spent on food decreases, but absolute expenditures on food rise. The second trend is that the proportion of money spent for different groups of foods varies as income increases, the calories obtained from carbohydrates decrease, and more calories are obtained from high quality carbohydrates from animal and vegetable products. The third trend is that as income rises there is a shift toward the refined, processed, and convenient foods.

In developing countries, absolute poverty is suffered by millions of people. In Kenya, the 1997 Welfare Monitoring Survey established KSh. 1239 (one thousand two hundred and thirty nine shillings) as the absolute poverty line in the rural areas and KSh. 2648 (two thousands six hundred and forty eight shillings) in the urban areas (GoK, 2000). The survey also found out that about 53 percent of households

in the rural area and 49 percent in the urban area have monthly income that are below the respective poverty lines. The National Poverty Eradication Plan 1999-2015 notes that household incomes that fall below the poverty line are insufficient to meet the minimum daily needs for food, shelter, clothing, and other essential non-food items (GoK, 1999).

2.3 Alleviation of Malnutrition

The government of Kenya in collaboration with donor agencies and non-governmental organisation have come up with multisectoral intervention strategies aimed at alleviating malnutrition. These include: improving household food security, preventing and controlling specific micronutrient deficiencies, promoting appropriate diets and promoting breastfeeding.

NDAP is one of the projects in the country making efforts to alleviate malnutrition and improve the standard of living in general, among the rural community. As mentioned in Chapter One, the aim of the project was to increase food production and improve nutritional status of the target population. This was achieved through provision of irrigation water to the project area. Irrigation has been known to significantly increase both the yield of the crops as well as the number of crops that can be grown in a year in areas with good quality soils. Consequently this encourages commercial farming as a way of generating income in households that rely exclusively on farming. Kigutha (1994) observed that irrigation schemes

would go a long way in improving the nutritional status of children, the most vulnerable members of the households, as irrigation water would provided throughout the year for food production.

Although commercialisation of agriculture is seen as the cornerstone of economic development in many developing countries it has had a negative effect on the staple food production as well as food consumption (UNICEF, 1989). Commercialisation of agriculture and in particular export cropping has often been implicated as a cause of poor nutrition. Critics contend that if the resources used to produce agricultural exports were used instead to produce food for local economy, the problem of malnutrition in many countries could significantly be reduced, or even eliminated. The conventional hypothesis states that an increased emphasis on commercial agricultural production leads to a deterioration of household food consumption and poorer nutritional status of children. In a study carried out in the Philippines, Boius and Haddad (1990) established that export cropping could significantly raise the incomes of smallholder producers. The higher profits from sugar production meant that these households could eat more varied diets, provide a better education for their children, enjoy better housing, and gain many other benefits that usually accrue with higher income. Katz (1994) also found out that production of non-traditional export crops in Guatemala had no negative impact on self-sufficiency in basic grains. Kennedy and Cogill (1987) observed similar findings that commercial agriculture led to increase in household incomes in a

study carried out in Kenya. As all the above commercialisation studies have confirmed, poor health and sanitation conditions are a serious constraint to the improved nutrition that increases in income might otherwise have made possible.

In Kenya, people concerned with improving nutrition and health have expressed concern that in areas with increased cash cropping deterioration in household level food security has occurred. Evaluation studies in Kenya have supported this concern and indicated that cultivation of cash crops detracts from food cultivation and this is one of the main causes underlying malnutrition (Hoorweg and Niemeijer, 1989). More often cash cropping is at the expense of food production for family use, moreover the amount of money generated from this shift does not always produce the purchasing and marketing patterns needed to offset the lack of food produced for family consumption (Harper, 1984). On the contrary, Kennedy and Cogill (1987) established that commercial agriculture has no effect on nutritional status.

Concern about possible negative effects of cash cropping on family welfare in Kenya, was reflected in the national food policy paper of 1981, which recommended that particular attention be given to safeguarding the family diet of small farmer who switch from food crop to cash crop production (GoK, 1981). A study carried out in South Nyanza, Kenya found that household energy intake in the sugar farms was not significantly different from that in non-sugar farm

household and there were no differences in the nutritional status or health of young children (Kennedy and Cogill, 1987).

The findings presented above is a clear evidence that information on the effects of commercialisation of agriculture is conflicting, with some researchers suggesting deterioration of nutritional status while others indicate that cropping pattern is not related to nutritional status. Thus conditions prevailing in any area must be studied in order to determine what actions need to be taken to improve nutritional status.

Chapter 3

3.0 Methodology

3.1 Study Setting

Nyeri district is one of the six districts in Central province and is situated between longitudes 36^0 and 38^0 east and between the equator, and latitude 0^0 38' south. The district experiences equatorial type of climate with two rainfall seasons. The long rains occur from March to May and short rains from October to December. Annual rainfall ranges from 500-2300 mm (GoK, 1997).

The study area, Kieni East is one of the seven divisions in the district covering an area of 727 km^2 (22% of the total district area) and is situated in the drier western leeward side of Mt. Kenya. The area lies between 2130-2400 metres above sea level with hill soils that are of moderate to high fertility, but aridity hinders full exploitation of its existing agriculture potential. Rainfall varies with altitude and generally ranges between 500-1200 mm rising to over 2000 mm in the upper areas. However, the rainfall pattern is erratic and is characterised by heavy showers and storms that sometimes cause severe erosion and considerable crop damage. The area has an average daily temperature range of between 16^0 - 27^0 C.

The study area is a recent settlement with a population of 83,635 according to the 1999 Kenya Population and Housing census (GoK, 2001). There are 21738 households with 30% growing high value cash crops such as pyrethrum and

horticultural crops and 40% households with high value food crops such as maize, beans, and Irish potatoes. The area relies heavily on irrigation water for horticultural production. Through the assistance of the NDAP 16 irrigation schemes have been established out of which 5 namely, Kambura-ini, Gitwe, Kirinyaga-Nyange, Narumoro-aguthi and Waraza/Lusoi have been operational for at least five years.

3.2 Research Design

A comparative, retrospective cross-sectional design that was also descriptive and analytical in nature was employed on two sub-samples to compare household food security and nutritional status of children in households with and without access to irrigation water.

3.3 Study Population

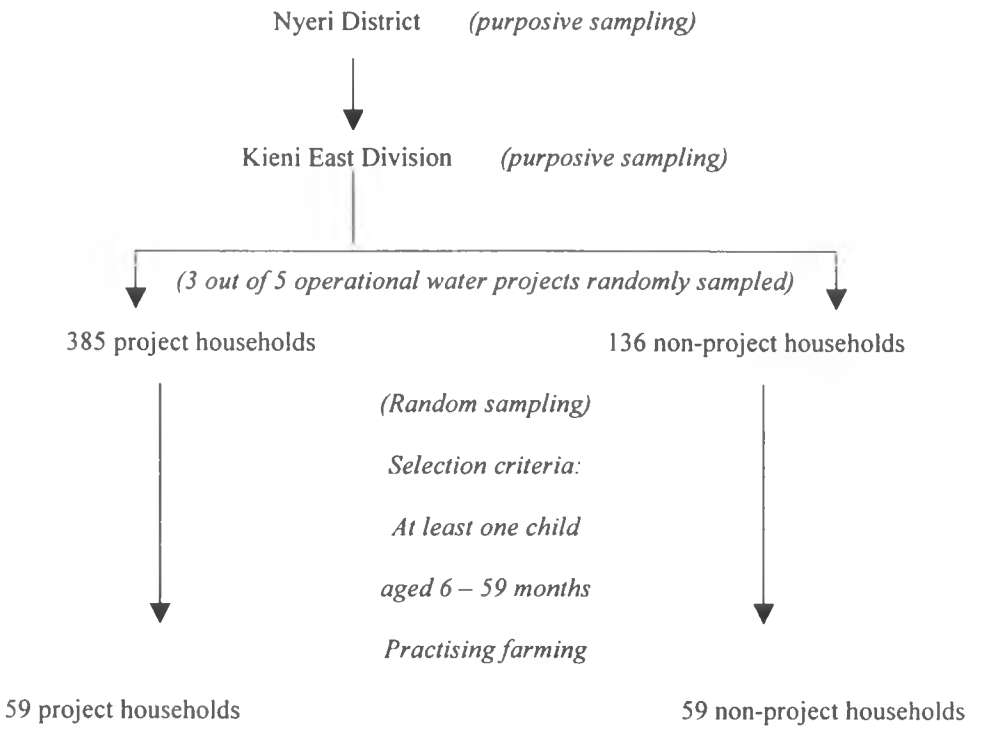
The study population consisted of two group of households. Households with access to irrigation water comprised the study group referred as project households in this study, while households without access to irrigation water made up the comparison group referred to as non-project households.

3.4 Sampling Procedure

A multistage sampling model was employed. NDAP funded the implementation of most of the water projects in the study area and hence the purposive selection of

Kieni East division. Out of the total sixteen water projects that are funded by the NDAP, only five qualified to be included in the study after satisfying the selection criteria of being in operation for at least five years. From these five, three projects, namely Kambura-ini, Waraza-lusoi and Narumoro-aguthi were randomly chosen through lottery. A list of all households, which also indicated whether or not households were connected to irrigation water supply, constituted the sampling frame comprising of 385 project households and 136 non-project households. From this list a total of 59 and 178 non-project and project households respectively satisfied the selection criteria of having at least one child aged between 6 – 59 months and being practising farmers. Subsequently, an equal number of project households (59) were randomly sampled using predetermined sampling interval, in order to have equal sub-samples. The sampling interval was obtained by dividing the total number of households in each area by the number of households to be sampled per village.

Figure 3. 1 Schematic presentation of sampling procedure



3.5 Training of Research Assistants

Several training sessions were organised for the research assistants involved in the study. The training that lasted three days addressed the following areas:

- Interviewing techniques and how to complete the questionnaires.
- Methods used to estimate land size and crop yields.
- How to undertake 24 – hour dietary recall.
- How to take anthropometric measurements. This consisted of a practical session at Narumoro Health Centre where the research assistants were able to take measurements of children who had attended clinic during that day.

3.6 Pre-testing of Questionnaires

The questionnaires, which were written in English and translated to Kikuyu language, were pre tested to ensure understanding and clarity. The investigator and four research assistants carried out the exercise, the latter had undergone a three days training on how to complete the questionnaires and how to take anthropometric measurements. Pre-testing involved 20 purposively selected households from Kirinyaga-Nyange water project, an area with similar geographical characteristics to those of the study area. Based on observations in the field, revisions were made accordingly.

3.7 Data Collection

A structured close-ended questionnaire (Appendix 7) was designed to collect the following information:

- Households' socio-demographic/economic characteristics
- Food production
- Income and expenditure patterns
- 24-hour dietary intake
- Anthropometric measurements

3.7.1 Food Production

Data collected was based on production figures of the period between January to December 2000. Respondents were asked to recall the crops that they had grown during the reference year, area under crop, yields, and amount of yield sold and that consumed at home. To confirm the yields of cereals and pulses, research assistant requested the respondents to measure (using provided containers) crop produce equivalent to amount that was harvested. The measurements were then converted into kilograms using respective conversions (Appendix 1).

To confirm the area under each crop, respondents were asked to state the amount of seeds per crop that they had planted during the reference year. The amounts were then converted into kilograms using respective conversion ratios (Appendix 1). Using the seed rates recommended by the MOALD as illustrated in Appendix 2, acreage under each crop was calculated (MOARD/JICA, 2000 and MOARD, 2001). This method is applied by the MOALD in the monitoring of food security situation in the country (MOARD, 2000).

3.7.2 Household Income and Expenditure Patterns

This encompassed spending and acquisition history of common foods and non-food items by households. Respondents were asked to recall food and non-food

expenditure in terms of quantity and monetary value per week or month. This was then used to estimate annual expenditure of each item for each household.

3.7.3 Dietary Intake

Energy and nutrient intake was determined using the 24-hour recall method, which has been used for years. The method is originally attributed to Wiehl and the technique for administering it is quite simple (Lee and Nieman, 1996). In this method, the mother of the index child or the person who prepared the food was asked to describe all the dishes that were prepared for the child during the previous day or the past 24 hours, as well as the ingredients that were used for each dish. The person was then asked to use the same utensils as in the previous day and measure water equivalent to the amount of ingredients used. The water was then measured using a calibrated jug and readings recorded in millilitres (mls). Similarly, the amounts served to the index child as well as any leftovers were recorded. The amount of leftovers was deducted from the original serving and the child's portion recorded in mls. The measurements were then converted into grams using respective conversion factors in Appendix 3 (King and Burgess, 1993). The nutritive value of all the ingredients used in the preparation of the different dishes and for all the foods consumed by the index child was determined using the national food composition tables developed for Kenya (Sehmi, 1993). The nutrients of interest were energy, protein, iron and vitamin A. The index children's intakes were then compared to the recommended dietary intake (RDI)

for children of the same age group (Appendix 4), in order to determine the level of intake in relation to the RDI (Sehmi,1993).

To determine the total energy available to the household per day, the calories in all the food prepared for the family were standardised by converting into equivalent consumer unit (CU) where one CU is equivalent to an energy standard reference by WHO of 2960 kilocalories per adult equivalent. The energy requirements of individuals in each household were expressed as a ratio of the reference and the total requirements for each household calculated in terms of CUs. The total CUs available to the household were then expressed as a ratio of the total required CUs to obtain the household dietary energy adequacy ratio (HDEAR).

3.7.4 Anthropometric Measurements

3.7.4.1 Weight

Weight was measured according to WHO recommendation to the nearest 0.1kg using SALTER scales with plastic pant, adjusted to zero before every reading (WHO, 1983). The index children wore light clothing. A correction for clothing was made during data analysis by subtracting 150 grams from all children's weight. This weight was arrived at after averaging the weights of light clothes worn by children of different age groups during the survey.

3.7.4.2 Length/Height

Recumbent height of children below two years of age or standing height of those aged two years and above was taken using a standardised length board, which had a fixed head rest and a movable foot piece and placed on a flat surface according to WHO recommendations (WHO, 1983; UN, 1986). The index child wore no shoes. Care was taken to maintain the child's head in an upright position, with legs stretched to a full extent and feet at right angles with legs. The height measurement was recorded to the nearest 0.1cm.

3.7.4.3 Mid-upper Arm Circumference (MUAC)

MUAC was taken using a non-stretchable measuring tape and measurement recorded to the nearest 0.1cm. The circumference of the upper-arm was measured midway between the point of the shoulder and the point of the elbow of the left arm (UN, 1986). The tape was put around the arm so that it fit closely but not so tight that it made folds in the skin.

3.8 Data Management

Weight-for-age, weight-for-height and height-for-age and their corresponding standard deviations (SD) scores, generally referred to as Z score, were calculated using Epi-info computer programme, and compared with those of the NCHS population. A Z score of 2 or –2 meant that the child is 2SD above or 2SD below the median of the respective Z score. WHZ refers to the Z score for weight-for-

height, HAZ refers to Z score for height-for-age and WAZ refers to Z score for weight-for-age. Index children were thereafter classified based on Z-scores as normal (WHZ > = - 2.0 and HAZ >= -2.0), wasted (WHZ < -2.0), stunted (HAZ < - 2.0), or wasted and stunted (WHZ < - 2.0 and HAZ < - 2.0) (WHO, 1995).

MUAC was analysed based on the following cut-offs: children with measurement below 12.5cm were classified as severely undernourished; 12.5 – 13.5cm as moderately nourished and those above 13.5cm as well nourished (King and Burgess, 1993).

3.9 Data Entry and Analysis

Data entry was done through use of ISSA-X computer package and then exported to STATA for Windows version 6.0 where cleaning for any possible inconsistencies was done. On STATA, standard tabulations were formulated and the data was analysed. Calculation of anthropometric indices was done using EPI INFO computer package. Further cleaning through flagging was carried for all Z scores to check on impossible values. No measurements were considered invalid among the three nutritional indices. The statistical paired t-tests and chi-square were used to test the differences between project and non-project households at 0.05 level of significance.

3.10 Data Quality Control

At the end of every day, questionnaires were screened to check for recording errors and completeness. The weighing scales were checked for accuracy, reliability and precision at the beginning of the survey, midway through the survey and before the last week of data collection. This was done by weighing standard weights to ensure that the scales reading coincided with the respective weights.

To reduce the chance of error during collection of data on food consumption, a well-designed form was used (Appendix 7). Editing and error checking routines were observed at the end of every day. Some of the common errors associated with collection of food consumption data include: incorrect identification of food; recording wrong amounts of food; and omission of data on parts of meals, entire meals, or entire day.

Chapter 4

4.0 Benefits of Irrigation on Agricultural Production, Income and Food Security

4.1 Introduction

Agriculture is the backbone of Kenya's economy. About 80 percent of the population rely on it for their livelihood. This proportion of the population depends mainly on their own production for household food supply and therefore any problem affecting food production has a direct bearing on the households accessibility to an adequate balanced diet. Consequently, the nutritional status of the rural population can sometimes be linked to the availability and accessibility to good farmland (UNICEF, 1989).

In Kenya, over dependence on rainfed agriculture is a major problem in food production, but it can be overcome through provision of irrigation water. The study area, Kieni East Division of Nyeri District, is situated in the drier western leeward side of Mt.Kenya and is characterised by erratic rainfall pattern. Although the soils are of moderate to high fertility, the full exploitation of the existing agriculture potential in the division is hindered by aridity. NDAP has since 1991 been assisting the community in this division in development of smallholder irrigation schemes and supporting agricultural extension.

Access to food, which is not only adequate in quantity but also in quality, may result to good nutritional status. Households may acquire food through their own production, purchases or remittances from friends or relatives. For an agrarian population, problems that affect agriculture and food production have a direct bearing on the household's ability to have sufficient income and access to an adequate diet. A household is said to be food insecure when one or more of its potential sources of food are strained or threatened. The purpose of this study was to investigate the effects of provision of irrigation water on household food production and food security in Kieni East Division.

4.2 Results

4.2.1 Social-demographic Characteristics of Survey Households

Findings on socio-demographic characteristics of the survey households showed that the two sets of households were similar in terms of household size, marital status of respondent, maternal and paternal education and occupation (Tables 4.1 and 4.2). Majority of the heads of households (95% in the project area and 88% in non-project area) were male (Table 4.1). There was no significant difference in the average household size, although households in the project area had slightly smaller households (5.0) compared to 5.2 in non-project households. Most of the respondents in the whole sample (90% in the project area and 86% in non-project area) were married.

Table 4.1 Socio-demographic Characteristics of Study Households

Characteristic	Project HH		Non-project HH		Statistical analysis	
	n	%	n	%	p-value	Test
Respondent's sex					0.7	x^2
Male	3	5	4	7		
Female	56	95	55	93		
Sex of Household Head					0.2	x^2
Male	56	95	52	88		
Female	3	5	7	12		
Mean household size	5.0 (1.7)		5.2 (2.1)		0.6	t-test
Marital Status of Respondent						
Married	53	90	51	86	0.7	x^2
Single	3	5	2	3		
Divorced/separated	1	2	3	5		
Widowed	2	3	3	5		

Notes:

The number in parentheses are standard deviations.

X^2 is chi square test

HH refers to household

Data on education showed that in non-project households, the number of mothers of index child who had only completed 1 – 4 years of primary education (16%), was twice that of mothers in the project households, which was 8%, but the difference was not significant (Table 4.2). Close to a half (49%) of mothers from project households had completed between 5 – 8 years of primary education compared to slightly over half (55%) in non-project households, but the difference was not significant

Table 4.2 Percent Distribution of Mother and Father of Index Child by the Highest Level of Education Attained and Occupation

	Project HH		Non-project HH		Statistical analysis	
Characteristic	**n**	**percent**	**n**	**percent**	**p-value**	**Test**
Mother's Education						
Percent ever attended school	59	100	58	98	0.3	x^2
Completed 1-4 of primary	5	8	9	16		
Completed 5 – 8 of primary	29	49	32	55		
Completed secondary school	14	24	11	19		
Not completed secondary school	9	15	6	10		
Post secondary	2	3	0	0	0.4	
Mother's Occupation					0.3	x^2
Farming	55	93	51	86		
Salaried employment	2	3	3	5		
Casual labour	0	0	3	5		
Jua-kali/business	2	3	2	3		
Other	0	0	0	0		
Father's Education						
Ever attended school	51	96	49	96	1.0	x^2
Completed 1 – 4 of primary	1	2	4	8		
Completed 5 – 8 of primary	15	29	22	45		
Completed secondary	22	43	20	41		
Not completed secondary	10	20	3	6		
Post secondary	3	6	0	0	0.04*	
Father's Occupation					0.3	x^2
Farming	17	32	16	31		
Salaried employment	13	25	14	27		
Casual labour	3	6	8	16		
Jua-kali/business	19	36	11	22		
Other	1	2	2	4		

Notes:

X2 refers to chi square test

HH refers to household

* p-value is significant

In the project households, the proportion of fathers of index child (69%) who had attained post-primary education was significantly higher than in non-project households where the number was 31 percent ($p = 0.04$). Further analysis showed that fathers from the project households were 2.5 times more likely to have attained post-primary education than those from non-project households.

4.2.2 Land Ownership

On land availability, majority of the project households (85%) compared to slightly over three-quarter (78%) of non-project households owned less than 3 acres, but the difference was not significant (Table 4.3). There was no significant difference in land size between the two sets of households, although the average acreage for non-project households was slightly higher than that of project households. The average land size of the project households was 2.1 acres (median = 1.75 acres) versus 2.3 acres (median = 1.5 acres) in non-project households.

Information on fertiliser use show that a significantly higher percentage of project households used both fertiliser and manure than did non-project households ($p = 0.0002$). Project households were 4.4 times significantly more likely to use both fertiliser and manure than non-project households. On the other hand, slightly over two fifths (42%) of non-project households compared to about a quarter (24%) of the project households used manure alone. In the two groups of

households fertiliser was mainly used on horticultural crops whereas manure and occasionally fertilisers were used on maize, beans and Irish potatoes.

There was highly significant difference in the number of households practising commercial farming ($p = 0.0002$). About two thirds (66%) of project households compared to close to a third (31%) of non-project households engaged in commercial farming. Project households were 4.4 times more likely to engage in commercial farming than non-commercial farming (odds ratio lies between 2.1 and 9.6 and p-value = 0.0001).

Table 4.3 Percent Distribution of Households by Land Size, Fertiliser Use and Type of Farming

Variable	Households		Statistical analysis	
	Project N=59	Non-project N=59	p-value	Test
Land Size			0.3	chi-square
Less than 3 acres	85	78		
More than 3 acres	15	22		
Mean Acreage	2.1 (1.8)	2.3 (2.1)	0.7	t-test
Median	1.75	1.5		
Fertiliser Use			0.0002*	chi-square
Fertiliser only	7	17		
Manure	24	42		
Fertiliser and manure	68	32		
None	1	8		
Type of farming			0.0002*	chi-square
Commercial	66	31		
Non-commercial	34	69		

Notes:

The numbers in parentheses are the standard deviations

*p-value is significant

4.2.3 Crop Production

Crop production in the study area had greatly been affected by drought that the area had experienced since 1998. There had been shortage of irrigation water as a result of declining water levels in the rivers, which resulted in water rationing. It was reported that the last time the area had a substantial harvest was in 1997. Therefore, crop production figures of the reference year, 2000, were lower than expected.

Table 4.4 Distribution of Households by Crops Grown

Household growing crop (% of total HH)	Project Households N = 59	Non-project Households N = 59
Maize	97	95
Beans	93	88
Potatoes	81	86
Cabbage	29	5
Carrot	7	0
Onions	7	2
Tomatoes	5	2
Snowpea	34	2
Other	0	8

Majority of project and non-project households mainly grew maize, beans and potatoes (Table 4.4). Cabbages were grown by slightly over a quarter (29%) of project households while slightly over a third (34%) grew snowpea[1]. A few

[1] Snowpea is a type of vegetable whose pods are eaten green before seeds are formed. It is mainly grown for export.

project households grew other horticultural crops such as carrots, onions and tomatoes.

Table 4.5 presents the area devoted to various crops. The mean acreage of any of the crops was small, ranging from 0.2 to 1.1 acres. Greater emphasis on subsistence crops was apparent in both study households. There were no significant differences in areas devoted either to maize or beans or potatoes although non-project households allocated slightly larger area per crop.

Table 4.5 Mean Acreage Devoted to Crops by Households.

Crops	Area devoted to crops (acres)		Statistical analysis	
			p-value	CI
	Project Households	Non-project Households		
Maize	1.0 (0.7)	1.1 (0.9	0.3	0.9 – 1.2
Beans	0.6 (0.6)	0.8 (0.9)	0.2	0.5 – 0.8
Potatoes	0.4 (0.5)	0.5 (0.4)	0.8	0.4 – 0.5
Cabbages	0.6 (1.4)	0.5 (0.5)	0.9	-0.03 – 1.2
Carrots	0.2	0	NA	
Onions	0.2	0.1*	NA	
Tomatoes	0.2	0.1*	NA	
Snowpea	0.3	0.1*	NA	

Notes:
The numbers in parentheses are standard deviations
*Only one observation
NA means not applicable
CI = confidence interval

Data on yields per acre is presented in Figure 4.1. There were no significant differences in the yields per acre of beans and potatoes in the two areas, although the project households harvested beans about double the amount harvested by non-project households. However, maize yields were significantly higher in the project households than in non-project households ($p = 0.05$).

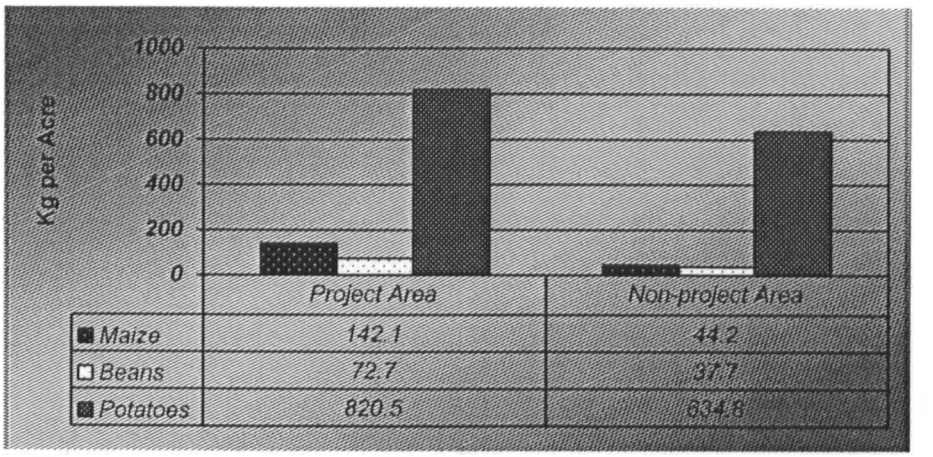


Figure 4. 1 Average Yields per Acre by Area

Slightly more than two thirds (67%) and slightly more than three-quarters (79%) of project and non-project households respectively, who had planted maize reported no yields at all (Table 4.4). About a half of the households who had planted beans in the project area and close to two thirds (65%) in the other area

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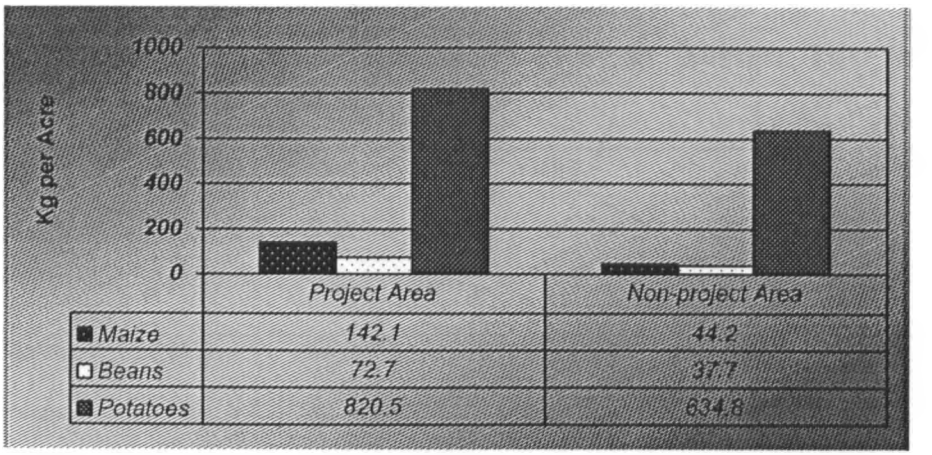

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recorded nil yields. However, there was no significant difference in the number of households who reported no maize and bean yields between the two groups.

As expected, significantly more project than non-project households reported that they harvested potatoes during the year of reference (p = 0.03). It was also noted that the project households were 2.4 times more likely to realise potato yields than non-project households (odds ratio lies between 1.08 – 5.99 and p-value=0.03).

Table 4.6 Distribution of Households by Crop, Number That Planted and Realised Yields

Crops	No of HH that Planted		Yields		No Yields		
	P	NP	P	NP	P	NP	p-value
	n	n	n	n	n	n	
Maize	57 (97)	56 (95)	19 (33)	12 (21)	38 (67)	44 (79)	0.2
Beans	55 (93)	52 (88)	22 (40)	18 (35)	33 (60)	34 (65)	0.6
Potatoes	48 (81)	51 (86)	32 (67)	23 (45)	16 (33)	28 (55)	0.03*

Notes:

The numbers in parentheses are percentages

Chi-square test is used to test that odds ratio = 1

*p-value is significant; Odds ratio =2.43 and 95% confidence interval (1.08, 5.99)

NP refers to non-project

P refers to project

n = number of households

HH refers to household

Non-project households sold slightly more than a quarter (27%) of the maize produced as compared to only 8 percent sold by the project households. In both sets of households only a small percentage of beans was sold, about 14 percent and

5 percent per acre in project and non-project households respectively. About a quarter of potatoes harvested were sold by the project households area versus close to a half (45%) in non-project area. However, there were no significant differences in amount of the three crops sold between the two types of households (Table 4.7).

The study established that the two groups of household left most of the produce of maize, beans and potatoes for home consumption. There was no significant difference in produce left for own consumption, although non-project households left slightly more than project households. There was no significant difference in the number of households in which maize, beans and potatoes lasted until the next harvest season. About two fifths of the project households compared to slightly over a quarter of non-project households reported that their maize lasted to the next harvest season.

4.2.4 Livestock Production

Data on livestock production is presented in Table 4.8. There were no significant differences in the number of households keeping any of the three types of livestock between the two areas. The average milk and egg production per annum in the non-project households was higher than in the project households but there was no significant difference.

Table 4.7 Mean Yield per Acre, Amount Sold and Percent Kept for Own Consumption and Percent of Food Self-Sufficient Households

Description	Project HH	Non-project HH	Statistical Analysis p-value	CI
Yields (kilogram per acre)				
Maize	142.1 (348.1)	44.2 (136.1)	0.05*	43.5 – 143.6
Bean	72.7 (163.3)	37.7 (82.1)	0.2	30.6 – 80.8
Potatoes	820.5 (1320.7)	634.8 (1482.9)	0.5	445.1 – 1004.6
Amount sold (kilogram per acre)				
Maize	11.8 (45.0)	12.1 (90.2)	1.0	- 1.3 – 25.1
Bean	10.5 (36.3)	1.8 (8.0)	0.09	1.1 – 11.4
Potatoes	207.9 (607.5)	286.6 (1261.0)	0.7	50.0 – 446.9
HH whose produce last to next harvest (% of total HHs growing the crop)				
Maize	40 (49.4)	29 (45.8)	0.2	25.5 – 43.6
Beans	38 (48.9)	35 (48.0)	0.7	26.8 – 45.5
Potatoes	36 (48.6)	34 (47.9)	0.8	25.4 – 44.7
Produce kept for home consumption (% of total production)				
Maize	88.7 (20.2)	93.8 (21.7)	0.5	83.1 – 98.2
Beans	89.0 (20.9)	94.4 (14.1)	0.4	85.6 – 97.2
Potatoes	81.8 (33.3)	81.8 (31.7)	1.0	73.1 – 90.5

Notes:

The numbers in parentheses are standard deviations

Statistical t-tests are used to compare differences between the means in the two areas

CI refers to confidence interval.

HH refers to household.

* p-value is significant

Table 4.8 Annual Livestock Production by Area, 2000

Description	Project area	Non-project area	Statistical analysis	
			p-value	CI
Cattle				
HH keeping cattle (% of total HHs keeping livestock)	66	63	0.7	56.0 – 73.0
Mean number of animals	2.8 (1.9)	2.5 (1.7)	0.4	2.2 – 3.1
Mean milk production (kilogram per animal)	1235.3 (842.3)	1671 (971.2)	0.07	1193.6 – 1669.4
Milk sold (% of total production)	30 (33.1)	38 (30.8)	0.3	25.0 – 41.6
Milk kept for consumption (% of total production)	69 (33.7)	61 (30.9)	0.3	56.8 – 73.6
Chicken				
HHs keeping chicken	71	59	0.2	57.0 – 74.0
Mean number of birds	10.0 (10.4)	8.0 (7.1)	0.3	7.0 – 11.1
Mean egg production (egg per bird)	125.8 (86.9)	131.7 105.3)	0.8	104.8 – 152.5
Eggs sold	22.2 (30.4)	23.4 (32.7)	0.8	14.9 – 30.7
Eggs kept for consumption	77.8 (30.4)	74.9 (32.7)	0.7	68.5 – 84.3
Sheep				
HHs keeping sheep	41 (49.5)	32 (47.1)	0.3	27.6 – 45.3
Mean number of animals	3.9 (3.0)	6.3 (6.8)	0.1	3.4 – 6.6

Notes:

The numbers in parentheses are standard deviations.

Statistical t-tests are used to compare the differences in livestock production between the two areas.

CI = confidence interval

HH refers to household

4.2.5 Income

4.2.5.1 Sources of Income

Apart from farming, the other sources of income in the study area are salaried employment, casual work and business. Close to a quarter (24%) of the two types of households reported salaried employment as a source of income (Table 4.9). Significantly more non-project households engaged in casual work ($p = 0.02$). There was no significant difference in the number of households that reported business as a source of income, although more project households (37%) than non-project households (31%) operated small business/juakali.

Table 4.9 Distribution of Households by Source of Income

Source of Income	Households				Statistical Analysis	
	Project		Non-project		p-value	CI
	n	%	n	%		
Salaried Employment	14	24	14	24	1.0	15.9 – 31.5
Casual Labour	13	22	25	42	0.02*	23.6 – 40.8
Business/ *Jua-kali*	22	37	18	31	0.4	25.2 – 42.6

Notes

Chi-Square was used to test the difference

CI – Confidence Interval

* p-value is significant

4.2.5.2 Income Levels

Table 4.10 shows percent distribution of households by income group and type of farming. Slightly less than a fifth (19%) of project households and close to a

quarter (24%) of non-project households were below the rural poverty line (below Ksh.1240), although the difference was not significant. However, when the households were classified according to the type of farming, the percentage of households below poverty line was significantly higher in non-commercial farming households (31%) than in commercial farming households, where this was 11 percent (p = 0.01).

Table 4.10 Percent Distribution of Households by Income Group and Type of Farming

Households/Type of Farming	Income Level	
	Below Poverty Line	Above Poverty Line
Households		
Project	19	81
Non-project	24	75
p-value = 0.5		
Type of Farming		
Commercial	11	89
Non-commercial	30	67
P = 0.01*		

Notes:

Chi square test was used to compare the differences between groups.

* p-value is significant

4.2.5.3 Income Expenditure

Table 4.11 presents the mean annual food and non-food expenditure by type of households. There was no significant difference either in the mean expenditure or

the percent expenditure. The two types of households spent slightly over half of the total budget on food (52% by non-project households and 51% by project households).

Table 4.11 Mean Annual Expenditure by Households

Area/statistical analysis	Food		Non-food	
	Expenditure	Percent	Expenditure	Percent
Households				
Project	40632.6	51	54281.6	49
Non-project	40214.7	52	44157.5	48
p-value	0.9	0.9	0.6	0.9
Confidence interval	34399.7 – 46424.1	47.8 – 55.4	30960.1 – 67117.5	44.6 – 52.2

Notes:

Statistical t-tests were used to compare the differences between the two areas.

Data on Table 4.12 shows that non-project households spent a larger percentage (11.6%) of the total budget on cereals and grains than the project households, which spent 7.8%. This was also the case with pulses and tubers where non-project households allocated more money than project households. On the other hand, project households spent significantly more money on milk (13.0%) than non-project households, which spent 8.1% (p-value = 0.02).

The mean annual non-food expenditure is shown in Table 4.13. Project households allocated a relatively higher proportion of the total budget (17.5% and about KSh. 16652)) to farming than non-project households, where the proportion was 11% and about KSh. 9239, although there was no significant difference between the two areas.

Table 4.12 Mean Annual Food Expenditure by Selected Food Groups

Food Group	Project HH Expenditure		Non-project HH Expenditure		Statistical analysis p-value	CI
	Ksh	percent	Ksh	percent		
Cereals and Grains	7441.9	7.8	9826.5	11.6	0.5	5464.4 – 11889.1
Roots and Tubers	5195.8	5.5	5219.2	6.4	1.0	3461.0 – 6954.5
Pulses	4755.6	5.0	5541.7	6.5	0.6	3573.7 – 6819.4
Vegetables	3033.5	3.2	2969.4	3.7	0.9	2288.7 – 3721.6
Fruits	2202.2	2.3	3410.4	3.9	0.4	1406.7 – 4302.8
Meat	3814.1	4.0	3194	3.6	0.5	2465.9 – 45.2.6
Milk	12181.3	12.8	6826	8.1	0.02*	7042.5 – 11672.7
Fats and oils	2420.2	2.6	2515.7	3.0	0.8	2006.8 – 2932.5
Sugar	4285.1	4.5	3893.4	4.4	0.7	3004.1 – 5140.3

Notes:

Statistical t-tests are used to compare the differences in food expenditure between the two areas.

CI refers to confidence interval

Expenditure is inclusive of food items produced by households.

* p-value is significant

There were no significant differences in amount of money spent on anyone non-food category between the two sets of households. As expected, project households spent more money (1.8 times) on farming than non-project households.

Table 4.13 Mean Annual Non-food Expenditure by Area

	Project area Expenditure		Non-project area Expenditure		Statistical analysis	
Non-food item	(KSh)	percent	(KSh)	percent	p-value	CI
Education	11747.0	12.4	7182.3	8.5	0.3	5495.8 – 13519.6
Farming	16651.9	17.5	9238.9	11.0	0.3	5352.7 – 20403.3
Fuel	4461.3	4.7	6849.4	8.1	0.1	4095.9 – 7300
Clothes	5937.5	6.3	6604.2	7.6	0.7	4150.0 – 8391.5
Household goods	4134.6	4.4	4648.8	5.5	0.7	2784.9 – 6026.6
Health	3826.7	4.0	2346.3	2.7	0.4	1171.9 – 5001.0
Transport	4728.7	5.0	8122.3	9.3	0.3	3263.7 – 9795.1
Family events	5815.0	6.1	2860.9	3.3	0.4	994.1 – 7415.6

Notes:

Statistical t-tests are used to compare differences in non-food expenditure between the two areas.

Households goods include items such as soap, petroleum jelly, lotion and toothpaste

Family events include all get together parties or welfare groups where household make contributions in cash

4.2.6 Food Security

In order to determine energy adequacy of diets consumed by study households, energy intake and requirements were calculated in terms of calories per adult equivalent. This method is most appropriate because it takes into consideration specific caloric requirements for each age and sex. In the two groups of households, the mean energy adequacy was well above 100 percent. However about a quarter of project households compared to close to a third (33%) of non-project households were below 80 percent of caloric requirement, although the difference was not significant (Table 4.14).

A slightly higher percentage of non-project households (28%) spent more than 60 percent of income on food compared to close to a quarter (22%) of project households.

When households were categorised by type of farming, the study found out that non-commercial farming households were 2.6 times more likely to spend a larger proportion of income on food than commercial farming households, but the difference was not significant. This indicates that commercial farming households are more likely to be food secure than non-commercial farming households.

Table 4.14 Distribution of Households by Measure of Food Security and Type of Farming

	Measure of Food Security			
	Income spent on food		Energy adequacy	
Household/Type of farming	> 60%	< 60%	< 80%	> 80%
Household				
Project	22	77	25	75
Non-project	28	72	31	69
p-value	0.6		0.6	
confidence interval	13.3 – 36.7	63.3 – 86.7	18.5 – 36.5	63.4 – 81.5
Type of farming				
Commercial	17	83	25	75
Non-commercial	34	66	30	70
p-value	0.1		0.6	
confidence interval	13.3 – 36.7	63.3 – 86.7	18.5 – 36.5	63.4 – 81.5

Notes:

Statistical t-tests are used to compare the difference in food security between the two areas and also between types of farming

4.2.6.1 Food Security Coping Strategies

The food security coping strategies applied by the households included food purchase, casual work, remittance from relatives and famine relief food. Purchasing of food was considered as a coping strategy only when staples, pulses and vegetables were purchased to offset shortage caused by insufficient own food production. Most households (86% in the project area and 83% in non-project area) indicated that they purchased food when they did not have enough food from own production (Table 4.15).

Table 4.15 Food Security Coping Strategies by Type of Household

			Statistical analysis	
Strategy	**Project HH**	**Non-project HH**	**p-value**	**CI**
Purchase	86	83	0.6	78.2 – 91.3
Casual labour	15	21	0.1	13.7 – 28.7
Remittances from relatives	12	10	0.8	5.3 – 16.7
Famine relief food	17	31	0.08	15.9 – 31.5

Notes:

CI = confidence interval

Statistical t-tests were used to compare the differences between the two areas.

4.2.7 Summary of Findings

- Project households are twice more likely to have harvested potatoes.
- Project households had significantly higher maize yields.

- A significantly higher proportion of the project households used both fertiliser and manure in crop production.
- On the other hand a significantly higher percentage of non-project households used only manure.
- Non-project households are more likely to engage in casual work as a means of earning a livelihood.
- A significantly higher proportion of non-commercial households had income below KSh. 1240, which is the poverty line for rural areas in the country.
- In either project or non-project households, about half of the total budget was spent on food.
- Project households spent significantly more money on milk.
- A higher percentage of the project households and commercial-farming households were food secure than were non-project households and non-commercial farming households respectively.
- Irrigation and commercial farming had positive influence on household food security.

4.3 Discussion of Results

The average household size of both the project households (5.0) and non-project households (5.2) is higher than the national average of 4.5 and that of Central Province (3.9) reported in the 1999 Kenya population and housing survey. Considering that the study area is arid or marginal area, the average land size of

2.1 acres in the project area and 2.3 in non-project area may be insufficient in providing adequate food and income for an average household size of five members. This is evident from the fact that only 40 percent of the project households and 29 percent of non-project households are self sufficient in maize, which is the staple food in the area. This seems to support the findings by Lynman (1979), that farmers in marginal areas and with land size less than five acres have difficulties in providing adequate food for home consumption. In a study in Nakuru district, Kigutha (1995) established that land size less than three acres was inadequate to meet the food needs of an average household. In 1973 the World Bank had estimated that in Central Province (Kenya), an average family size of 6 members that relies exclusively on farm production requires about 7.9 acres of high quality land to provide adequate food and income (World Bank, 1973).

Irrigation is a major input in increasing crop yields alongside use of fertiliser, pesticide and improved seed varieties (Biswas and Per Pinstrup-Andersen, 1985; Smith, 1986). This could be the reason why project households compared to non-project households are four times more likely to use both fertiliser and manure. Also, a household is more likely to recover money used to purchase fertiliser, when relying on irrigated agriculture than on rainfed agriculture since one is more certain of a harvest. On the other hand, non-project households would rather use manure, which is cheaply available to them, than spend more in order to purchase

fertiliser for yields that may never be realised, given that in this area rainfall is unreliable.

Irrigation encourages households to shift from subsistence to commercial farming. Households are able to grow high value crops, mainly horticultural crops that have high gross margins thereby generating income. As mentioned in Chapter three, the study area has soils of moderate to high fertility, which if irrigated can allow double or triple cropping hence utilising the available land optimally. The most commonly grown horticultural crops are cabbages and snowpea. This is due to the fact that the two crops have ready market and good returns, especially if planting is timed such that harvesting coincides with a period when demand is high. However, project households are unable to take full advantage of the ready market because of the limiting land sizes and unreliability of irrigation water. The average acreage devoted to anyone horticultural crop was small ranging between 0.2 to 0.6 acres. It was noted that due to unpredictability of rainfall, non-project households do not grow crops that are very sensitive to water stress, such as horticultural crops and hence have relatively few crops that compete for the small land size unlike the project households.

The impact of irrigation on food production in the study area may be understated, given that the reference year was a drought period. This affected irrigation water availability, resulting in water rationing and consequently unreliability of water,

particularly to project households located far from the water catchment area. However, inspite of unreliable irrigation water, project households were twice as likely to realise potato yields than non-project households were, emphasising the importance of irrigation water. Also, the fact that yields per acre of maize in the project area were significantly higher than in non-project area indicates the importance of irrigation and fertiliser in crop production.

In livestock production, the study established that irrigation has no significant influence on the mean milk and egg production. This could be attributed to the great emphasis on horticulture by project households and thereby allocating more land to crop production and leaving little land that cannot sustain livestock. Since horticulture is both time and labour intensive, it is likely that livestock get less attention due to the fact that horticultural crops have better returns. Moreover it appears that the study households keep livestock mainly for subsistence purpose, given that most of the eggs and milk produced is consumed at home. The lower milk production in the project households could have resulted to a deficit in supply of milk for family consumption forcing the households to spend more money than non-project households to offset the milk shortage.

The main sources of income in the study area include farming, casual labour, salaried employment and business or *jua-kali*. This study established that significantly more non-project households than the project households reported

casual work as a source of income. Non-project households unlike the project household do not grow any short period maturing crop and consequently have low labour demand, hence offer casual labour mostly to project households, in order to generate the badly needed fast cash. Snowpea, which is grown by about a third of the project households requires intensive labour throughout the growing and harvesting period, ensuring availability of regular casual work.

Commercial farming does not only increase household income but is also seen as the cornerstone of economic development in many developing countries (Kennedy and Cogill, 1987; UNICEF, 1989). This is supported by the findings of this study, which show that a significant number of commercial farming households had average monthly income above Ksh 1240, which is the rural poverty line according to the 1997 KWMS (GoK, 2000). Households that have income below the poverty line are unable to access the minimum requirement of food and essential non-food commodities. A study carried out in South-western Kenya found that commercial households had significantly higher incomes than non-commercial farming (Kennedy and Cogill, 1987). This concurs with findings of a study carried out in the Philippines that export cropping can significantly raise the incomes of smallholder farmers (Bouis and Haddad, 1990).

The mean annual non-food expenditure by the project households is higher than that of non-project households. Mwadime (1992) and Kennedy and Cogill (1987)

observed similar findings. Provision of irrigation water encourages growing of horticultural crops, which require more capital than growing of subsistence crops, and it is also labour intensive. Consequently, project households allocate more money on farming than non-project households. Furthermore, with reliable irrigation water, households are certain of high yields and they can risk investing substantially in farming.

A household is said to be food secure if it meets 80% or more of its total dietary energy requirement. For an agrarian population, problems that affect agriculture have a direct bearing on the household's ability to have sufficient income and consume adequate diet (UNICEF, 1989). The study area is a marginal area and had experienced drought prior to survey period, which resulted to irrigation water rationing and in most households consequent crop failure. This affected not only crop production, but also household income; hence the findings of this study could have underestimated the impact of irrigation. Rationing of irrigation water not withstanding, three quarters of project households were food secure emphasizing contribution of irrigation in sustaining household food availability. There was marginal difference in the number of households spending more than 60 percent of income on food between commercial and non-commercial farming households. This could be explained by the fact that significant number of commercial farming households had higher income than non-commercial farming households, thereby allocating smaller proportion of income on food. This follows Engel's law, which

states that "as income increases, the proportion of total income on food decreases" (Caliendo, 1979). However, since there was no significant difference in household food security between commercial farming households and non-commercial farming households the second hypothesis of this study is accepted. That is there is no significant difference in food security between project and non- project households.

Chapter 5

5.0 Role of Irrigation on Improvement of Nutritional Status of Young Children

5.1 Introduction

Irrigation is a major input in increasing crop yields especially in areas with good quality soils, which subsequently leads to either, increased household income and/or improved household food availability. In households where the resultant increase in yields or income is used to meet the dietary needs, improved nutritional status results. The previous chapter established that irrigation in the study area has resulted to improved crop production and higher income. Chapter 5 investigates the role of irrigation on improvement of nutritional status of young children.

Prevalence of malnutrition in 6 – 59 months age group is usually used as an indicator for nutritional status of the entire population, because this sub-group is more sensitive to nutritional stress. Nutritional status is determined using height-for-age, weight-for-age and weight-for-height indices. In developing countries, stunting affects about a third of the children below five years of age. In Africa, the prevalence of underweight and wasting has been reported to be 29.1% and 9.6% respectively. The highest levels of stunting are observed in Eastern Africa; where on average 48.1 percent of pre-school children are affected (ACC/SCN, 2000). In Kenya, the prevalence of stunting has been reported to be 33%, wasting 6% and underweight 22% (NCPD, CBS and MI, 1999). Central Province where the study

area is located has lower prevalence (28% stunted; 6% wasted and 14% underweight) than the national figure. The Nyeri district development plan reported that the prevalence of malnutrition in the study area could be worse due to the fact that it is arid and characterised by erratic rainfall pattern (GoK, 1997). However no data was available on the prevalence of malnutrition in the semi-arid and arid areas in the district.

5.2 Results

5.2.1 Dietary Intake

The mean daily energy and protein intake of the index children is presented in Table 5.1. There were no significant differences in energy and protein intake either between the two areas or between commercial and non-commercial households. On average, all children had higher energy and protein intakes except for children (12 – 23 months) from non-project households whose energy intake was below the recommended daily intake. The mean energy and protein intake of children (24 – 35 and 35 – 59 months age group) from non-project households was higher than that of children from project households.

Table 5. 1 Mean Energy and Protein Intake by Age Group

Age in Months	Energy (kcal)		Statistical analysis		Proteins (grams)		Statistical analysis	
	Project	NP	p-value	CI	Project	NP	p-value	CI
* 6 – 11	-	-	-	-	-	-	-	-
12 – 23	1317.1	1121.4	0.4	1007.4 – 1431.1	46.4	41.5	0.5	36.0 – 51.9
	(552.7)	(622.8)			(18.8)	(25.3)		
n	16	16						
24 – 35	1488.4	1818.0	0.2	1365.1 – 1870.7	51.5	59.1	0.4	46.4 – 62.5
	(565.8)	(750.2)			(19.8)	(22.3)		
n	17	11						
36 – 59	1858.3	1861.3	1.0	1618.6 – 2101.2	64.5	64.9	1.0	55.4 – 73.9
	(954.8)	(704.9)			(37.4	(26.1)		
n	22	25						

Notes:

* n was 3 in either of the study area.

The numbers in parentheses are standard deviations

CI refers to confidence intervals

Statistical t-tests are used to compare the means of each nutrient in the two areas.

Table 5.2 presents the mean iron and vitamin A intake and shows that on average all the children in the two areas consumed diets higher in vitamin A and iron than the RDI. Children below two years of age and from non-project households had higher Vitamin A intake than children of the same age from the project households. The mean intake of iron of children from project households was

higher than that of children from non-project households except for children in the 36 – 59 months age group.

Table 5. 2 Mean Intakes of Iron and Vitamin A by Age and Area

Age in months	Vitamin A (RE)		Statistical analysis		Iron (milligram)		Statistical analysis	
	Project	NP	p-value	CI	Project	NP	p-value	CI
6 – 11	638.0	645.1			16.0	7.4		
	(74.1)	(197.2)	1.0	501.7 – 781.4	(10.3)	(4.0)	0.3	2.9 – 20.6
12 – 23	395.6	521.8			15.7	13.9		
	(457.3)	(478.9)	0.5	291.2 – 626.5	(7.2)	(8.1)	0.5	12.1 – 17.5
24 – 35	912.4	622.6			19.7	19.2		
	(1007.4)	(656.3)	0.4	455.7 – 1141.4	(11.7)	(8.9)	0.9	15.4 – 23.6
36 – 59	743.8	732.3			21.9	22.6		
	(567.3)	(604.5)	0.9	567.0 – 908.2	(14.1)	(11.5)	0.8	18.6 – 26.0

Notes:
The numbers in parentheses are standard deviations
NP refers to Non-project.
CI refers to confidence interval
RE is retinal equivalent
Statistical t-tests are used to compare nutrient intake in the two areas

Slightly more than two fifths (42%) of all children from non-project households who were under five years of age compared to 39 percent of all children from the project households had energy intakes below the RDA (Figure 5.1). Incidentally, a higher proportion of children from the project households had vitamin A intake below the RDA.

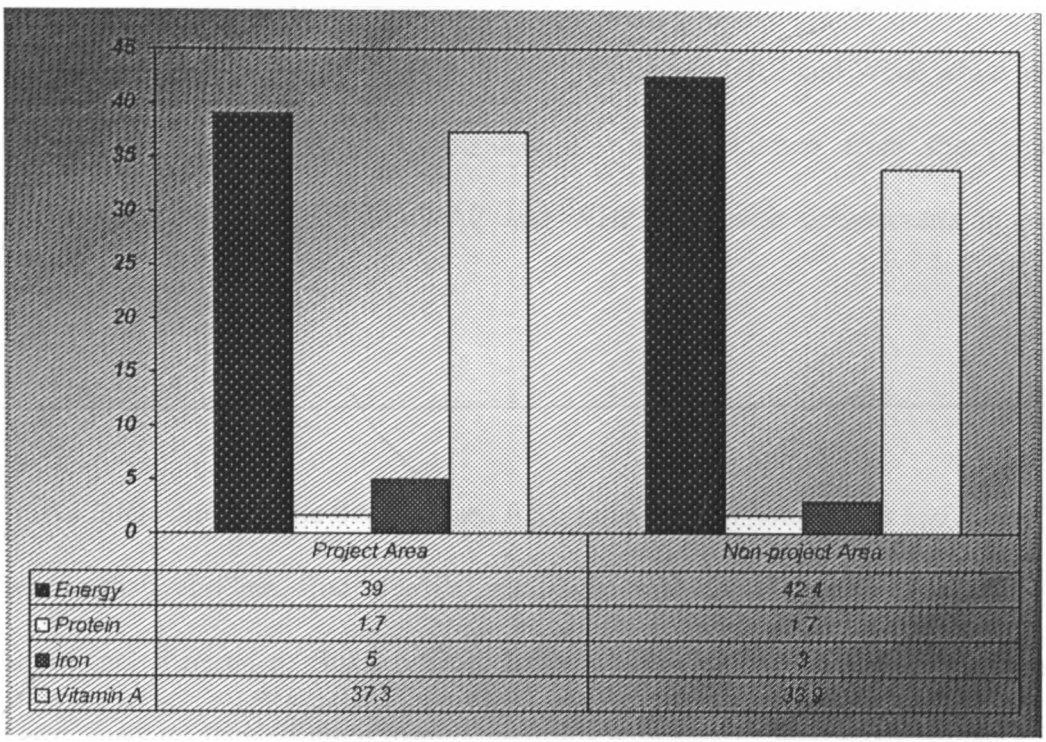

Figure 5. 1 Percent Distribution of Children Aged 6 – 59 months With Energy and Nutrient Intake Below RDA

5.2.2 Nutritional Status of Children 6 – 59 months

Data on Table 5.3 show that on average, children from the project households had higher HAZ, WHZ and WAZ, although there were no significant differences. When the study households were categorised by type of farming, children from commercial farming households in the project area had significantly higher WAZ ($p = 0.05$). Also, children from project households with income above the rural poverty line had significantly higher HAZ than those from non-project households ($p = 0.04$).

There were no significant differences in any nutritional indicators between female and male children although female children had higher HAZ and WHZ while male children had higher WAZ (Appendix 5). Male children from the project households had higher HAZ, WAZ and WHZ than their counterparts in non-project households.

It was interesting to note that children from male-headed households had higher Z-scores than children from female-headed households. Although there was no significant difference, children from households with bigger land holdings had better Z-scores than children from households with smaller land sizes. Irrespective of land sizes, children from project households had better mean Z-scores suggesting that irrigation has some influence on the nutritional status though not significant.

Table 5. 3 Mean Z-scores by Area, Type of Farming, Income Level, Sex of Index Child and Land Size

	HAZ		WAZ		WHZ	
Variable	**Project**	**NP**	**Project**	**NP**	**Project**	**NP**
Household	-0.65	-0.99	-0.43	-0.7	0.05	-0.01
	(1.3)	(1.4)	(1.0)	(1.2)	(1.1)	(1.2)
Type of Farming						
Commercial	-0.73	-1.0	-0.42[a]	-1.03	0.11	-0.45
	(1.4)	(1.2)	(1.2)	(0.9)	(1.1)	(0.9)
Non-commercial	-0.5	-0.99	-0.45	-0.55	-0.07	0.19
	(1.3)	(1.5)	(0.8)	(1.3)	(0.7)	(1.3)
Income Level						
Below KSh.1240	-0.93	-0.13	-0.68	-0.67	-0.06	-0.63
	(1.5)	(1.8)	(1.0)	(1.5)	(1.0)	(1.1)
Above or Equal to KSh.1240	-0.59[b]	-1.2	-0.37	-0.72	0.08	0.12
	(1.3)	(1.2)	(1.1)	(1.1)	(1.0)	(1.1)
Sex of Index Child						
Male	-0.7	-1.0	-0.3	-0.83	0.19	-0.24
	(1.2)	(1.0)	(1.0)	(0.9)	(1.1)	(0.8)
Female	-0.6	-0.97	-0.59	-0.57	-0.11	0.24
	(1.5)	(1.8)	(1.1)	(1.4)	(0.9)	(1.6)
Land Size						
Less or Equal to 3 acres	-0.69	-1.1	-0.5	-0.8	0.02	-0.001
	(1.4)	(1.4)	(1.1)	(1.2)	(1.0)	(1.3)
More than 3 acres	-0.4	-0.5	-0.1	-0.4	0.22	-0.02
	(0.8)	(1.4)	(0.9)	(1.3)	(0.8)	(0.9)

Notes:

Statistical t-tests are used to compare the difference in mean z scores between the two areas.

The numbers in parentheses are standard deviation.

[a] p-value = 0.05.

[b] p-value = 0.04.

NP refers to Non-project area

The prevalence of stunting and underweight, which are long-term measures of nutritional status, was higher in non-project households than in the project households but the difference was not significant (Figure 5.2).

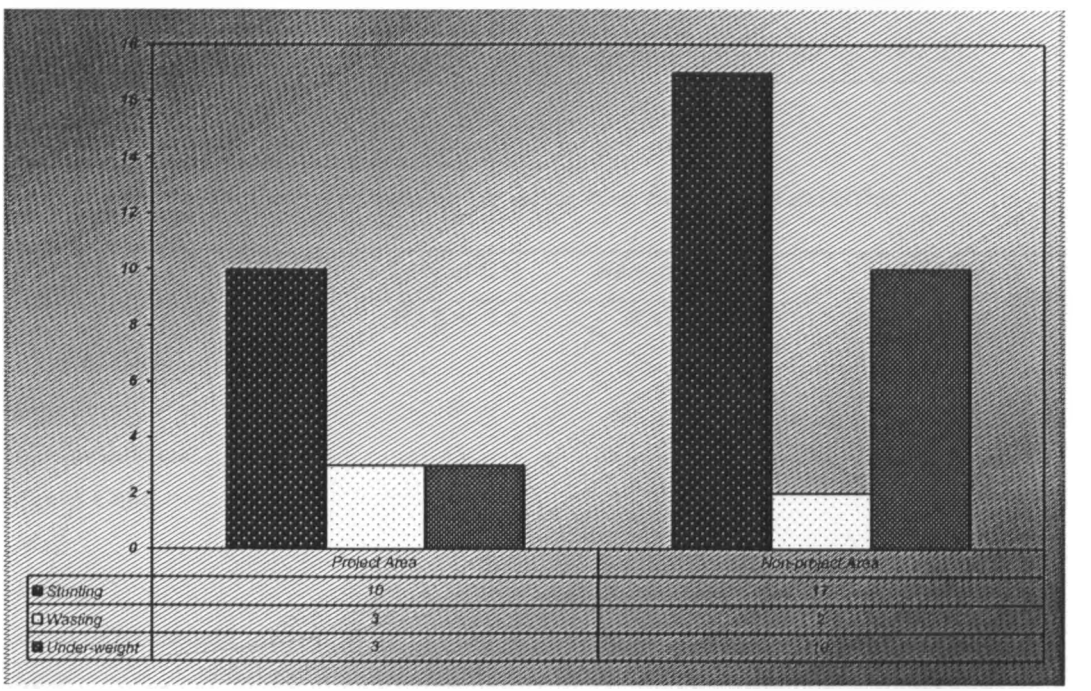

Figure 5. 2 Prevalence of Stunting, Wasting and Under-weight

There were no significant differences in the prevalence of stunting or wasting or underweight in the two areas (Appendix 6). The prevalence of wasting among children from households with income below the rural poverty line was significantly higher than that of children from households with income above

poverty line (p = 0.05). Although there were no significant differences, the prevalence of stunting and underweight were higher among children from low-income households than among children from high-income households.

Table 5.4 shows that a slightly higher percentage of children from non-project commercial farming households were stunted. Also, the prevalence of stunting was significantly lower in the higher-income project households (p = 0.02).

Table 5. 4 Prevalence of Stunting by Area and Selected Variables

Variable	Project HH	Non-project HH	p-value
	HAZ < -2.0	HAZ < -2.0	
Type of Farming			
Commercial	8	22	0.1
Non-commercial	15	15	1.0
Sex of Child			
Male	9	13	0.6
Female	11	21	0.3
Head of Household			
Male	9	15	0.3
Female	33	29	0.9
Land Size			
Less or equal to 3 acres	12	20	0.3
More than 3 acres	0	8	0.4
Income Level			
Below Poverty Line	36	0	0.02*
Above Poverty Line	4	20	0.02*

Notes:
* p-value is significant

Data in Table 5.5 shows that the prevalence of underweight was significantly higher among male children from non-project area than those from the project households ($p = 0.03$). Although there were no significant differences, the proportion of children who are underweight is slightly lower in the project households among the selected variables.

Table 5. 5 Prevalence of Underweight by Area and Selected Variables

Variable	Project Households WAZ < - 2.0	Non-project Households WAZ < - 2.0	p-value
Type of Farming			
Commercial	3	11	0.2
Non-commercial	5	10	0.5
Sex of Child			
Male	0	13	0.03*
Female	7	7	0.9
Head of Household			
Male	4	8	0.4
Female	0	29	0.3
Land Size			
Less or equal to 3 acres	4	11	0.2
More than 3 acres	0	8	0.4
Income Level			
Below Poverty Line	9	14	0.7
Above Poverty Line	2	9	0.1

Notes:
* p-value is significant

5.2.3 Summary of Findings

- Slightly over two fifths (42%) of children from non-project households compared to 39% from the project households consumed calories below the RDA.
- Children from commercial farming households in the project area had significantly higher WAZ
- Children from high-income project households had significantly higher HAZ.
- The prevalence of stunting was significantly lower in project households with higher income.
- The prevalence of wasting was significantly higher in low-income households than in high-income households.
- Irrigation has positive influence on the nutritional status of young children.

5.3 Discussion of Results

The findings of this study clearly show that the average calorie and nutrient intake of children under five years of age were above the RDA. However, the mean energy intake of children (12 – 35 months) from non-project households was lower than the RDA. This could probably be due to the fact that, in most households, children of this age are commonly fed from the family dish, which may not provide them with adequate calories. Moreover, family dish comprised of a mixture of maize, beans and occasionally potatoes and this is typically a diet high in bulk, which is not only of poor digestibility but also highly unpalatable to these

children. Furthermore young children with limited stomach capacity are unable to consume sufficient quantities of such food to meet their energy and nutrient requirements.

This study established that irrigation has no significant influence on dietary energy intake of pre-school children. However, this may not be the case since the drought experienced in the study area during the reference year adversely affected household food availability and this could have resulted to low calorie intake. It can also be argued that project households could not realise good yields of horticultural crops due to unreliability of irrigation water and therefore had limited economic returns. Subsequently less income was available to purchase food in order to offset the lack of food produced for family consumption. Another explanation could be that income earned from sale of cash crops was not necessarily used to meet the households' dietary needs. Therefore, there is need for further research in order to establish the true situation.

A higher proportion of children from the project households had lower vitamin A intake than the RDA compared to children from the non-project households. The most plausible explanation is that project households normally grew vegetables (which are good sources of vitamin A) mainly for sale thereby leaving little or none for home consumption. A good number of project households grew snowpea, which even though it is a source of vitamin A, it was not consumed at

home. This is an export crop and rural households do not have knowledge on its preparation method. In fact most homemakers reported that snowpea that is rejected by the buyer is usually used as livestock feed.

Although the prevalence of underweight and stunting among children in the project households was lower, the fact that there were no significant differences indicates that provision of irrigation water per se does not have a significant influence on nutritional status. Therefore, the first hypothesis of this study that states that "there is no significant difference in the nutritional status between project and non-project households" is valid. However there is need for further investigation on the role of irrigation on nutritional status, because the findings of this study could have underscored the importance of irrigation given that drought that was prevalent in this area adversely affected availability of the water. This consequently had negative impact on crop yields as well as household income and hence affected household food availability. The prevalence of stunting was higher in non-project households while the proportion of children who were wasted was higher in the project households, concurring with findings by Matsvimbo (1997).

The prevalence of stunting and underweight (which are long-term measures of nutritional status) were lower among children from commercial farming households than non-commercial farming households. There were no significant differences between type of farming and nutritional status. Kennedy and Cogill

(1987) observed similar findings that commercial agriculture has no effect on nutritional status. These findings contradict the conventional hypothesis that increased emphasis of commercial farming lead to poorer nutritional status of children.

Interestingly, children from male-headed households had better Z-scores than children from female-headed households. This is contrary to findings by Kennedy and Cogill (1987) that children from female-headed households do significantly better on both HAZ and WAZ. This could be attributed to the small number of female-headed household in the study sample, which was three of the project households and seven of non-project households.

The link of access to land and nutritional status is well established, with prevalence of stunting and underweight being higher among children of landless households than children of landed households (Biswas and Pinstrup-Andersen, 1985; Victoria et al., 1986; Haaga et al., 1986). In this study, the prevalence of wasting, stunting and underweight was higher among children from households with less land. Also, the average Z-scores of all the three nutritional indicators were lower in households with less land. The importance of irrigation on improvement of nutritional status is once again noted in that irrespective of land size, children from project households had better Z-scores.

The study found that the prevalence of wasting was significantly higher in low-income households. This supports the findings by Martorell (1985) that low-income smallholder households have the highest incidence of malnutrition because low-income levels limit the kinds and amount of food available for consumption by households. Alderman and Garcia (1983) also found out that malnutrition in children was more severe in households with lower average per capita. This is in line with the findings of this study that the prevalence of wasting, stunting and underweight was higher in households with income below poverty line. According to the 2000 Kenya Economic Survey, households with income below the poverty line are unable to access the minimum requirement of food and essential non-food commodities.

When study households were categorised by the level of income, children from higher-income project households had significantly higher HAZ and also the prevalence of stunting in this category was significantly lower. Since households in the same income bracket were considered, it implies that there could be factor(s) other than income that affected nutritional status in the two groups of households. The problem analysis framework of household food insecurity illustrated in chapter 2, identified poor crop production and low purchasing power, as the causes of inability of households to acquire needed food. But the high-income households had the same purchasing power, meaning that the difference could only have been caused by food production levels. As aforementioned in chapter 4, food production

was higher in project household due to availability of irrigation water, which could have resulted to high per capita food availability and subsequently improved nutritional status. Smith and Haddad (1999) identified low per capita food availability as one of the factors associated with child undernutrition in Sub-Saharan Africa.

Chapter 6

6.0 Conclusion and recommendations

6.1 Conclusion

The findings of this study indicate that irrigation is a key input in increasing crop yields in arid and semi-arid areas. In the project households, increase in crop yields subsequently led to improved household food availability and/or higher incomes.

Research results do not allow a definite conclusion to be drawn regarding the role of irrigation on the nutritional status of young children. However, it is clear that irrigation has safeguarded the nutritional status of young children because children from the project households were better off.

1. Provision of irrigation water positively influence crop yields particularly when combined with good crop husbandry practices. Project households were twice as likely to realise potato yields than non-project households. The yields in the project households could have been much higher, were it not for unreliability of irrigation water.

2. Improved food production and higher incomes in the project households could have enhanced food availability at household level ensuring adequate intake of dietary energy.

3. Project households grew vegetables mainly for sale and they also lacked knowledge on the utilization of some of the vegetables such as snowpeas. This is likely to have had a negative impact on vitamin A and iron intake of pre schools children.

4. Irrigation has encouraged commercial farming and this has led to higher household incomes and a higher likelihood of sustaining households above the Kenyan rural poverty line (Ksh 1240).

5. The improvement of income in commercial farming households has contributed to improved household food security.

6. Project households are food secure enabling them to allocate higher proportion of their income to non-food items such as farming and education.

7. Irrigation has contributed to improved household food availability thereby safeguarding the nutritional status of young children.

6.2 Recommendations

1. The water project management committee should mobilise the households to ensure that irrigation water is available throughout the year, in order to maximise the potential benefit of irrigation on crop production and nutritional status of young children.

2. Non-project households should apply appropriate technologies to harness the available water to irrigate home gardens and small, but intensive vegetable plots.

3. All households should be trained on utilisation of snowpea and other under-utilised micronutrient-rich local foods in order to encourage their consumption at household level.

4. Kitchen gardening should be promoted, particularly in the project households where more children consumed diets with lower vitamin A and iron than RDA. Since in project households most vegetables are grown for sale, this would ensure that households have some vegetables for home consumption.

5. Micro-irrigation techniques such as drip irrigation alongside soil and water conservation measures should be promoted in the study area. This will ensure efficient utilisation of the available water.

6. Food preservation should be encouraged during peak seasons to ensure year round food availability.

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Appendices

Appendix 1 Equivalent Weights of Commonly Used Containers

Container	Weight in Kilograms
2 kg Kimbo tin of cereals or grains or pulses	2
1 debe of cereals/grains/pulses	16
1 bag of cereals/grains/pulses	90
1 bag of potatoes	130
1 bag of cabbage	126
1 bag of carrots	138
1 box of tomatoes	64
1 carton snowpea	2.5

Appendix 2 Seed Rates for Selected Crops

Crop	Seed Rate	
	Kg/ha	Kg/acre
Maize	25	10
Beans		
Pure stand	110	45
Intercrop	100	40
Potatoes	2000 - 2400	800 – 960
Cabbages	300	121
Carrots	5.5	2.2
Onions	3	1.2
Tomatoes	150 - 200	61 – 81
Snowpea	50 - 60	20 - 24

Source: MOARD/JICA (2000) and MOARD (2001)

Appendix 3 Equivalents Weights and Volumes of Foods

Food	Weight of food (grams) in 100ml
Cereals flours	59
Stiff porridge	100
Soft porridge	100
Raw rice	85
Potato raw diced	63
Beans/peas raw	80
Cabbage raw shredded	30
Green leaves raw chopped	31
Onions raw chopped	68
Tomato sliced	77
Banana mashed	95
Pawpaw mashed	100
Sugar	83
Meat mince/ground	95
Milk fresh	100
Margarine	95
Oil	88

Source: King and Burgess (1993)

Appendix 4 Daily Requirements of Energy, Protein, Iron and Vitamin A for Different Age Groups

Age (months)	Energy (kcal)	Protein (g)	Iron (mgs)	Vitamin A (RE)
0 – 11	820	13.5	5 –10	300
12 – 23	1150	13.5	5 –10	250
24 – 35	1350	15.5	5 – 10	550
36 – 59	1550	17.5	5 - 10	300

Source: Sehmi, J.K. (1993)

Appendix 5 Mean Z-scores by Selected Variables

Variable	Weight-for-Age	Height-for-Age	Weight-for-Height
Area			
Project	-0.43 (1.0)	-0.65 (1.3)	0.05 (1.1)
Non-project	-0.7 (1.2)	-0.99 (1.4)	-0.01 (1.2)
p-value	0.2	0.2	0.8
Confidence interval	-0.77- -0.36	-1.08 - -0.57	-0.18 - -0.23
Type of farming			
Commercial	-0.6 (1.1)	-0.81 (1.3)	-0.07 (1.1)
Non-commercial	-0.5 (1.1)	-0.83 (1.5)	0.11 (1.1)
p-value	0.7	0.95	0.4
Sex of index child			
Male	-0.55 (1.0)	-0.85 (1.1)	-0.02 (1.0)
Female	-0.58 (1.3)	-0.79 (1.6)	0.07 (1.3)
p-value	0.9	0.8	0.6
Sex of household head			
Male	-0.51 (1.1)	-0.81 (1.3)	0.08 (1.1)
Female	-1.1 (1.6)	-1.01 (2.0)	-0.60 (1.0)
p-value	0.1	0.7	0.07
Land size			
Less than or equal to 3 acres	-0.63 (1.1)	-0.9 (1.4)	0.01 (1.2)
More than 3 acres	-0.27 (1.1)	-0.5 (1.2)	0.08 (0.9)
p-value	0.2	0.2	0.8
Income			
Below Ksh 1240	-0.7	-0.5	-0.4
Above or equal to Ksh 1240	-0.5	-0.9	0.1
p-value	0.6	0.2	0.05*

Notes:

The numbers in parentheses are standard deviation.

Statistical t-tests are used to compare the difference among the means of the nutritional indicators and anyone variables

* p-value is significant

Appendix 5 Percentage of Children Between 6-59 Months Below Common Cut-offs for Nutritional Status by Area, Type of Farming, Sex of Index Child and Land Size

Variable	n	Underweight	Stunted	Wasted
Area				
Project	59	3	10	3
Non-project	59	10	17	2
p-value		0.1	0.3	0.6
Type of farming				
Commercial	57	5	12	4
Non-commercial	61	8	15	2
p-value		0.5	0.7	0.5
Sex of index child				
Male	62	6	11	2
Female	56	7	16	4
p-value		0.9	0.5	0.5
Land size				
Less than or equal to 3 acres	96	7	16	3
More than 3 acres	22	5	5	0
p-value		0.6	0.2	0.4
Income				
Less than Ksh 1240		12	16	8
More than or equal to Ksh 1240		5	12	1
p-value		0.3	0.6	0.05*

Notes:

Statistical t-tests are used to compare the difference in the two areas.

* p-value is significant

Appendix 6 Questionnaire

HOUSEHOLD FOOD SECURITY AND NUTRITION SURVEY

KIENI EAST DIVISION

NYERI DISTRICT

Household's background information

Location ..... ☐ Sub-location .....

Water scheme ..... ☐ Household number ☐☐☐

Respondent's Name ---------- Sex: Male = 1, Female = 2 ☐

Marital status ☐

1= Married, 2 = Single, 3 = Separated/Divorced, 4 = Widowed

Name of Household head ---------- Sex: Male = 1, Female = 2 ☐

Name of Interviewer ---------- Date / /

Now I would like some information about the people who usually live in your household or who depend on head of household. *(Interviewer: record Head of household in line No.1 and mother of the index child in line No. 2)*

Line No. (1)	**Name of household member** (2)	**Sex** 1 = male 2 = female (3)	**Age in years** (4)	**Relationship to head of household** * (5)
01				
02				
03				
04				

* Codes for Q. 5: Relationship to head of household

01 = head
02 = spouse
03 = son or daughter
04 = son-in-law or daughter-in-law
05 = grandchild
06 = parent
07 = parent-in-law
08 = brother or sister
09 = other relative
10 = adopted/foster/step child
11 = not related
98 = don't know

6. Did you ever attend school? ☐

1 = Yes
2 = No (skip to Q. 8)

7. What is the highest level you attended? ☐

1 = Completed 1-4 of primary
2 = Completed 5-8 of primary
3 = Completed secondary
4 = Not completed secondary
5 = Post secondary
6 = Adult education
98= don't know

8. What is your main activity? ☐

1 = Farming/ housewife
2 = Salaried employed
3 = Casual labourer
4 = *Jua-kali*/ business
96 = Other (specify) _____

(Check the marital status of respondent, if not married skip to Q 12, if married then ask)

9. Did your husband ever attend school? ☐

1 = Yes
2 = No (skip to Q.11)

10. What is the highest level he attended? ☐

1 = Completed 1-4 of primary
2 = Completed 5-8 of primary
3 = Completed secondary
4 = Not completed secondary
5 = Post secondary
6 = Adult education
98 = don't know

11. What is your husband's occupation? ☐

1 = Farmer

2 = Salaried employed

3 = Casual labourer

4 = *Jua-kali*/ business

96=other (specify) _____

Water availability

12. What is the main source of water for this household? ☐

1 = Piped water

2 = River/Spring

3 = Well

4 = Rain water

13. How long does it take you to get there, get water, and come back?

Minutes

------ Km

0 = on premises

14. Do you use the water to irrigate your crops? ☐

1 = Yes

2 = No

15. How reliable is the water supply? ☐

1 = reliable (skip to Q.17)

2 = slightly reliable

3 = unreliable

16. If 2 or 3, for how many months in a year is the water not reliable?

Months

Food production

17. What is the size of your land?

	Land size in acres
Owned	.....
Rented	.....
Others	.....
Total	.....

Now I would like some information on crop production in the past one year

Crop	Total area (acres)	Yields	Amount sold	Amount kept for own consumption	
		Kg KSh	Kg KSh	kg KSh	Does the produce last to next harvest? 1 = Yes 2 = No
	(18)	(19)	(20)	(21)	(22)
Maize					
Beans					
Potatoes					
Cabbages					
Carrots					
Onions					
Tomatoes					
Snowpea					
Other (specify)					

23. Do you use fertiliser and /or manure for your food production? ☐

1 = Fertiliser

2 = Manure

3 = Fertiliser and manure

4 = None

24. Do you cultivate crops only meant for sale? ☐

1 = Yes

2 = No (skip to Q.27)

If Yes, Which crops and how much land is usually allocated to each?

Crop **(25)**	**Acreage** **(26)**

27. Apart from own production how else do you obtain food for your household?
(Interviewer: code accordingly)

Food source	**1 = Yes** **2 = No**
Purchase from the market	
Casual work	
Remittances from relatives	
Famine relief food	

28. Do you keep livestock? ☐

1 = Yes

2 = No (skip to Q.33)

Now I would like some information about the livestock you have kept in the past one year?

Livestock (29)	Number (30)	Production (31)		Amount (32)	
		No. of animals	Average production	Consumed	Sold

Income and expenditure

33. Apart from farming what are the other sources of your household income?

(Check by ticking applicable source to the household)

Sources	Check
1 = Salaried employment	
2 = Casual labour	
3 = Business/*Jua-kali*	
96 = Other (specify)	

34. How much is the monthly income for your household? ☐

1 = Less than 1,240 shillings

2 = Over 1,240 shillings

98= Don't know

35. What amount of household income per month is allocated to:

(Expenditure on food items includes all food purchased and home produced)

Food items	**Expenditure per year (KSh)**			**Non-food items**	**Expenditure per year (ksh)**
	Own Prodn.	**Purchased**	**Total**		
Cereals and grains				Education	
Root and tubers				Farming	
Pulses				Fuel	
Vegetables				Clothes	
Fruits				Supplies and household goods	
Meat				Health expenses	
Milk				Transport	
Fats and oils				Family events	
Sugar					

24 -Hour Dietary Recall

(Record the following information for the index child - the youngest child in the household

aged between 6-59 months)

36. Name of the index child .....

Sex : Male ☐ Female ☐ Age ☐ months

37. What foods has (name) eaten in the last 24 hours?

(Include food and beverage: start with the last thing (name) ate or drank and go back in your recall for the past 24 hours).

Time	Dish	Total Vol. of dish	Ingredients		Amt. Served to child (a)	Amt. Left over by child (b)	Amt. Consumed by child (a-b)
			Name	Amt(ml)			

38. Was this day's food and beverage intake typical? ☐

1 = Yes (skip to Q.40)

2 = No

39. What was the difference from (name) usual pattern of food consumption?

_____

_____

Anthropometric measurements

Now I would like to take the height, weight and arm circumference measurements of (name of the index child).

40. Anthropometric measurement for the index child

Line No. Child's name…

Sex: Male ☐ Female ☐ Date of Birth / / /

Age------ Months Date of weighing / / /

1st Weight (0.1 kg) ---------- 1st Height (0.1 cm) ----------

2nd Weight (0.1 kg) -------- 2nd Height (0.1 cm) ----------

MUAC (0.1mm) ----------