UTILISATION OF SMALL GRAIN CEREALS AND THEIR CONTRIBUTION TO THE PROTEIN AND ENERGY INTAKES OF CHILDREN AGED 6-59 MONTHS IN YATHUI DIVISION, MACHAKOS DISTRICT, KENYA.

BY

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DECLARATION

I, Mary Mutete Muema hereby declare that this dissertation 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 parents, Reuben and Grace Muema for sacrificing so much for my education and giving me the best foundation in life. To my husband Judah Mualuko, and our children, David, Titus, Janet and Faith for their support, patience, endurance and encouragement throughout the period.

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ABSTRACT

A cross sectional study which was descriptive in nature was carried out during the month of September, 2004 among households with children aged 6-59 months in Kiunduani and Itumbule sub-locations of Kibauni location, Yathui division, Machakos district. The main objective of the study was to determine the factors associated with production and utilization of small grain cereals and their contribution to the protein and energy dietary intakes of children aged 6 to 59 months.

The principal tool of investigation was a structured questionnaire that was administered to mothers or children care takers. Methods used were anthropometric measurements and dietary intake recall. Purposive sampling was done at District and Division levels whereas simple random sampling was done at location and sub-location levels. Systematic sampling was done at household level giving a sample size of 260 households. The inclusion criteria was a child aged between 6-59 months. In households with more than one child at this age category, only one child was picked randomly as the index child. A sub sample of 36 households was randomly selected for the 24-hour dietary recall. Data was collected with the assistance of five field assistants. The SPSS computer package was used for data entry and analysis. Nutritional status indices such as weight-for-age, height-for-age and weight-for-height were computed using the Epi-info program.

The findings of the study indicate that there was no significant difference in production and utilization of small grain cereals in households headed by people aged more than fifty years and those headed by people aged below fifty years. The same was realized when the male and female headed households were compared indicating that the production and utilization

of small grain cereals is not determined by age or the sex of the heads of the households. However, mean acreage of sorghum (0.4) was higher than that of finger millet (0.2).

Energy intake from sorghum/finger millet was significantly low (y-error bars not overlapping) only among study children aged 36-59 months. This could be attributed to the fact that as the children grow older, they take less porridge and hence less of the small grain cereals. Protein intake from other foods by the study children was significantly higher than that from sorghum and millets except for children aged 12-35 months. This could probably be because of the fact that these children are within the weaning period.

There was no significant difference ($p>0.05$) in malnutrition rates among study children in households which mixed the small grain cereals with other foods and those in households where mixing was not practiced.

Finally, a significant relationship was noted between wasting, underweight and the sorghum/finger millet calorie and protein intakes by the study children whereas stunting did not show any relationship with the same. However, no significant difference was observed in malnutrition of the study children among households that produced the small grain cereals and those which did not produce.

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DEFINITION OF TERMS

Definitions

Indigenous food plants

Indigenous food plants are those which are native to a particular area.

Focus Group Discussion

A non- randomly selected group of people brought together to discuss and explore a limited number of defined topics.

Traditional Food Plants

Traditional food plants are those which are accepted by a community through custom, habit and traditional as appropriate and desirable for consumption. People are used to them. Prepare them and enjoy eating the dishes containing them.

Food Security

Food security is defined as access to sufficient, safe and nutritious food to meet the dietary needs of all members of the household and food preference for an active and healthy life at all times. (FAO, 2005).

Household

A household is a group of people who may be related by blood or not but share food from the same pot.

Utilization

Utilization is the act of using something.

Abbreviations

A.E.Z	–	Agro Ecological Zones
AIDS	–	Acquired Immune Deficiency Symptoms
ASAL	–	Arid and Semi Arid Lands
CBO	–	Community Based Organization
CDC	–	Center for Disease Control
FA	–	Field Assistant
FAO	–	Food and Agriculture Organization of the United Nations
G.O.K	–	Government of Kenya
HFA	–	Height for Age
hh	–	household
M.O.A	–	Ministry of Agriculture
NCHS	–	National Center for Health Statistics
NGOs	–	Non Governmental Organizations
N.D.P	–	National Development Plan
PEM	–	Protein Energy Malnutrition
RDAs	–	Recommended Daily Allowances
PEM	–	Protein energy malnutrition
SPSS	–	Statistical Package for Social Scientists
WHO	–	World Health Organization
WFA	–	Weight for Age
WFH	–	Weight for Height
UNICEF	–	United Nations Children's Emergency Fund

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CHAPTER 1

1.0 INTRODUCTION

1.1 Background Information

It is a global concern that native or traditional indigenous foods are disappearing. These include the small grain cereals, mainly millet and sorghum grown in Kenya and other countries in the semi – arid tropics (SAT).The disappearance of these crops might bring unacceptable effect on health as a result of loss in food diversity. Appropriate action is necessary to prevent the persistent flow toward this loss as it might worsen the state of malnutrition in the world as a result of increased food insecurity. The state of food insecurity in the world estimates the total incidence of undernourishment in the developing countries at 780-798 million in 1999/2001 (FAO, 2003). It suggests that 17% of people in the world were undernourished in 1999 – 2001 down from 18% in the mid 1990s.

It is currently being realized that in Africa, traditional food plants can make a substantial contribution in meeting the nutritional needs of both urban and rural communities. Their nutritional value is also being recognized by nutrition scientists (Sebit 1994). It has been found that traditional native diets in those few places in the world where people still mostly eat what they raise and gather have been found to promote health and long life for reasons only gradually coming to be understood (Paula, 1997).

There is, therefore, the need to promote consumption and production of the small grain cereals. They usually survive drought better than maize and other exotic cereals and would therefore help alleviate food insecurity in the Arid and Semi Arid lands (ASAL).

1.2 Statement of the Problem

Machakos District lies in the ASAL areas of Kenya and receives an average annual rainfall of less than 600mm in the low lands (GOK 2003). Households in Machakos District like in several other parts in Kenya have been negatively affected by the many changes in food habits. Some of these habits which have been introduced by so called Western Civilization have been harmful. These, among others have resulted to negligence of small grain foods including the small grain cereals. Most of the households have turned to consumption of maize, rice and wheat. The major food crops grown within the district are maize and beans and due to population pressure crop production has been pushed to marginal areas only suitable as range land. Maize requires higher annual rainfall and is less tolerant to drought as compared to millet and sorghum and as a result there has been seasonal crop failure of mainly maize (MOA , 2003). This is because those areas receive very little annual rainfall. This contributes to food insecurity in the area, an underlying factor of malnutrition.

Small grain cereals are usually grown in portions of farms which have low soil fertility and where manure and fertilizer is rarely used (MOA, 2002). This results in their low production and utilization.

1.3 Justification of the Study

In Kenya the rapidly expanding population has caused imbalances between the national demand for food and supply, creating increasing dependency on food imports and food aid (UNICEF 1998). Districts like Machakos which lie in the ASAL areas are usually more affected. They

usually receive erratic rainfall which is less than 600mm per year. This results in seasonal crop failures where maize is usually produced and consumed as main staple food. This results in seasonal food shortages and hence household food insecurity. Traditional small grain cereals are drought resistant and therefore can do better in such climatic conditions. Such food crops would therefore help to alleviate hunger and malnutrition because they also have a higher nutritional value than maize.

This study therefore sought to investigate the utilization of small grain cereals which can survive better in those marginal areas. It would also establish their contribution to diets of children aged 6 to 59 months who usually suffer the highest mortality rates due to malnutrition.

1.4 Purpose of the Study

The study was carried out in order to generate information on the production and utilization of small grain cereals at household level, and their energy and protein contribution to the diets of children aged 6 to 59 months. The information generated would provide a basis for enhancement of the promotion of small grain cereals as a food insecurity solution in Machakos district and other ASAL areas.

1.5 Objectives of the Study

1.5.1 Main objective

The main objective of the study was to determine the factors associated with production and utilization of small grain cereals and their contribution to the protein and energy dietary intakes of children aged 6 to 59 months in the study area.

1.5.2 Specific objectives

The study was carried out with the following objectives:

1 To determine the socio-demographic characteristics of the study population.

2 To determine factors associated with the production and consumption of small grain cereals in the households.

3 To determine how small grain cereals are utilized in the households.

4 To determine the contribution of small grain cereals to the dietary energy / protein intakes of children aged 6 to 59 months.

5 To determine the nutritional status of children aged 6 to 59 months and how this relates with dietary intake, household production and utilization of small grain cereals.

1.6 Research Questions

- What are the factors that affect production and consumption of small grain cereals?
- How are small grain cereals utilized in the house holds?
- What is the contribution of small grain cereals to the dietary intakes of children aged 6 to 59 months?
- Is there a relationship between the dietary energy / protein intake, production and utilization of small grain cereals and nutritional status of children aged 6 – 59 months?

1.7 Hypotheses

- Small grain cereals do not contribute significantly to dietary energy and protein intakes of children aged 6 to 59 months.
- There is no relationship between dietary energy and protein intake, production and utilization of traditional small grain cereals and the nutritional status of children aged 6 to 59 months.

1.8 Benefits of the study

The results of the study were expected to be of benefit to the government, Non governmental Organizations (NGOs), Community based organizations (CBOs) and the community. The information could consequently be used as a baseline for future surveys and programmes to be employed in the area especially for promotion of the small grain cereals. The information could also be used as a tool to source for funding for the projects and programmes. The community could also use the information to improve their food availability by producing and consuming more of the sorghum and millets.

CHAPTER 2

2.0 LITERATURE REVIEW

2.1 Introduction

Sorghum and millets have been important staples in the semi arid tropics (SAT) of Asia and Africa for centuries, being produced by 28 countries in the continent. . These crops are still the principal sources of energy, protein, vitamins and minerals for millions of the poorest people in these regions (FAO 1995).

Sorghum and millets are grown in harsh environments where other crops grow or yield poorly. They are grown with limited water resources and usually without application of any fertilizers or other inputs by a multitude of small-holder farmers in many countries. Therefore, and because they are mostly consumed by disadvantaged groups, they are often referred to as "coarse grains" or "poor people's crop". They are not usually traded in the international markets or even in the local markets in many countries. The farmers seldom therefore have an assured market in the event of surplus production (FAO 1995).

2.1.1 Sorghum

Sorghum, Sorghum bicolor (L.) Moench, is known under a variety of names: great millet and guinea corn in West Africa, kafir corn in South Africa, dura in Sudan, mtama in Eastern Africa, jowar in India and kaoliang in China. In the United States it is usually referred to as milo or milo-maize. Sorghum belongs to the tribe Andropogonae of the grass family Poaceae. The genus

Sorghum is characterized by spikelets borne in pairs. Sorghum is treated as an annual, although it is a perennial grass and in the tropics it can be harvested many times.

Harlan and de Wet (1972) published a simplified classification of sorghum which has been checked against 10 000 head samples. They divided cultivated sorghum into five basic groups or races: bicolor, guinea, caudatum, kafir and durra. The wild type and shatter cane are considered two other spikelet types of Sorghum tricolor. A study of polymorphism of 11 enzymes permitted classification of sorghum into three enzymatic groups. The first includes mainly guinea varieties of West Africa; the second Southern African varieties of all five races; and the third durra and caudatum types of Central and East Africa (FAO 1995).

The cultivated sorghum of the present arose from a wild progenitor belonging to the subspecies verticilliflorum. The greatest variation in the genus Sorghum is observed in the region of the northeast quadrant of Africa comprising Ethiopia, Sudan and East Africa (Doggett, 1988). It appears that sorghum moved into Eastern Africa from Ethiopia around 200 AD or earlier. It was adopted and carried to the savannah countries of eastern and southern Africa by the Bantu people, who used the grain mainly to make beer. The Bantu people probably began their expansion from the region of southern Cameroon about the first century AD, moved along the southern border of the Congo forest belt and reached Eastern Africa possibly before 500 AD. The present-day sorghums of Central and Southern Africa are closely related to those of the United Republic of Tanzania and more distantly related to those of West Africa, as the equatorial forests were an effective barrier to this spread (FAO 1995).

Sorghum was probably taken to India from Eastern Africa during the first millennium BC. It is reported to have existed there around 1000 BC. Sorghum was probably taken in ships as food in the first instance; chow traffic has operated for some 3 000 years between East Africa (the Azanean Coast) and India via the Sebaean Lane in Southern Arabia. The sorghums of India are related to those of Northeastern Africa and the coast between Cape Guardafui and Mozambique.The spread along the coast of South east Asia and around China may have taken place about the beginning of the christian era, but it is also possible that sorghum arrived much earlier in China via the silk trade routes.

Grain sorghum appears to have arrived in America as "guinea corn" from West Africa with the slave traders about the middle of the nineteenth century. Although sorghum arrived in Latin America through the slave trade and by navigators plying the Europe-Africa-Latin America trade route in the sixteenth century, the crop did not become important until the present century. The case is similar for Australia.

Grain sorghum grown primarily for food uses can be divided into milo, kafir, hegari, feterita and hybrids. There are other classes of sorghums such as sorghos, grass sorghums, broom-corn sorghum and special purpose sorghum.The sorghum kernel varies in colour from white through shades of red and brown to pale yellow to deep purple-brown. The most common colours are white, bronze and brown. Kernels are generally spherical but vary in size and shape. The caryopsis can be rounded and bluntly pointed, 4 to 8 mm in diameter. The 1000-kernel weight

has a very wide range of values, from 3 to 80g, but in the majority of varieties it is between 25 and 30g. The grain is partially covered with glumes. Large grains with corneous endosperm are usually preferred for human consumption. Yellow endosperm with carotene and xanthophyll increases the nutritive value. Sorghum grain that has a testa contains tannin in varying proportions depending on the variety.

2.1.2 Sorghum use as human food

While total food consumption of all cereals has risen considerably during the past 35 years, world food consumption of sorghum has remained stagnant, mainly because, although nutritionally sorghum compares well with other grains, it is regarded in many countries as an inferior grain. Per caput consumption of sorghum is high in countries or areas where climate does not allow the economic production of other cereals and where per caput incomes are relatively low. These include especially the countries bordering the southern fringes of the Sahara, including Ethiopia and Somalia, where the national average per caput consumption of sorghum can reach up to 100 kg per year. Other countries with significant per caput consumption include Botswana, Lesotho, Yemen and certain provinces in China and states in India. In most other countries food consumption of sorghum is relatively small or negligible compared to that of other cereals (FAO 1995).

More than 95 percent of total food use of sorghum occurs in countries of Africa and Asia. In Africa, human consumption accounts for almost three-quarters of total utilization and sorghum

represents a large portion of the total caloric intake in many countries. For example, in Burkina Faso about 45 percent of the total annual caloric intake from cereals comes from sorghum, although its share has declined from 55 percent in the early 1960s.

Available data from Africa indicate that despite an increase in total food use between the early 1960s and the mid-1980s, the average per caput consumption declined from 20 to 15 kg per year. Decreases were concentrated in Kenya, Mozambique, Nigeria and Somalia but occurred also in Botswana, Ethiopia, Lesotho and Zimbabwe. In Asia, both total and per caput food use of sorghum declined.

This decline in per caput consumption in many countries was due in part to shifts in consumer habits brought about by a number of factors: the rapid rate of urbanization, the time and energy required to prepare food based on sorghum, inadequate domestic structure, poor marketing facilities and processing techniques, unstable supplies and relative unavailability of sorghum products, including flour, compared with other foodstuffs. Changes in consumption habits were concentrated in urban areas. Per caput food consumption of sorghum in rural producing areas remained considerably higher than in the towns. In addition, national policies in a number of countries had a negative influence on sorghum utilization as food. For instance, large imports of cheap wheat and rice and policies to subsidize production of those crops in some countries had considerable negative impact on the production of sorghum. (FAO,1995).

2.1.3 Sorghum use as animal feed

Grain use for animal feed has been a dynamic element in the stimulation of global sorghum consumption. The demand for sorghum for feed purposes has been the main driving force in raising global production and international trade since the early 1960s. The demand is heavily concentrated in the developed countries, where animal feed accounts for about 97 percent of total use, and in some higher-income developing countries, especially in Latin America where 80 percent of all sorghum is utilized as animal feed. The United States, Mexico and Japan are the main consuming countries, followed by Argentina, the former Soviet Union and Venezuela. These countries, together account for over 80 percent of world use of sorghum as animal feed.

2.1.4 Finger millet

Finger millet, *Eleusine coracana* L., is also known as African millet, koracan, ragi (India), wimbi (Swahili), bulo (Uganda) and telebun (the Sudan). It is an important staple food in parts of Eastern and Central Africa and India. It is the principal cereal grain in northern and parts of Western Uganda and Northeastern Zambia. The grains are malted for making beer. Finger millet can be stored for long periods without insect damage and thus it can be important during famine. Numerous cultivars have been identified. In India and Africa, two groups are recognized: African highland types with grains enclosed within the florets; and Afro-Asiatic types with mature grains exposed outside the florets. It is believed that Uganda or a neighbouring region is the centre of origin of E. *coracana*, and it was introduced to India at a very early date, probably

over 3 000 years ago. Though finger millet is reported to have reached Europe at about the commencement of the christian era, its utilization is restricted mostly to Eastern Africa and India.

The height of cultivars varies from 40 cm to 1 m and the spike length ranges from 3 to 13 cm. The colour of grains may vary from white through orange-red deep brown and purple, to almost black. The grains are smaller than those of pearl millet, and the mean 1 000-seed weight is about 2.6 g.

2.1.5 Utilization of finger millet

Of the 30 million tonnes of millet produced in the world about 90 percent is utilized in developing countries and only a tiny volume is used in the developed countries outside the former Soviet Union. Exact statistical data are unavailable for most countries, but it is estimated that a total of 20 million tonnes are consumed as food, the rest being equally divided between feed and other uses such as seed, the preparation of alcoholic beverages and waste. Six countries (China, Ethiopia, India, the Niger, Nigeria and the former Soviet Union) are estimated to account for about 80 percent of global millet utilization (FAO, 1995).

2.1.6 Finger millet as human food

Per caput food consumption of millet varies greatly among countries, though it is highest in Africa. In the Sahel, millet is estimated to account for about one-third of total cereal food consumption in Burkina Faso, Chad and the Gambia, roughly 40 percent in Mali and Senegal

and over two thirds in the Niger. Other countries in Africa where millet is a significant food item include Ethiopia, Nigeria and Uganda. Millet is also an important food item for the population living in the drier parts of many other countries, especially in Eastern and Central Africa but also in the Northern coastal countries of Western Africa. In developing countries outside Africa, millet has local significance as a food in parts of some countries such as China, India, Myanmar and the Democratic People's Republic of Korea. Although national per caput levels are rather low in the countries that consume the most millet, i.e. China and India, food use of millet is important in certain areas of these countries.

World consumption of millet as food has only grown marginally during the recent past in contrast to the significant increase in consumption of other cereals. There has been a tendency in all countries for the per caput consumption of millet to decline when per caput income exceeds certain levels because of the lower prestige associated with its consumption.

2.1.7 Finger millet as animal feed

Utilization of millet as animal feed is negligible in absolute terms and compared with other uses and other cereals. It has been estimated that only about 10 percent of the millet used globally is fed to animals.

2.1.8 Pearl millet/bulrush millet

Pearl millet, *Pennisetum glaucum*, is also known as spiked millet, bajra (in India) and bulrush millet. Pearl millet may be considered as a single species but it includes a number of cultivated races. It almost certainly originated in tropical Western Africa, where the greatest number of both wild and cultivated forms occurs. About 2000 years ago the crop was carried to eastern and

central Africa and to India, where because of its excellent tolerance to drought it became established in the drier environments.

The height of the pearl millet plant may range from 0.5 to 4 m and the grain can be nearly white, pale yellow, brown, grey, or purple. The ovoid grains are about 3 to 4 mm long, much larger than those of other millets, and the 1000-seed weight ranges from 2.5 to 14 g with a mean of 8 g. The size of the pearl millet kernel is about one-third that of sorghum. The relative proportion of germ to endosperm is higher than in sorghum (FAO, 1995).

2.2 Sorghum and Millets in Kenya

In Kenya sorghum and millet have been used as staples especially in the marginal areas. About 80% of the land mass falls within the Arid and Semi arid land where these crops are more adapted than any other cereal and are therefore important for food insecurity alleviation in such areas.

The crops are also more resistant to diseases and pests and therefore require fewer chemicals and have less production costs. The finger millets can also be stored for a long time without insect damage. According to surveys done in Kenya there has been a marked fluctuation in the area under sorghum and millet production between 1996 and 2000. There has been falling consumption arising from a change in eating habits and low productivity (GOK, 2002).

2.3 Food Insecurity in the World and its Link to Decline in Traditional Foods.

Globally it is difficult to know exactly how many households are food insecure given definitions and measurement problems as well as inadequate data. It is even more difficult to identify the number of food insecure individuals given intra household inequalities and those suffering different kinds of problems in different regions as well as changes over time.

The state of food insecurity in the world estimates the total undernourishment in the developing countries at 776 million persons in 1997/99 (FAO, 2001). One factor that has highly contributed to this low food production in the developing countries is drought which results in failure of crops that need high rainfall.

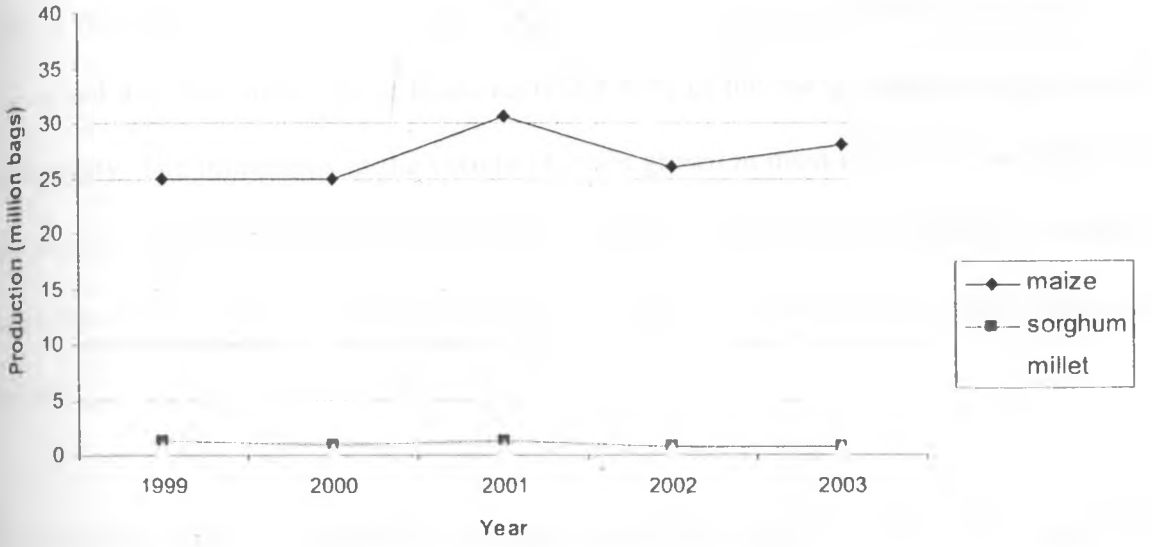
Thousands of food producers gathering in Italy in October 2004 voiced concerns that the decline in traditional food production was posing a serious threat to food security in a world where hunger affects 846 million people and 35 countries suffer from food insecurity. Globalization was thought to impact on the decline in traditional food production by influencing consumer preferences, causing many young people to prefer junk food to traditional dishes. Monitoring the effects of globalization and trade liberalization on local markets, supporting the production of traditional foods and diversifying economies were raised among possible solutions to these problems. It was also suggested that governments advocate the consumption of highly nutritious small grain cereals and grains, which are also resistant to extreme climate and disease (SLOW FOOD, 2004).

2.4 Food Production in Kenya

Food production in Kenya has been declining since the late 1980s. The national food production index which was over 100 between 1987 and 1992 dropped to 94 in 1993. When the production figures are adjusted for population size, it is evident that production has not kept pace with the rapidly growing population. With the gap between the food needs and domestic production widening, it is reasonable to expect that the food security situation will continue to deteriorate if remedial measures are not taken (UNICEF, 1998).

One of the fundamental issues in Kenya is local food production. The main foods are maize, wheat, rice, milk, starchy roots and tubers. The production of these foods depends on rainfall pattern and they are therefore highly vulnerable to weather variations. A year of good harvest with improved access to food may be followed by poor rains and deterioration in food supply. According to economic surveys of 1999, 2000, 2001, and 2004 the agricultural sector has been performing poorly and the production of the main staple, maize has continued on a downward trend over the period.

A decline in the production of maize is interpreted as a sign of food insecurity in Kenya. Drought resistant crops such as sorghum and millets do better than maize during bad years and lack of promotion of these drought resistant crops has resulted in their diminished production over the years as seen in figure 2.0.



Source: CBS (Economic survey, 2004).

Figure 2.0 Estimated production of sorghum, millet and maize in Kenya

This is a matter of concern because maize which has replaced these crops is more dependant on regular rainfall (UNICEF 1998).

As a result of declined production there has been increased demand for food. The national average per capita calorie supply also declined in the last decade. The declining supply of calories means that food insecurity is on the rise in the country.

2.5 Food Consumption Patterns in Kenya

Maize is the staple food for the majority of Kenyans and thus the chief source of energy and protein for both rural and urban populations. It is reported that the average small holder in the rural areas of Kenya obtains a large share of daily energy intake from a limited range of foods. This is made up of about 61% from cereals, 12% from root crops, 5% from beans, 5% from sugar, and 4% from milk. These foods represent 87% of the energy intake for the rural farming community. The limitations in the variety of crops grown in most rural areas are likely to reflect monotony in the diets which may also be limited in quality. The limitation in variety of the crops grown has resulted as households have continued to neglect the small grain traditional foods.

It is reported that poor households in Kenya small holder areas suffer from intermittent food shortages, some of which can be acute, but that the grossly inadequate intake of food that is prolonged enough to show up in high incidence of severe malnutrition is rare (Heyer 1990). Different estimates of poverty in small holder agricultural areas suggest that more than 25% of rural agricultural households are poor enough not to be able to afford what are regarded as minimum food requirements (FAO 1986).

2.6 Protein Energy Malnutrition

Protein energy malnutrition (PEM) is the most wide spread form of malnutrition in the developing world. Its prevalence is highest in developing countries but it is difficulty to estimate accurately (UNICEF, 1994). In most developing countries PEM is fairly prevalent among infants and pre-school children. Protein energy malnutrition, micronutrient deficiency and the

accompanying infectious diseases have long been linked to unacceptable high mortality rate of infants and pre-school children (UNICEF, 1994). In most of these developing countries, many children suffer from the moderate or severe forms of protein energy malnutrition. In any one country the prevalence rates are influenced by the season, the availability of food, incidence of infection and the state of development of the health services.

It has now been realized that energy is usually the limiting factor in most young children's diets although protein quality and quantity is often low (Svanberg, 1988). In most cases diets deficient in energy and protein are also deficient in vitamins and minerals.

Malnutrition constraints people's ability to fulfill their potential. Hungry and undernourished people have less energy to undertake work and are less able to attend school. Studies carried out in developing countries have also shown that malnutrition has an effect on learning ability. Not only is good nutrition key to healthy development of individuals, families and societies but there is also growing reasons to believe that improving the nutrition of women and children will contribute to overcoming some of the greatest health challenges facing the world including the burden of chronic and degenerative diseases, maternal mortality, malaria and AIDS.

2.6.1 The role of traditional food plants in alleviation of malnutrition.

Malnutrition has always been a concern of the under privileged in developing countries and Kenya is no exception. It causes increased morbidity and mortality among the vulnerable groups (UNICEF, 1993). Traditional foods can help alleviate malnutrition through;

Broadening the food base

The forgotten and neglected food plants should be rediscovered to broaden the food base using significantly more of the available resources. They are particularly important in the cropping strategies and consumption patterns of poor people. They provide a varied diet, often rich in minerals and vitamins.

Enhancing nutritional status

The nutritional value of diets is enhanced by traditional foods. They add flavor and taste to diet, improve palatability and help to balance proteins, vitamins and mineral intakes in Africa. Traditional food plants supply an estimated 80% of vitamin A and more than one third of vitamin C. Millet and sorghum are quiet rich in calcium, iron, B vitamins and other nutrients as shown in tables 2.2 and 2.3. Therefore, apart from alleviating hunger during times of famine, they can help in improving micronutrient intakes especially iron. Iron deficiency anaemia is the most common type of nutritional anaemia affecting young children and women of reproductive age (3-9). Nutritional deficiency due to lack of bioavailability dietary iron accounts for over 50% of the cases. Preventing and correcting iron deficiency among women is crucial because of the negative consequences which includes increased morbidity and decreased immunity among others.

The traditional food systems of small grain peoples contain a wealth of micronutrients that have been poorly described and reported in scientific literature. This lack of scientific coverage prevents the information from being included in health training programmes. While small grain

peoples are often the most marginalized and disadvantaged sub groups of a population, their traditional knowledge and diverse food resources may be substantial enough to be used to improve their own micronutrients status.

Table 2.0 Mineral Composition of Sorghum and Millet (mg)

Grain	P	Mg	Cg	Fe	Zn	Cu	Mn
Sorghum	352	171	15	4.2	2.5	0.44	1.15
Pearl Millet	379	137	46	8.0	3.1	1.06	1.15
Finger Millet	320	137	398	3.9	2.3	0.47	5.49

Source Rao and Deosthel, 1980; 1983

Table 2.1 Nutritional content of millet, sorghum and maize per 100grams of edible portion.

Food	Water (mls)	Energy (calories)	Protein (g)	Fat (g)	Carbohydrates (g)	Fibre (g)	Calcium (mg)	Iron (mg)	Thiamine (mg)	Riboflavine (mg)
sorghum	12	329	12.3	3.1	70.7	1.9	25	5.4	0.3	0.13
Finger millet	11	329	7.4	1.3	77.7	4.3	329	17.1	0.18	0.11
maize	11	359	9.3	4.4	73.7	1.8	12	3.8	0.34	0.10

Source: FAO 1997

Improving household food security

Seasonal food scarcity accentuates the severity and incidences of malnutrition. Many traditional crops are drought resistant and can be grown without expensive inputs and have qualities that enhance long storage periods. The option to improve food production through exploiting the potential traditional food products is naturally sustainable, cheap and locally available alternative

to resolving at least part of food shortage problems. At some time an emphasis on the development of traditional food plants will help enhance and maintain the biodiversity.

Increasing household and national incomes

Traditional food plants benefit both producer and consumer. The producers mainly women increase their families' consumption and generate income by selling surplus in local markets. Generally women use this income for improving the nutrition and welfare of their children (Gujt, 1995).

Kenya is forced to import large quantities of food to meet local production shortfalls. At national level, payment for food imports has become an increasingly heavy drain on the scarce foreign exchange resource. Increased production of a range of traditional food crops particularly staples will increase food supply and thus contribute to reduction of food importation.

2.7 Protecting Traditional Diets

A neglected but important topic is the protection of dietary tradition especially relevant for those countries where diet related chronic diseases are not prevalent but where economic development permits at least some people to purchase a wide variety of food including animal food products.

In general traditional diets in Asia, Africa and Latin America is based on cereals or root crops with significant amount of legumes, fruits and vegetables. Often poultry, meat and dairy products provide only a small proportion of total energy but are appreciated as side dishes or tasty addition to the staple foods.

Usually these diets do not cause the chronic diet related diseases associated with animal foods as they are high in complex carbohydrates and if plenty of fresh vegetables and fruits are also consumed, the diets are often rich in beta carotene and vitamin C, which are antioxidants.

Protecting good traditional diets start with protecting or enhancing the production and marketing of traditional foods. One obvious attraction of many western dishes is convenience as busy people are attracted to them and homemakers can save time in using them.

2.8 Fermentation of small grain cereals

Sorghum and millet are known to contain anti – nutritional factors mainly phytates and tannins which hinders mineral absorption. Lactic acid fermentation has been associated with reduction in these anti – nutritional factors and is therefore likely to enhance mineral absorption (Lorri, 1995). Fermentation also increases the protein digestibility of the cereal based gruels. At household level, fermentation is usually done through traditional processing of the cereals. This improves the bioavailability of minerals especially iron. Fermentation is one of the oldest methods of preparing and preserving food known to mankind. Foods have been fermented since ancient times to improve palatability, texture and shelf life, and in some cases to improve their safety. Fermentation has evolved largely from a practical need to preserve for later consumption, a fresh food item that would otherwise spoil or waste if it came into production in quantities too great to be eaten at the height of its availability. Most of us today are unaware that many of the foods we consume are regularly prepared by the fermentation process.

The properties of fermented food are generally considered attractive and desirable than those of unfermented raw materials. In addition to improved external properties (i.e. taste, texture,

aroma), fermented foods are in many cases improved in their nutritional value and keeping quality. Generally, traditional methods of manufacturing fermented foods are not complicated and do no require expensive equipment. Fermentation of small grain foods is therefore considered by many to be an effective, inexpensive and nutritionally beneficial alternative to the problems of food scarcity and malnutrition in the developing world.

In Uganda fermentation has successfully been used to produce high nutritional products from sorghum and millet grains especially "Bushera". This is the most commonly produced traditional fermented beverage produced in South Western Uganda (Muyanja *et al,* 2003).

There is a possible black lash if consumers in developing countries abandon traditional fermented foods for "smart" sophisticated products popularized in Europe and America, for example the replacement of small grain fermented cereal drinks with cola beverages could have a significant negative impact on daily nutrition of many consumers in developing countries (Wood, 1994).

2.9 Gap in Knowledge

It is likely that the consumption of sorghum and millets throughout the semi arid tropical regions vary widely among seasons, communities and families. Detailed and reliable data on their consumption are either scanty or currently unavailable. One reason for the lack of information is the fact that to collect such information extensive surveys are needed (FAO, 1995).

Information on contribution of small grain cereals to the diets of children aged 6 to 59 months in marginal areas is lacking in available literature. Studies carried out on those crops have focused

mainly on their potential role in alleviation of food insecurity and malnutrition. Little has also been documented on how these foods are utilized in the Kenyan households.

CHAPTER 3

3.0 STUDY SETTING AND METHODOLOGY

3.1 Study Area

The study was carried out in Yathui Division Machakos District. The district is one of the thirteen districts that form Eastern Province. It borders Nairobi city and Thika district to the northwest, Kitui and Mwingi districts to the east, Kajiado district to the west, Makueni to the south, Maragwa to the north and Mbeere district to northeast. The location of the district is shown on map 1 (Appendix 6). The distrct covers an area of 6281.4 km² most of which is semi-arid. High and medium potential areas where rain fed agriculture is carried out consists of 1574km² or 26 per cent of the total area. Administratively, the district is divided into twelve divisions, sixty-two locations and two hundred and twenty five sub-locations (GOK, 2002).

Yathui division is one of the twelve divisions in the district and lies about 50km South of Machakos district headquarters. It boarders Mwala division to the North and West , Katangi division to the East, Makueni district to the South and Kitui district to the South east. The location of the division is shown in map 2 (Appendix 6). The division covers an area of 574 Km^2 and lies in the Agro Ecological Zone (AEZ), LM4 (30% and LM5 (70%). The land use is basically subsistence farming although some farmers are engaged in dairy farming, cotton production and beekeeping.

Administratively the division has six locations namely Yathui, Wamunyu, Miu, Muthetheni, Ikalaasa and Kibauni location. The study was specifically carried out in Kibauni location.

Population

Currently the division has an estimated population of 65567 people with a population density of 120 persons per square kilometer and 11926 house holds. Majority of the people in the division belong to the Kamba tribe.

Climate and topography

The division receives a bimodal rainfall in October to December (short rains) and March to June (long rains). The short rains are more reliable and averages about 350-400mm while the long rains are less reliable and averages 250mm. The daily mean temperatures vary from 20 to 35 degrees centigrade. The division has gentle undulating ridges with a slope ranging between 3-15%.

Soils, drainage and vegetation

The soils range from shallow sandy loams to red loam. The predominant soil types are the sandy loams interspersed with pockets of murram and rocky soils. The soils are of medium depth and are fairly drained. The area is served by several seasonal streams which feed into Miu and Athi rivers and the vegetation is predominantly short shrubs mainly *Lantana camara* with scattered small grain trees.

Social economic status

The main occupation in the area is subsistence farming with majority of families rely on income from sale of farm produce, livestock and their products. Some members of the community are

employed off farm in and outside the division. Most of the women make sisal hand wooven baskets which they sale in the local and other markets.

3.2 Methodology

3.2.1 Study population.

The study population consisted of households with children aged 6 to 59 months. The respondents were the mothers or caretakers of the children.

3.2.2 Study design

The research was a descriptive, cross sectional study carried out in Yathui division of Machakos district, during the months of August and September 2004.

3.2.3 Sample

3.2.3.1 Sample size determination

The sample size (260 households) was determined according to Fischer, (1991) formula using a prevalence of stunting among children aged below five years in eastern province of 32.9% (K.D.H.S, 2003)

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

Where n = the derived minimum sample size

Z = the standard normal deviate, 1.96 which corresponds to 95% confidence interval.

P = proportion of stunted children in the target population estimated to be 32.9%.

q = 1-P

= 1 - 0.329

= 0.67

d = degree of accuracy desired which was 0.06.

Therefore $n = \frac{Z^2Pq}{d^2}$

$= \frac{(1.96)^2 \times (0.329) \times (0.67)}{(0.06)^2} = 236$

10% attrition $= \frac{10}{100} \times 236 = 24$

Therefore sample size = 236 + 24

= 260.

3.2.3.2 Sampling procedure

Machakos District was selected purposively because it lies in the semi arid areas of Kenya. The district consists of 12 divisions, from which Yathui division was selected purposively. The division lies in the low mid land zones, one of the areas that experiences seasonal crop failure hence seasonal food shortages. Kibauni location was selected by simple random sampling as well as Kiunduani and Itumbule sub locations. Six villages were then selected from the two sub locations by simple random sampling. The sampling procedure is schematically shown in figure 3.0.

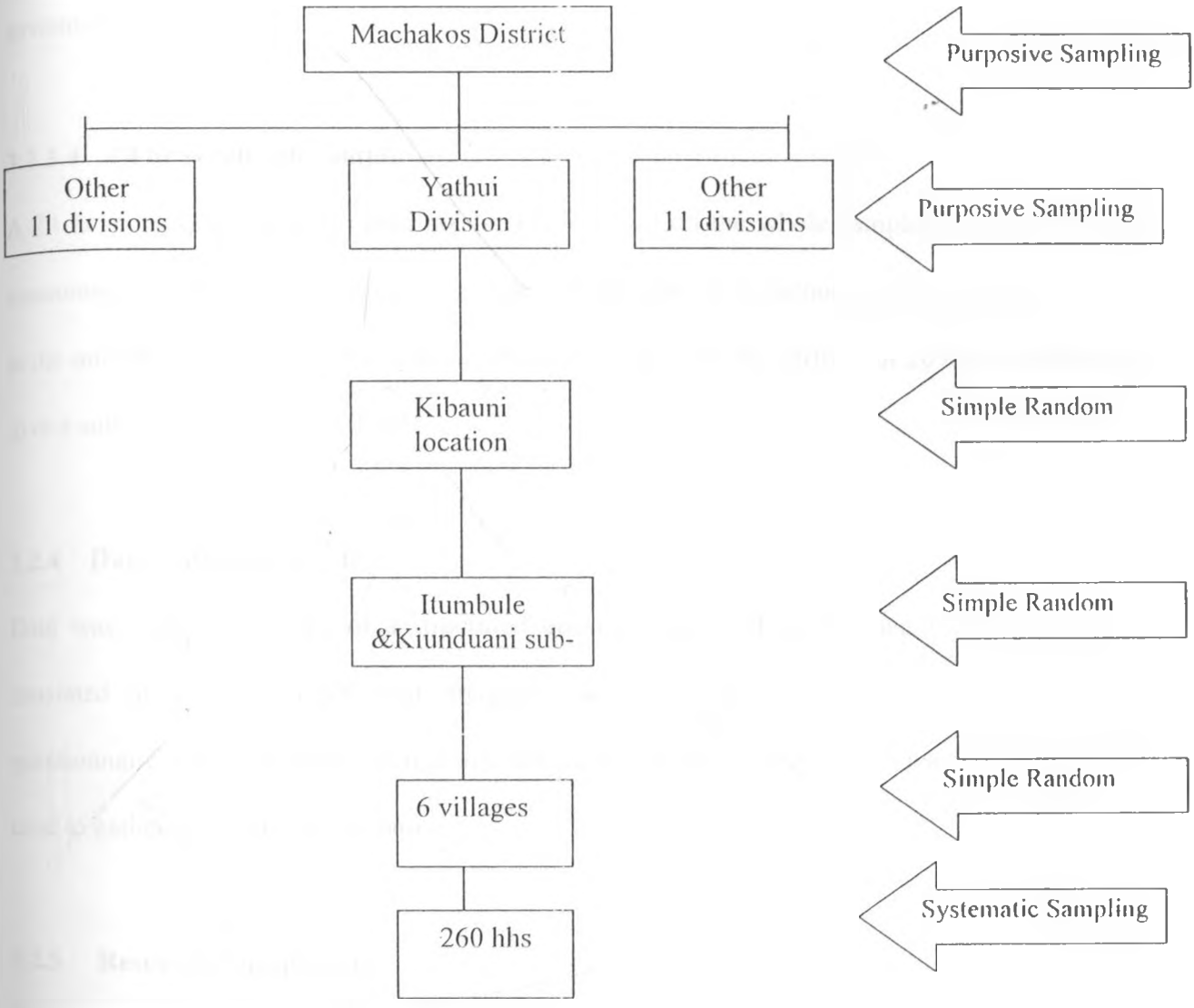


Figure 3.0: Sampling procedure

3.2.3.3 Sampling frame

A sampling frame was created by registering all households with a child aged 6-59 months in the six study villages. During this exercise, sub-locational maps were used as guides to the village

boundaries. A sample of 260 households was then obtained from the sampling frame by systematic sampling.

3.2.3.4 24 hr recall sub-sample

A 24 hr recall questionnaire could not be administered on the whole sample because it is time consuming. A sub- sample was therefore selected whereby 30 households were considered which is the minimum sample size that can statistically be analysed. An attrition of 20% was allowed to give a sub-sample of 36 households.

3.2.4 Data Collection Tools

Data was collected by use of a structured questionnaire. A food frequency checklist which consisted of a list of foods with frequency-of-use response categories and a 24hr recall questionnaire were part of the main structured questionnaire. A focus group discussion guide was used to gather qualitative information.

3.2.5 Research Equipments

Kitchen weighing scales and measuring cylinders were used to estimate ingredients used to cook the foods and the volumes of food cooked and that consumed by the index child during the 24-hr recall interview. Length boards, salter scales with plastic pants and sisal rope were used to carry out anthropometric measurements. The length boards were used for taking length and height of the children while salter scales, plastic pants and the sisal rope were used to take their weight measurements.

3.2.6 Recruitment and Training of Field Assistants

Five field assistants were recruited whereby only those with adequate literacy and numeric skills were considered. They all had an education level of at least form four and were recruited from the study area since they were conversant with the local culture, food practices and the language. The field assistants were then trained for two days on questionnaire interpretation, method of interaction, data collection techniques as well as recording. They were also trained on the basic field ethics and how to create rapport with the respondents.

3.2.7 Pre-testing of the study tools

Pre-testing of the study tools was carried out in a village that neighbours the study villages. A total of fifteen households were pre-tested on. The field assistants were used to pretest the questionnaire, which was adjusted accordingly before the definitive study began. An average of 12 households was visited per day.

3.2.8 Data Collection

With the pre-tested structured questionnaire, data were collected in the month of September 2004.

3.2.8.1 Socio-demographic data

Data was collected on various characteristics of the study population which included; age, sex marital status, education level, occupation, religion, relationship of household members to the household head, land and type of land ownership.

3.2.8.2 Food production and utilization data

Data was collected on the type of crops grown and their acreages, reasons for not growing the small grain cereals, fermentation of the small grain cereals, their time of utilization, their products and people who consume them among the study population.

3.2.8.3 Food Consumption data

Food frequency data

A food frequency checklist was used which consisted of foods commonly eaten in the population. It was used to obtain information on the usual food consumption patterns. Frequency of consumption of sorghum, millets and other foods was obtained. The consumption frequencies were obtained from the index child's mother or the care taker.

24 Hr Recall

A 24-hour recall questionnaire was administered on a sub-sample of 36 households before which a pre-market survey was carried out to determine the weights and prices of commonly consumed foods sold in the markets. The respondents who were mothers or care takers of children aged 6-59 months were asked to remember in detail the type and quantity of foods and beverages consumed during the previous 24 hours by the index child. This was followed by questions on ingredients and amounts used for preparation of the dishes. Kitchen scales were used to obtain actual weights of ingredients used. Graduated measuring cylinders were used to obtain the total volumes of dishes cooked and that consumed by the index child. Dishes and cups used to serve the child were filled with water up to where the food had reached. Then this water was measured with the measuring cylinder to estimate the volume of the food eaten. The amounts of proteins

and energy contained in the foods eaten were then calculated using the National food composition tables by Schmi, 1993.

3.2.8.4 Nutritional status data

Data on nutritional status of children aged 6-59 months was obtained by taking the anthropometry measurements of height and weight. Standardized specific techniques were used as described by world health organization (WHO 1983).

Procedure for taking the measurements

Height measurement

A child aged two years and above was measured while standing.The measuring board was placed on a smooth level, flat hard surface preferably against a wall, tree or a door post. Shoes, sandals, socks or any other heavy items were removed. The child was assisted to stand with his/her back against the measuring board, as the assistant kept the child calm and composed.

The child was positioned with bare feet together with the position of heels, buttocks, shoulders and back of the head touching the board. The chin was held so that the child was looking up straight. After adjusting the head piece to make it level, it was lowered until it was firm on top of the head of the child. It was then pressed gently to ensure that it remained in contact with the head. The child's height was read to the nearest 0.1cm and the reading was recorded immediately. The head piece was removed and the procedure was repeated for a second reading.

Length Measurement

Children less than two years old were measured while lying on their back using the horizontal measuring board. The child was laid on the measuring board with the top of the head pressed firmly against the fixed end, ensuring that he/she was lying flat in the centre of the board.

The knees were held straight and the movable foot board brought firmly against the heels so that the feet were at right angles. The length was read and recorded to the nearest 0.1cm. The procedure was repeated for a second reading

Weight Measurement

Weight of the child was taken by use of calibrated Salter Scale, plastic pant and a rope. The Salter Scale was hooked onto a tree branch or ceiling and left to hang freely. It was ensured that the scale was well secured and stable. The scale, with weighing pants hanging on it, was adjusted to zero before weighing the child. The child was undressed to have only minimal clothing and then was put into the weighing pants and lowered gently on to the Salter Scale. The child's weight was read ensuring that he/she was hanging freely and not holding onto anything. The weight was read to the nearest 0.1 Kg. The procedure of reading and recording was repeated for a second reading.

Age of the child

Growth monitoring cards were used to record child's exact date of birth, which was later used to calculate the child's age in months. In cases where the cards were not available, mothers and care takers were asked to recall the dates of birth of the children using calendar of events.

3.2.8.5 Focus group discussion

A focus group discussion (FGD) was conducted with randomly selected 10 women from the study population. The principle researcher conducted the discussion while two assistants recorded the information on the general perception of the small grain cereals. The FDG was to obtain information on whether those cereals were available in the area and whether they were consumed as often as before. Information was obtained on the way those cereals were prepared and their products. Consent was obtained from the participants before any recording was done. A focus group discussion guide (see appendix 2) was used.

3.2.9 Data Quality Control

This was achieved through pre-testing of the questionnaire. Counter checking of the filled questionnaires was done every day by the researcher to check for completeness and clarity of entries. Any incomplete questionnaires were checked with repeat visits. Supervision was done by direct observation of the interviewers in the field as questionnaire was administered and measurements were taken.

After entering the data, frequencies of all the variables were done to ensure that all information had been correctly entered.

3.2.10 Ethical and Human Rights Considerations

Before the study was carried out, the researcher obtained permission to carry out the study from the ministry of education. There after the researcher visited the offices of Machakos district commissioner and medical officer of health who both gave permission for the study to be carried

out. Any information collected was handled confidentially and it was ensured that a feedback was to be given after the study was carried out.

3.2.11 Entry into the community

Before the actual data collection, mobilization was done through briefing and discussing the study with the administration, namely the Divisional officer, Chief of Kibauni Location and Assistant Chiefs of Itumbule and Kiunduani sub-locations and the village heads men. A chief's baraza was held which helped to create awareness on the study among the community members.

3.2.12 Data Processing and Analysis.

The data was transformed into codes that had been developed during questionnaire preparation, entered and analyzed at the ANP computer room, upper Kabete campus, University of Nairobi, using SPSS version 8 (statistical package for the social sciences) computer package. There after, frequencies of all the variables were generated and used in checking for outliers. To ensure that all the information had been correctly entered frequencies for non continuous data and the mean values for continuous data were obtained before carrying out statistical analysis. It was then analysed with SPSS and Epi info computer packages.

Descriptive statistics where means and frequencies were determined on socio-demographic characteristics, crop production, utilization and consumption of the small grain cereals were carried out. Chi-square test to determine whether association between variables are significant or not was done and correlations were used to determine the strength of the associations between variables. T-test to test for difference between means of different variables was also done. Y-error

bars were used to determine whether there was any significant difference between protein and energy intakes by study children from small grain cereals and from other foods.

3.2.12.1 Estimation of caloric and protein intake

From the 24 hr-recall data, the amounts of food consumed by the index child were obtained in volume and then converted into their gram equivalents. The total daily intake of calories and proteins by the child were then calculated by use of the Kenya food composition tables compiled by Sehmi (1993). The adequacy of protein and caloric intake was expressed as the proportion of the recommended daily allowance (RDA).

3.2.12.2 Assessment of nutritional status

The Epi info computer package was used to compute Z score deviations of the weights or heights from the weights and heights of the National Centre for Health Statistics (NCHS) reference children of the same height (or age). The indices obtained were weight-for-age, height-for-age, and weight-for-height, as indicators of underweight, stunting, and wasting, respectively. The children were considered to be malnourished when the respective Z scores were below -2 SD from the median for NCHS reference children.

CHAPTER FOUR

4.0 RESULTS

4.1 Introduction:

This chapter presents the results of the study under the following topics: Demographic characteristics of the study.population, land ownership and food production, food consumption, utilization of small grain cereals, contribution of small grain cereals to dietary energy and protein intake of children aged 6-59 months and how this relates to their nutritional status.

4.2 Demographic Characteristics:

The study covered 260 households in Kiunduani and Itumbule sub locations of Kibauni location with a total population of 1434. The ethnicity of the study population was mainly kambas. The majority (98%) were christian, 1.2% had no religion and only 0.8% were traditionalists.

4.2.1 Age and sex distribution

Table 4.0 shows the distribution of the study population by age. Almost one quarter of the population was below 5 years old, 51.8% was aged less than 15 years, 47% was aged between 15 years and 64 years and 1.2% was 65 years and above with about three quarters being males.

Table 4.0 Distribution of study population by age.

	Distribution of study population by age (N=1434)	
Age in years	Frequency	%
0-4	342	23.8
5-14	401	28.0
15-44	553	38.6
45-64	121	8.4
65-100	17	1.2

The distribution of the study population by age and sex is shown in the figure 4.0. The male to female ratio was 1:1.1 with 48.8% males and 51.9% females.

The dependency ratio defined as, $\frac{\text{no. of persons below 15 years + those>65 years}}{\text{Total no. of persons between 15 and 65 years}}$

among the study population was 1:1.1.

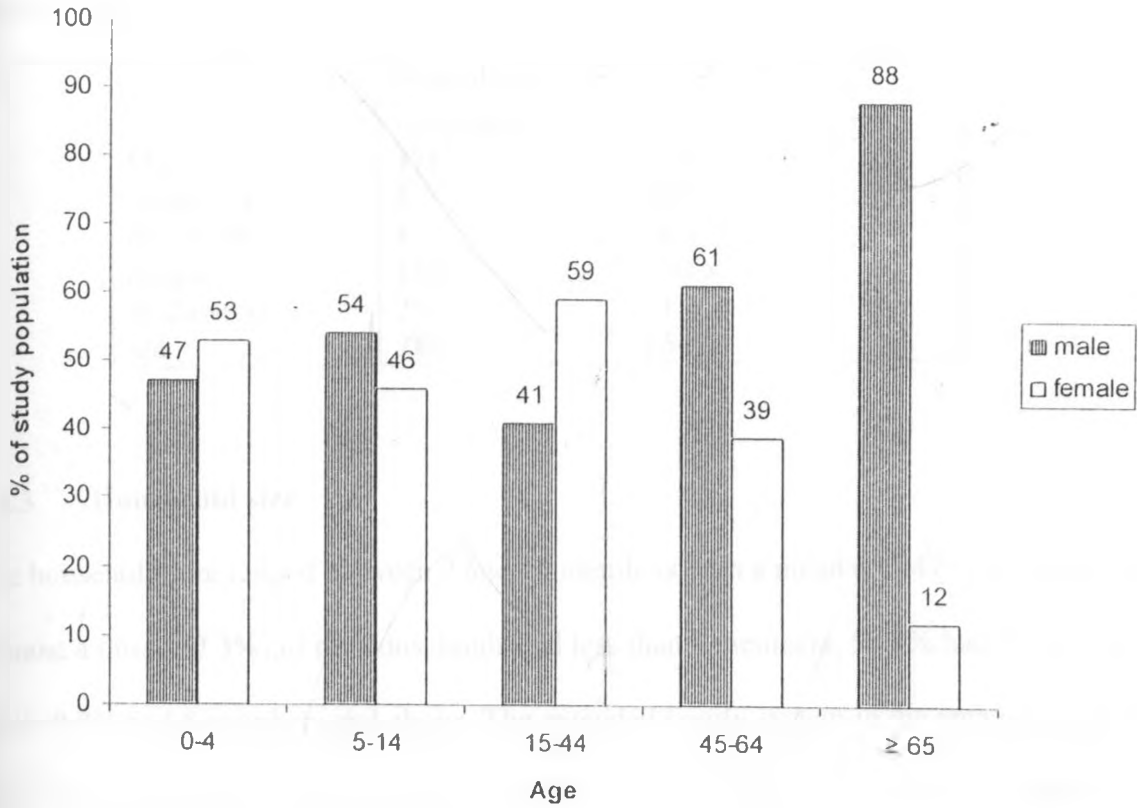


Figure 4.0 Distribution of study population by age and sex

4.2.2 Marital status

About a quarter of the population were married, very small proportions were separated and divorced while very few were single (10.5%). Almost a half of the study population was below 16 years and therefore too young to have married.

Table 4.1 Distribution of study population by marital status

	Marital status (N=1434)	
	Frequency	%
Married	478	33.3
Separated	2	0.1
Divorced	1	0.1
Single	150	10.5
Widow(er)	23	1.6
n/a	780	54.4

4.2.3 Household size

The household size ranged between 2 and 10 members with a mean of 5.47±1.69 members. Almost a third (32.3%) of the households had less than 4 members, 58.8% had 5-7 members while 8.8% had 8 members and above. The extended family system in the area was quite low for there were only 9.6% of the household members who were not nuclear family members of the household head. They included; grandsons, granddaughters, mothers, fathers, daughter in laws, great-granddaughters, great-grandsons, sister in laws and nephews with majority being the grand children.

Table 4.2 Distribution of study population by non- nuclear family members.

Relation to household head	Non nuclear family members	
	frequency	%
No relation	5	0.3
Grandson	49	3.4
Granddaughter	60	4.2
Mother	3	0.2
Father	1	0.1
Daughter in law	14	1.0
Brother	2	0.1
Great great grand daughter	1	0.1
Great great grand son	1	0.1
Sister in law	1	0.1
Nephew	1	0.1

4.2.4 Occupation of the study population

The study population was characterized by various occupational activities except for those who were students. The most common form of occupation among the study population was housewifery followed by farming as seen in table 4.3. Part of the study population was also involved in casual labour and business. The least proportion of the population was in permanent employment.

Table 4.3 Population distribution by occupation

Occupation	Population (N=1434)	
	n	percentage
Housewife	204	14.2
Farming	159	11.1
Casual labour	98	6.8
Business	63	4.4
Permanent employment	39	2.7
None	22	1.5
Not applicable	389	27.1
Student	460	32.1

A similar trend was observed among the mothers (n=260) when considered separately as seen in figure 4.1

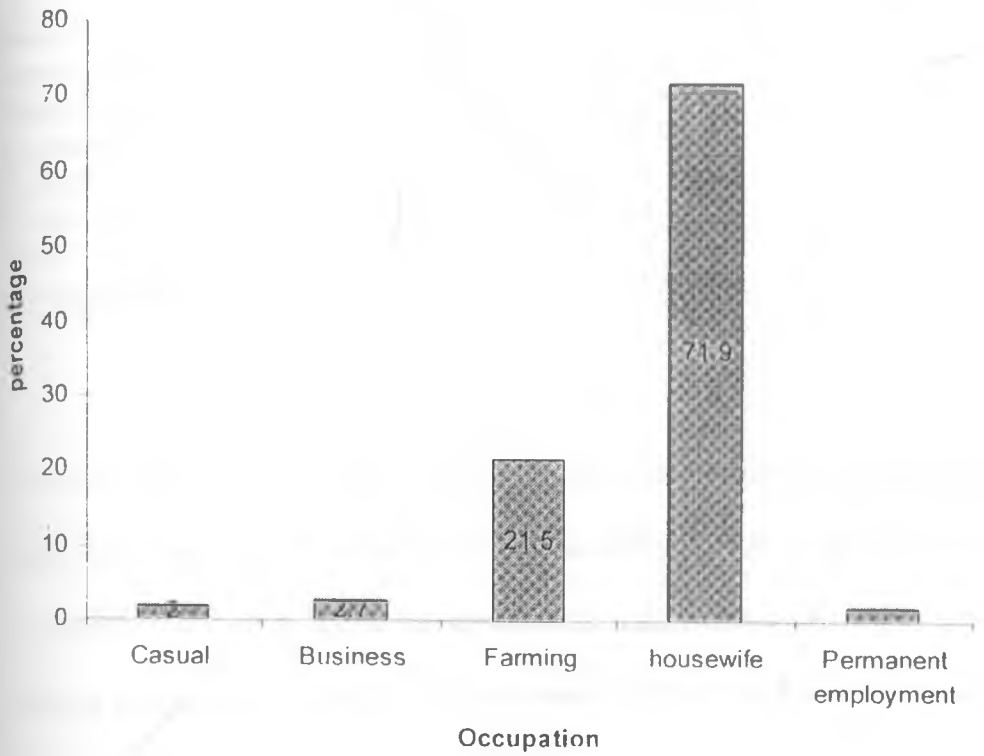


Figure 4.1 Maternal occupation

4.2.5 Level of education

About a quarter of the population was below six years and therefore too young to have attended school as seen in table 4.4. Almost equal proportions had attained lower primary and secondary education level. Majority of the study population had attended school up to upper primary while a very small proportion (0.1%) had gone up to university level. Of the 2.8% who had not attained any education where, 1.3% males and 1.5% females.

Table 4.4 Distribution of study population by education level.

Education level	Distribution of population by education level	
	n	percentage
Nursery	35	2.4
Lower primary	195	13.4
Upper primary	562	39.2
Secondary	191	13.3
College	23	1.6
University	2	0.2
None	39	2.7
Not applicable	390	27.2

Figure 4.2 shows the education level of the household heads of the study population considered separately. It was observed that half of the household heads in the study population had gone up to upper primary while a third had attained secondary education. A very small proportion had attained college and university education while 8.1% of the household heads had no education.

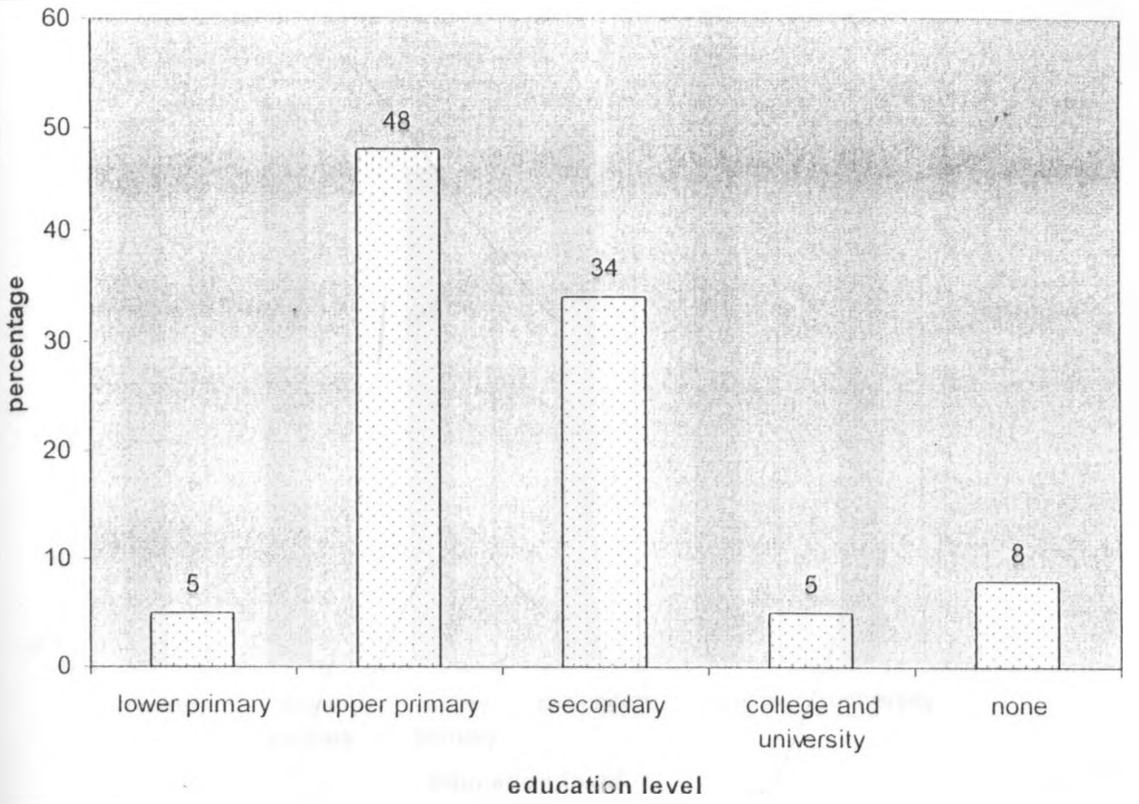


Figure 4.2 Distribution of household heads by level of education.

It was realised that education level among males and females was almost the same as seen in figure 4.3.

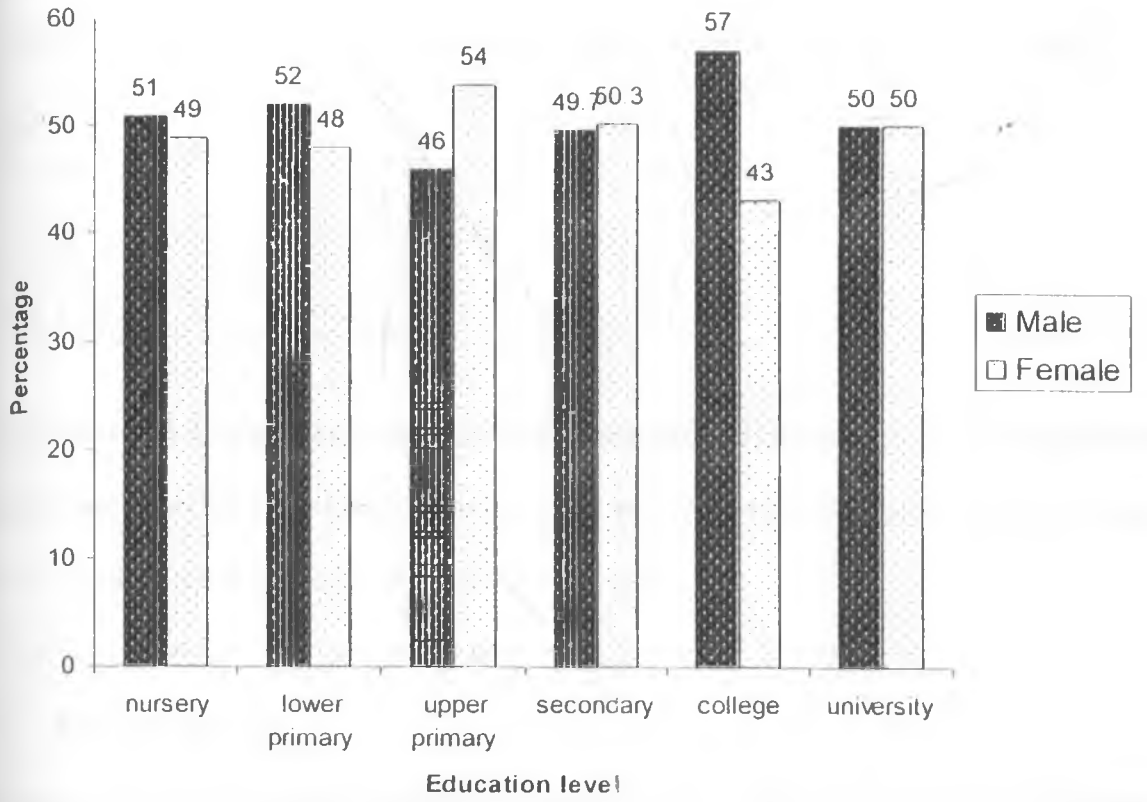


Figure 4.3 Distribution of study population by education level and sex.

4.3 Land Ownership.

The vast majority (98.8%) of the households owned some land while 1.2% did not own any land. The type of land ownership in most households was communal where the entire land belonged to the head of the extended family. This constituted 85.7% of the type of land ownership in the area, while12.4% of the study population cultivated their own land and only 1.9% rented land.

4.3.1 Acreage of land

The mean acreage of land owned by the study households was 4.4±2.8 acres with majority of the households owning between 2-6 acres as shown in table 4.5.

Table 4.5 Distribution of households by land acreage

Acreage	Distribution of households by land acreage (N=260)	
	n	Percentage
0-2	24	9.2
2.1-4	93	35.8
4.1-6	77	29.6
6.1-8	31	11.9
8.1-10	14	5.4
10.1-25	21	8.1

A t-test showed that there was a significant difference ($p<0.05$) in mean of land acreage between Itumbule and Kiunduani sub locations in the study area whereby Kiunduani had a higher mean (5.2 ± 2.7) while Itumbule had a mean of 3.7 ± 2.8 acres.

4.4 Food Production

The most commonly produced food crops in the study area included maize, beans, pigeon peas, cow peas, green grams, cassava and sweet potatoes (table 4.6). Most of the households grew the small grain cereals except for bulrush millet which was not produced at all. Sorghum and finger millet were the widely produced small grain cereals in the study area.

Table 4.6 Food crop production by the study households

Food crop	Study households (N=260)	
	n	percentage
Maize	259	99.6
Beans	255	98.5
Pigeon peas	253	97.3
Cow peas	253	97.3
Green grams	219	84.2
Sorghum	214	82.3
Finger millet	163	62.7
Bulrush millet	0	0
Cassava	140	53.8
Sweet potato	156	60

Figures 4.4 and 4.5 shows the distribution of household heads and production of sorghum and finger millet respectively.

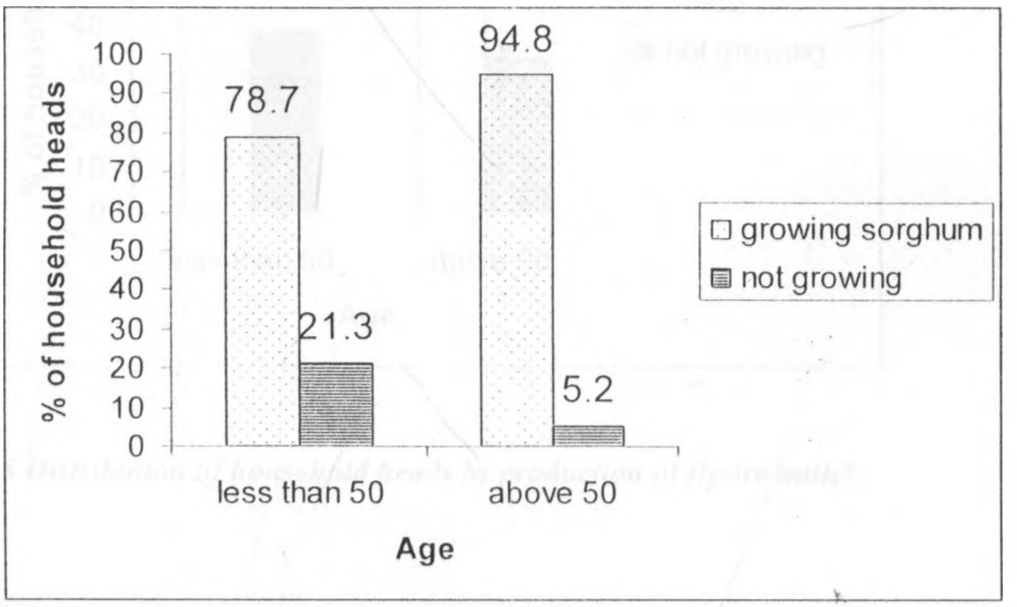


Figure 4.4 Distribution of household heads by production of sorghum.

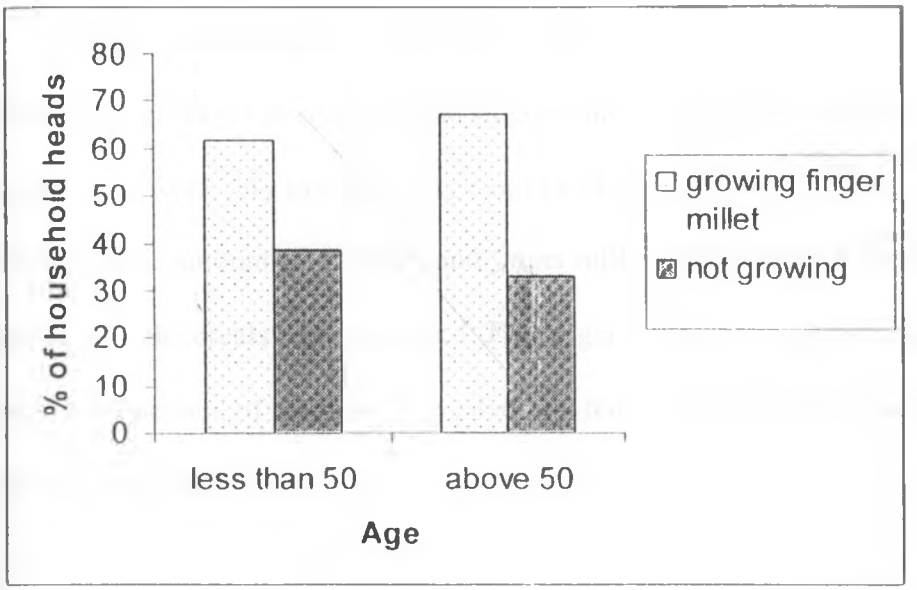


Figure 4.5 Distribution of household heads by production of figure millet

A chi-square test showed that there was a significant difference (p value < 0.05) in production of sorghum among the households headed by young people and those headed by older people with the later being the most producers. The relative risk (odds ratio) was less than one. Finger millet production did not show any significant difference (p>0.05) among the households headed by young and those headed by older people.

4.4.1 Production of small grain cereals

The mean acreage of sorghum (0.4) was higher than that of finger millet (0.2) and it constituted 9% of the total household land size in the study population. The land under finger millet was about only 5% of the total household land size. A t-test showed that there was no significant difference (P>0.05) in the mean acreage of sorghum and millet in households headed by males and those headed by females.

4.4.2 Amount of small grain cereals harvested

The mean amounts (kgs) of sorghum and finger millet harvested during the last short rain season before the study were very low at 50.2kgs and 11.1kgs respectively. Figure 4.6 shows the distribution of the amount of sorghum and finger millet harvested by different uses. A higher proportion of both cereals was consumed. The finger millet was consumed more than the sorghum. Four percent of sorghum harvested was fed to poultry while none of the finger millet was given to animals.

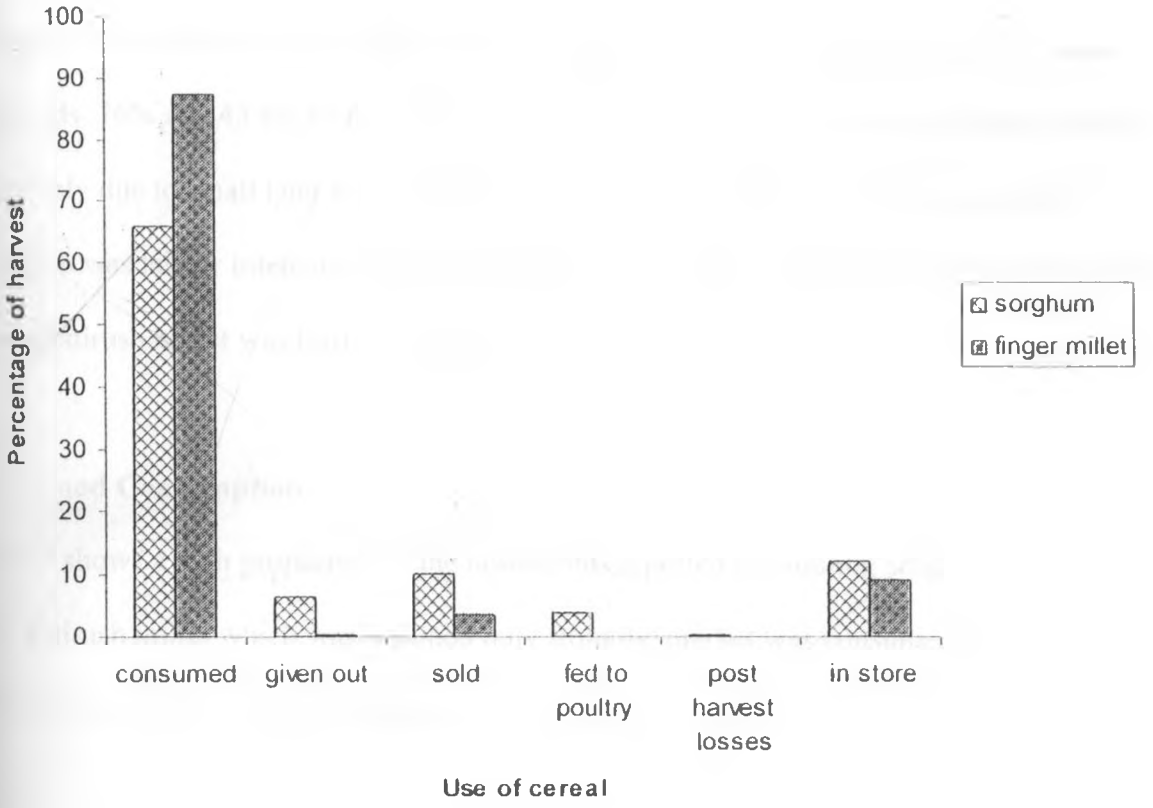


Figure 4.6 Distribution of harvested small grain cereal by different uses.

A t-test showed that there was no significant difference ($p>0.05$) in the mean amounts of sorghum harvested among male and female headed households. However a significant difference ($p<0.05$) was observed in the mean amounts of finger millet harvested between female and male headed households.

There was a positive correlation ($p<0.05$) between the acreages under which the two crops were planted and the amounts harvested. A positive correlation was also realized between the age of the house holdhead and the amount of sorghum and finger millet harvested.

Sorghum	r=0.265	p=0.000
Finger millet	r=0.142	p=0.022

Various reasons were mentioned as to why the small grain cereals were not grown by some households. 76% and 43.8% of the study households did not grow sorghum and finger millet respectively due to small land sizes. Another 43% did not grow finger millet because its production was labour intensive. The main reason, reported by study households (60.8%) for not growing bulrush millet was bird infestation.

4.5 Food Consumption

Table 4.7 shows a high proportion of the households reported consuming sorghum and finger millet. Bulrush millet which was obtained only from the market was consumed by a relatively small proportion of the study population.

Table 4.7 Consumption of small grain cereals

Crop	Proportion (%) of study households (N= 260)		
	consuming	consuming only to a small extend	not consuming
sorghum	48.8	50.4	0.8
Finger millet	45.8	53.8	0.4
Bulrush millet	11.9	41.2	46.9

Table 4.8 shows the preference of various energy foods by the study population. Most of the households rated maize as the first preferred food. A third of the study households rated finger millet as the third preferred food. A high proportion of the households rated bulrush rush millet as the last preferred food while none of the study holds rated the other small grain cereals as last preferred.

Table 4.8 Distribution of study population by preference of various energy foods.

Preference	Proportion (%) of study households						
Rank	sorghum	finger millet	bulrush millet	maize	cassava	Sweet potato	rice
1	13.5	0	0	80.6	0	0	0.8
2	26.7	42.7	0.4	6.6	0.4	1.6	27.1
3	35.7	32.5	0.4	12.4	0.8	5.1	13.2
4	18.2	21.3	0.4	0.4	4.7	20.5	34.1
5	4.3	3.1	1.6	0	19	62.5	10.9
6	1.6	8.8	5.8	0	69	10.9	12.0
7	0	0	91.5	0	0	0	2.0

Table 4.9 Distribution of study households by frequency of consumption of some common foods

Food	Frequency of consumption (% of households)					
	daily	Once per week	2 days per week	3 days a week	Once a month	Never
Cereals						
Maize	87.7	0	0.4	0.8	0	0
Sorghum	38.5	35	65	6.5	1.2	0
F. millet	31.2	34.2	8.1	10.4	8.5	0
B. millet	0	0	0	0	13.5	86.5
Rice	1.2	14.2	26.2	24.2	9.6	0
Root crops						
Cassava	0.8	26.5	10.5	1.5	30.8	14.6
S. potato	0	19.2	15.4	5.0	34.6	5.0
Legumes						
Beans	5.8	7.3	26.9	31.9	1.9	0
P. peas	0.4	12.7	47.5	25.1	2.7	0
G. grams	0	39.2	28.1	11.2	0	0
Vegetables						
Kales	13.1	4.2	9.2	17.0	12.7	0
Spinach	1.9	18.1	5.0	0.4	29.6	38.8
Cabbage	0.4	14.2	31.5	22.7	11.9	0
Tomato	43.5	1.2	2.3	11.9	0	0
Onion	48.1	1.2	3.1	9.2	0	0
Animal products						
Beef	0.4	31.9	16.9	0	35.4	0.8
Chicken	0	10.4	1.2	0.4	66.5	1.2
Eggs	0.8	34.6	39.6	6.2	7.3	1.2
Fruits	1.5	10	52.1	27.4	3.9	0

A third of the study households consumed sorghum and finger millet on daily basis (38.5% and 31.5% respectively). None of the households consumed bulrush millet on daily basis. A large proportion (13.2%) consumed once per month and the majority (86.5%) never consumed it. Cassava and sweet potatoes were mostly consumed either once per week or once per month.

Generally vegetables were not available in adequate amounts for most of the households. Onions and tomatoes were consumed on daily basis by slightly less than half of the households (48.1% and 43.5% respectively).

Beans and pigeon peas were the main legumes consumed by the study households, mostly 2-3 times per week as shown in table 4.9. Half of the study households consumed fruits twice in a week.

Various reasons for not consuming were reported. The major reason (sorghum 94.35%, bulrush millet 94.7% and finger millet 47.6%) for low consumption of the three cereals was reported as unavailability of the cereal at household level. High price was reported as the second main reason (46.5%) for low consumption of finger millet, while 3.5% of the households reported that sorghum had a bad taste. Bulrush being considered as a low class food was reported as the second main reason for its low consumption.

4.6 Utilization of the small grain cereals

Most of the products that used to be made from the small grain cereals in the past which included main dishes for the whole household were no longer being produced. Porridge was the main product made during the study time. It was used as breakfast for mainly the children. Other members of the study households used porridge just as a snack.

It was reported that the small grain cereals were not available in the markets and whatever was available was quite expensive for the study households.

Table 4.10 shows the distribution of study households by the products made from small grain cereals.

Table 4.10 Distribution of study households by the products made from small grain cereals

	% of households making the product		
products	sorghum	Finger millet	Bulrush millet
porridge	98	95.7	21.8
ugali	0.4	1.3	21.8
beverage	0.4	0	0
pilau	0.8	0.8	0
githeri	0.8	0	0
cake	17.2	2.2	0
Mandazi	6.9	0	0

A high proportion (sorghum 66.7%, finger millet 67.1% and bulrush millet 29.7%) of the study households were making products from the three small grain cereals mostly for the young children as shown in figure 4.7

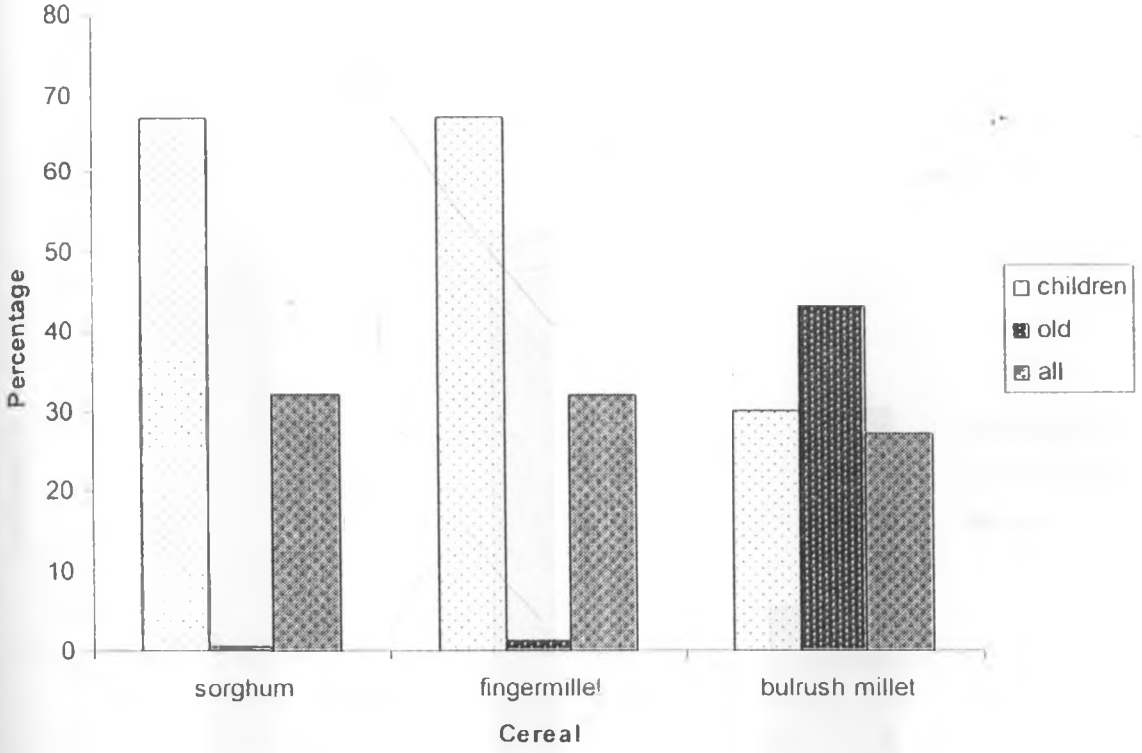


Figure 4.7 Distribution of study household members who consume small grain cereals most.

Only bulrush millet was consumed by a high proportion (43.15%) of the older people unlike sorghum and finger millet.

A high proportion (sorghum 88.4%, finger millet 89.2% and bulrush millet 29.9%) of the study households consumed the three small grain cereals through out the year provided they were available. Bulrush millet consumed was obtained only from the market. Smaller proportion (sorghum 11.2%, finger millet 10.4% and bulrush millet 3.8%) consumed the small grain cereals mostly only during the dry season as seen in figure 4.8.

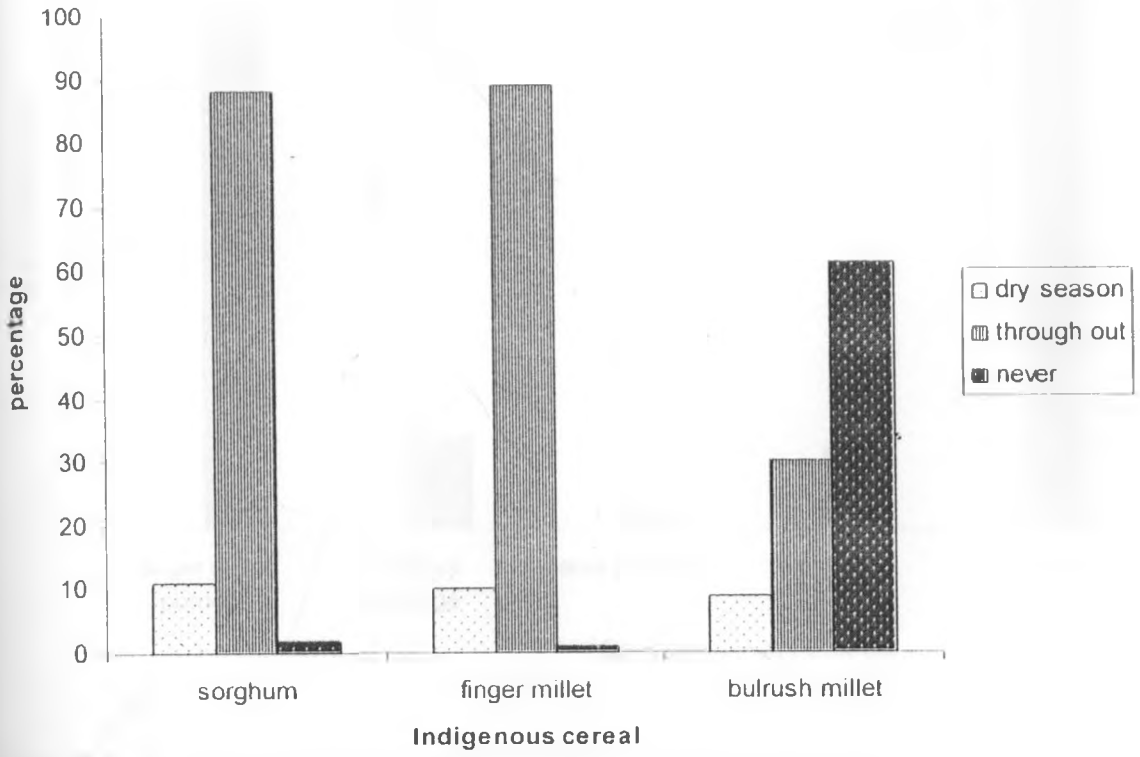


Figure 4.8 Distribution of households by when small grain cereals are consumed.

A high proportion (39%) of the study households were feeding their infants with finger millet porridge as the first complementary food following cow's milk (47%). Finger millet and sorghum were used as complementary food more than maize which was used by only 1% of the households (figure 4.9).

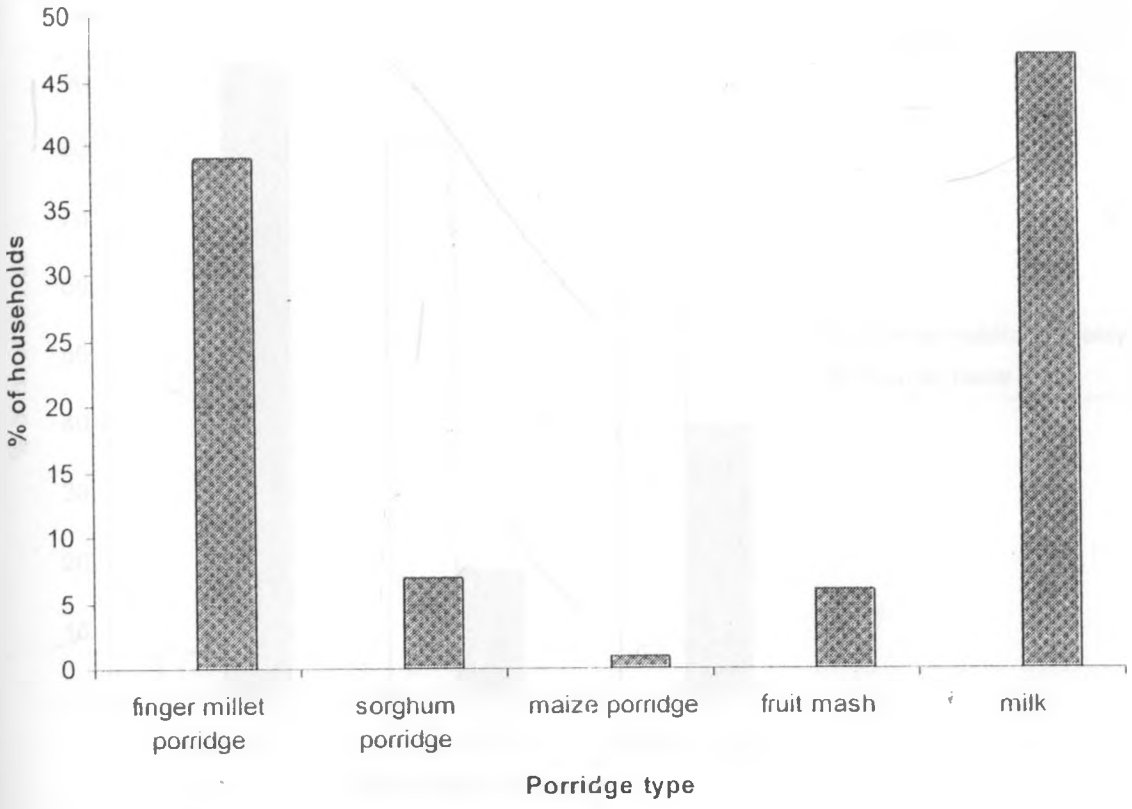


Figure 4.9: Distribution of households by first complementary food

A high proportion of the households reported mixing the small grain cereals with maize. Beans were also (sorghum 21.45%, finger millet 18.4% and bulrush millet 5.2%) mixed with the small grain cereals.

Figure 4.10 shows the main reason for mixing sorghum with other foods was to improve its taste. Improvement of nutrition quality was reported as the main reason for mixing other foods with finger millet and bulrush millet (finger millet 81.1% and bulrush millet 59.6%).

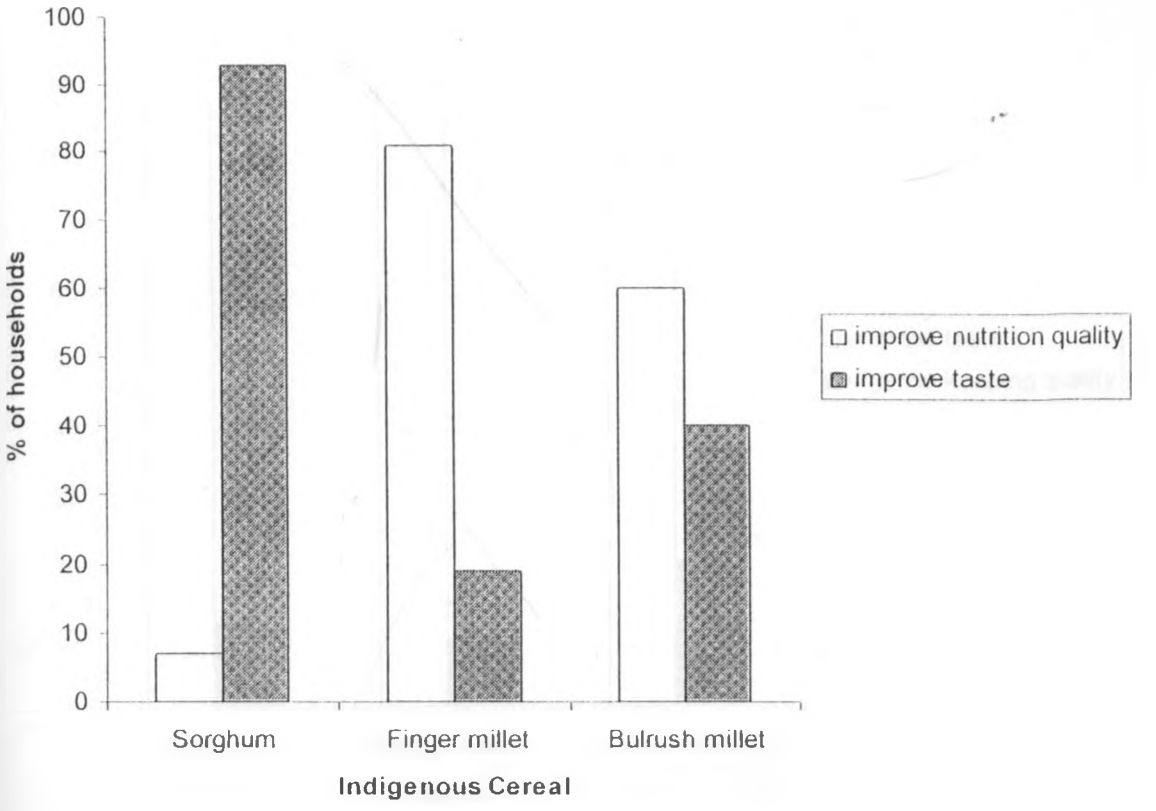


Figure 4.10 Distribution of households by reasons for mixing small grain cereals with other foods

Fermentation of the three small grain cereals was not a common practice among the study households (sorghum 12.5%, finger millet 11.3% and bulrush millet 4.7%). Among those who fermented, porridge was the only product made from the fermented flour. The main reason for fermentation was to improve the taste of the product (sorghum 87.9%, finger millet 90.3% and bulrush millet 78.6%). Another reason for fermentation was to improve the keeping quality (figure 4.11).

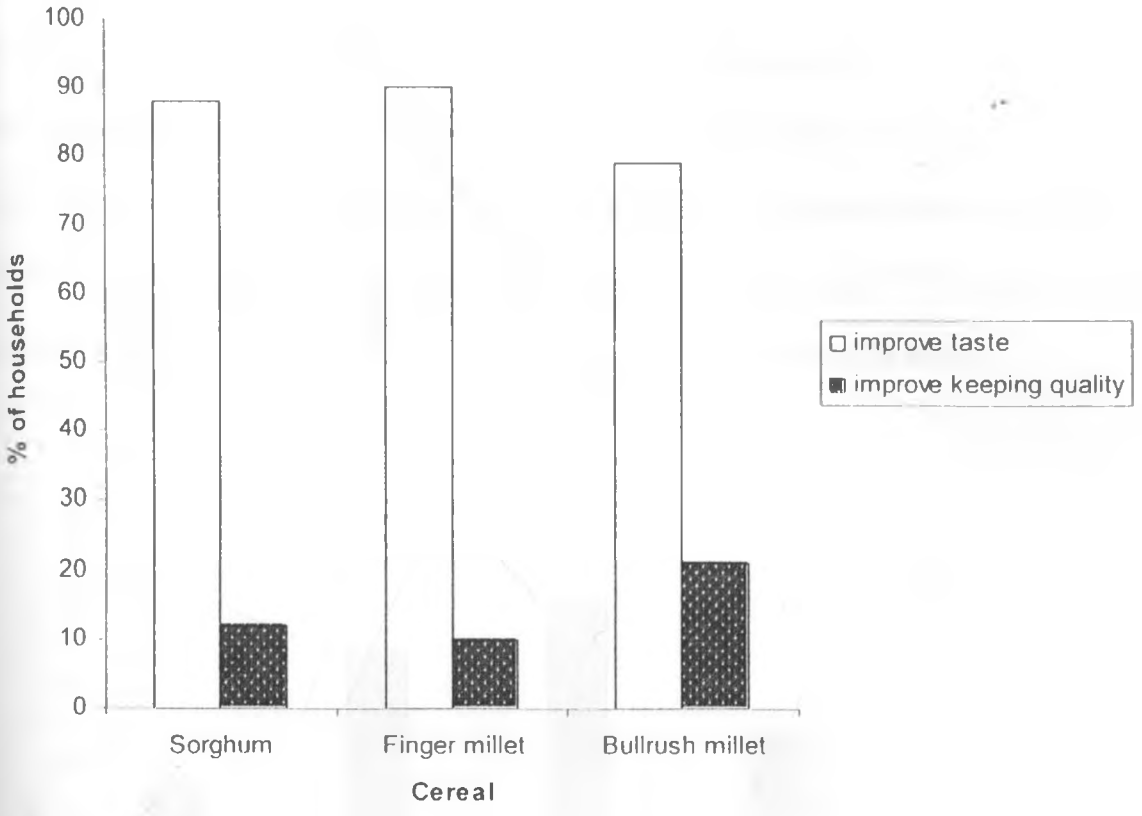


Figure 4.11 Distribution of study households by reasons for fermenting small grain cereals.

There was no significant difference ($p>0.05$) in the percentages of those who fermented the small grain cereals among the households headed by household heads aged above 50 years and those aged less than 50 years.

The study also revealed no significant association ($p>0.05$) between households that fermented the small grain cereals and occupation of the household heads.

4.7 Dietary Intake

Figure 4.12 shows the distribution of study children by energy intakes in relation to recommended daily allowances. Only about a third (30.6%) of the study children were consuming enough of calories when their daily intakes were compared with the recommended daily allowances (RDA). Children aged 12-23 months and those aged 24-35 months were most affected with 75% and 87.5% respectively getting less calories than the RDA.

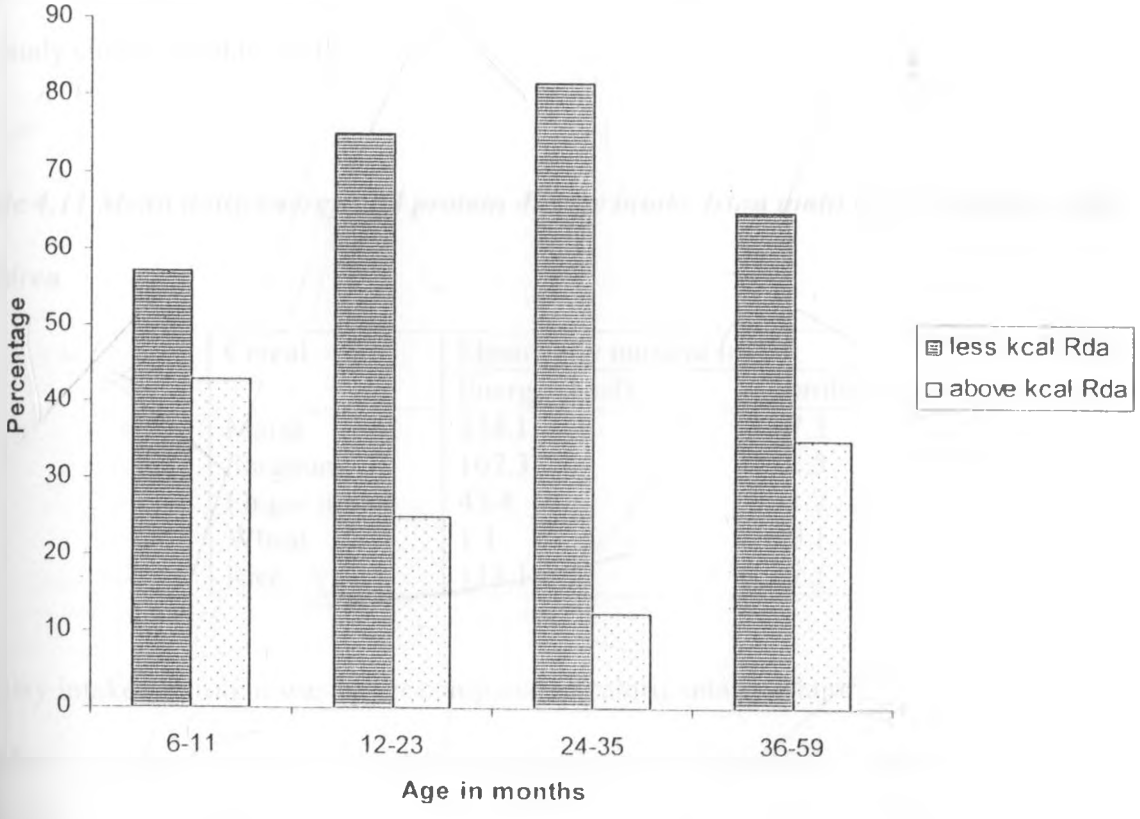


Figure 4.12 Distribution of study children by age and Energy intake in comparison to calorie recommended daily allowances.

Linear regression showed no linear relationship ($p>0.05$) between total caloric and protein intake and the size of land of the households.

Overall daily dietary caloric intakes indicated that majority of the study children got most of their calories from maize which contributed the highest (mean of 454 kcals) daily calorie intake. Among the cereals, wheat contributed the least amounts of calories to the daily intakes (mean daily intake of 1.1 kcals). While maize contributed the highest amount (mean of 7.3g) to the protein intake, finger millet provided the least with a mean protein daily intake of 1.2g among the study children (table 4.11).

Table 4.11 Mean daily energy and protein dietary intake from main cereals among study children

Cereal	Mean daily nutrient intake	
	Energy (kcal)	protein (g)
Maize	454.1	7.3
Sorghum	107.3	2.5
Finger millet	43.4	1.2
Wheat	1.1	0.1
Rice	113.1	2.1

Dietary intake of protein was better compared to caloric intake. Majority (80.6%) of the study children consumed amounts of proteins which were above the RDA. Table 4.12 shows that all the children aged 12 -35 months consumed protein amounts well above the RDA.

Table 4.12 Distribution of children by protein intake in relation to protein RDAs

Rda	% of children N=36			
	6-11 months (n=7)	12-23 months (n=4)	24-35 months (n=8)	36-59 months (n=17)
Less	57	0	0	18
Above	43	100	100	82

43% of children aged 6-11 months were consuming proteins below their RDA. The mean intake of calories and proteins by the study children were 1218.8 and 28.9 respectively. There was no significant difference ($p > 0.05$) in the mean intake between boys and girls among the study children.

The mean percentage of sorghum/finger millet calories out of the total caloric intake was 40.7% which was slightly lower than that of maize among the study children. A t-test showed that that there was no significant difference ($p>0.05$) in mean percentage intake of sorghum and millet calories between boys and girls among the study children. Most of the children in the different age groups had less than 50% of the total caloric intake contributed by sorghum and millet as shown in figure 4.13.

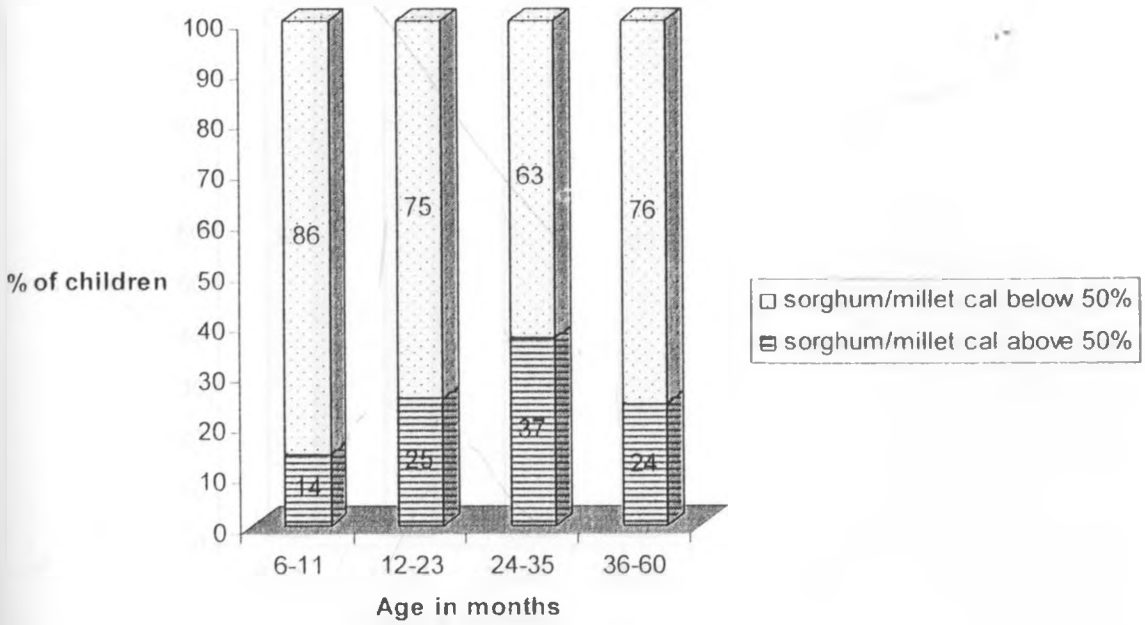


Figure 4.13 Distribution of study children by amount of calorie intake from sorghum/millet and age

Children aged 6-11 months had the least amounts of calories contributed by sorghum and millet. The amounts of sorghum/finger millet protein intakes varied among the different age groups of the study children. A higher proportion of the study children across the different age groups had less than 50% protein intake from sorghum and finger millet (figure 4.14).

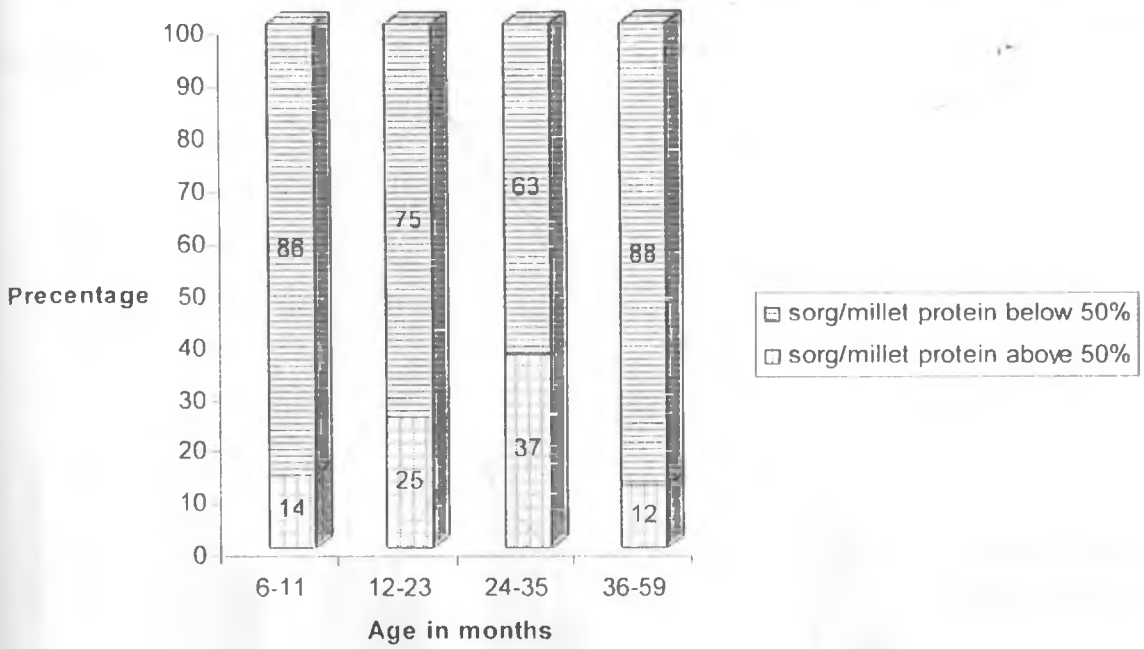


Figure 4.14 Distribution of study children by amount of protein intake from sorghum/finger millet and age.

The study showed that there was no correlation ($p > 0.05$) in calorie intake adequacies and the amounts of calories contributed by sorghum and millet. The same was observed with amounts of proteins contributed by sorghum and millet.

Figures 4.15 and 4.16 show the mean and standard deviations of calorie intakes from sorghum/finger millet and from other cereals by the children of different age groups.

There was no significant difference in the intakes of calories from sorghum and other cereals by the different age groups of the study children except for the children aged 36-59 months. The

same was observed in the protein intakes by the study children whereby a significant difference in protein intakes from sorghum/finger millet and the other cereals was observed only among children aged 36-59 months.

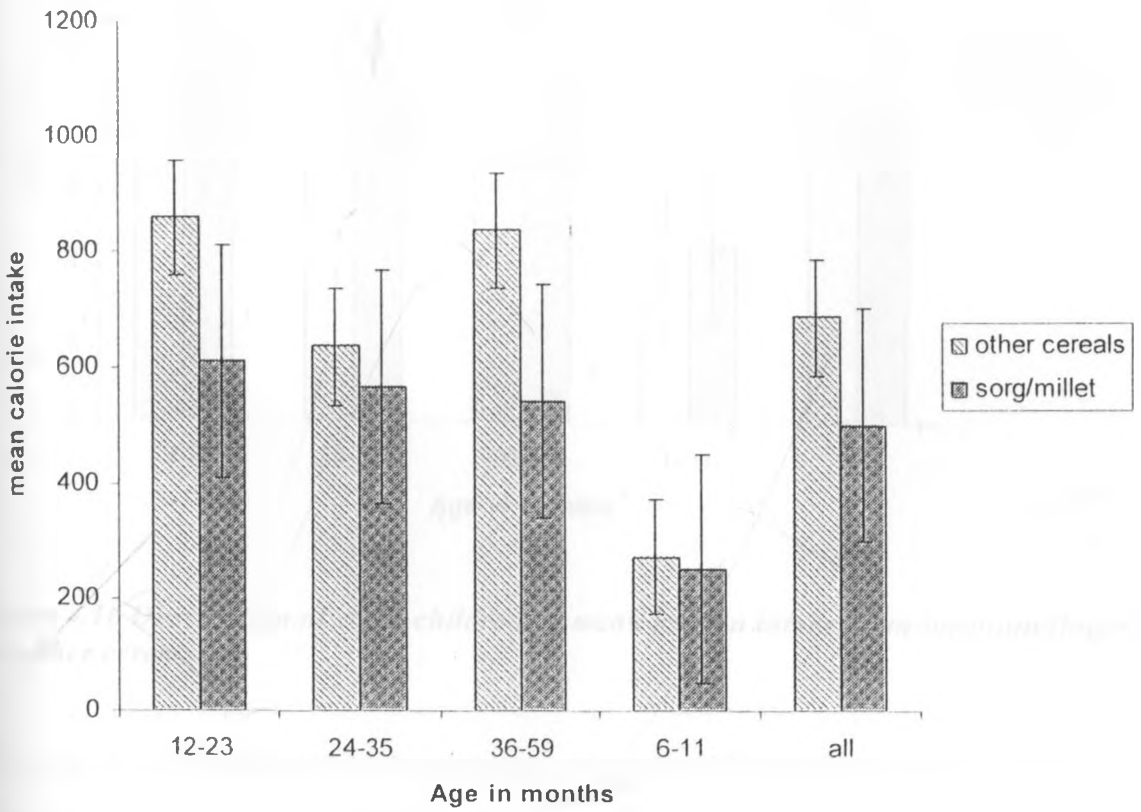


Figure 4.15 Distribution of study children by mean caloric intakes from sorghum/finger millet and other cereals

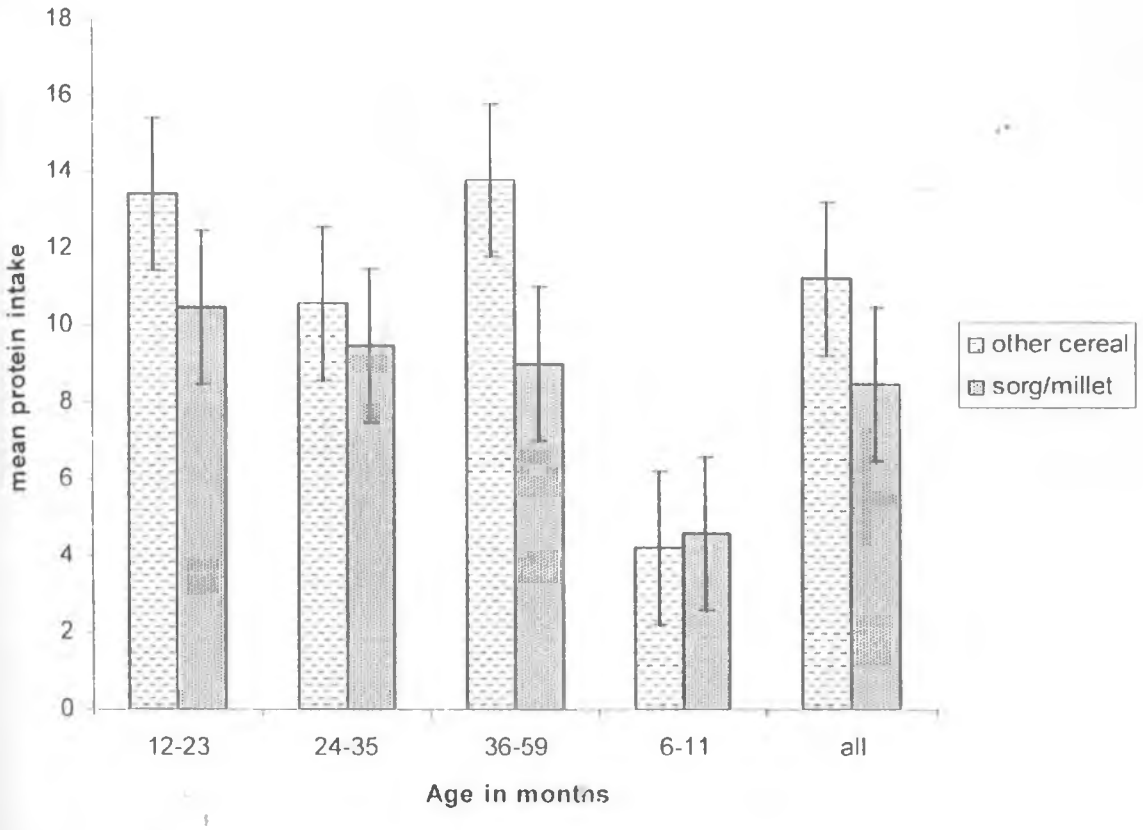


Figure 4.16 Distribution of study children by mean protein intake from sorghum/finger millet and other cereals.

When protein and calorie intake from sorghum/finger millet and all the other foods were considered, it was revealed that there was a significant difference in mean calorie intakes from sorghum/finger millet and that from all the other foods only among children aged 36-59 months (figure 4.17).

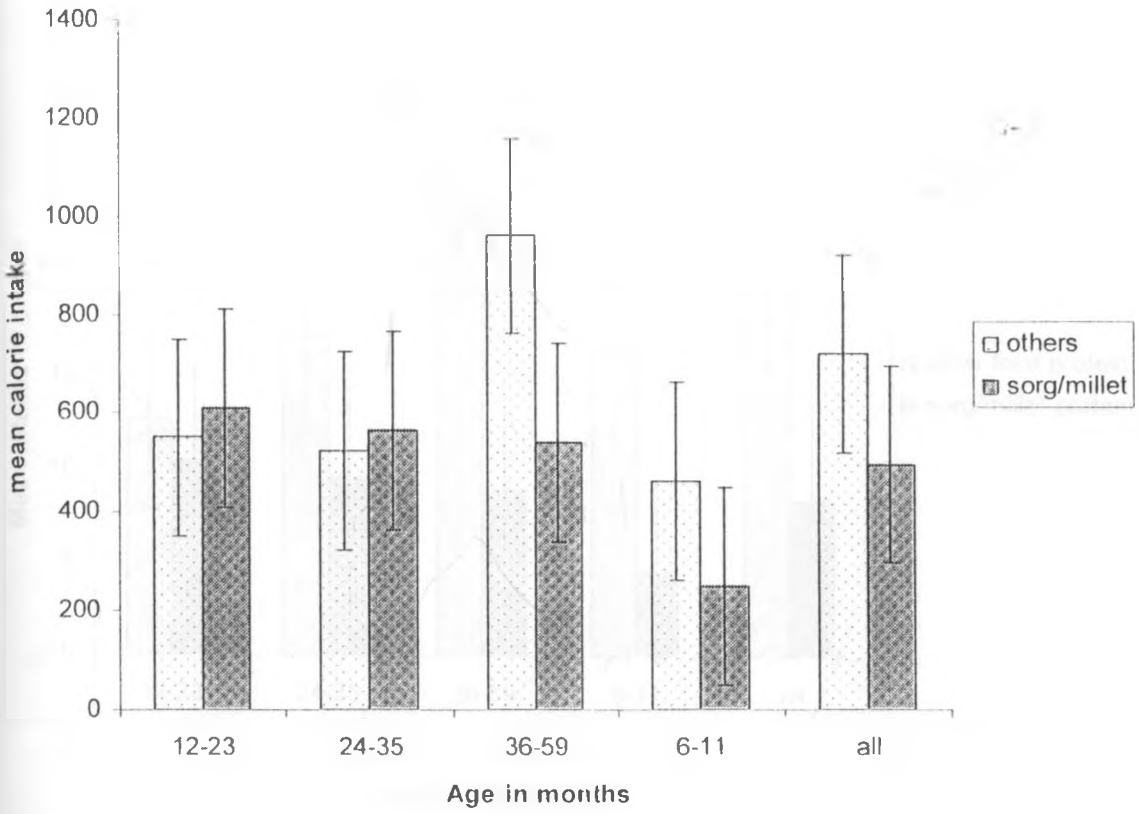


Figure 4.17 Distribution of study children by mean calorie intake from sorghum/finger millet and other foods.

Figure 4.18 shows that there was significant difference in mean protein intake from sorghum/finger millet and other foods among children aged 36-59 months, 6-11 months and all children.

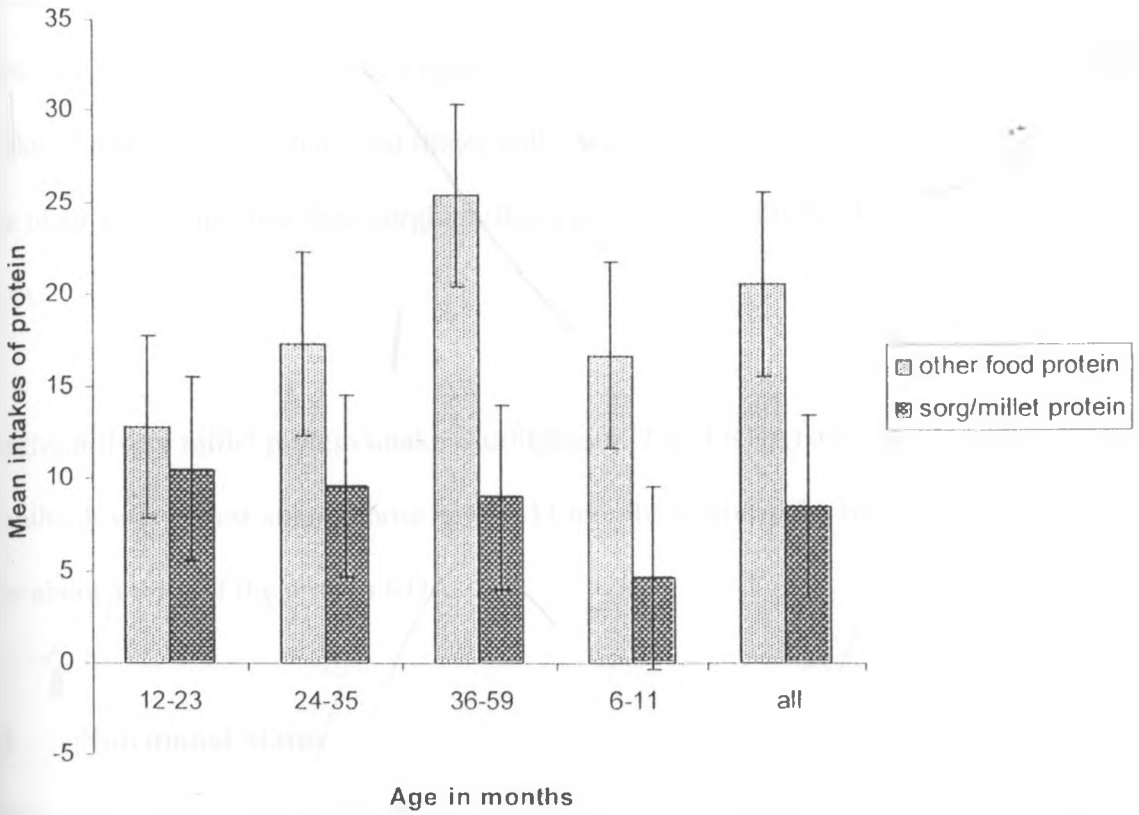


Figure 4.18 Distribution of study children by mean intakes of protein from sorghum/finger millet and all other foods.

Sorghum/finger millet contributed the highest energy and protein RDAs for children aged 12-23 months while in ages 6-11 months it contributed the lowest (Table 4.13).

Table 4.13 Distribution of study children by mean proportion of caloric and protein RDA contributed by sorghum/finger millet.

Age group	Proportion (%) of RDA contributed by sorghum/finger millet	
	Caloric intake	Protein intake
6-11	23.2	34.2
12-23	44.3	77.8
24-35	41.8	61.7
36-59	34.5	51.5

Table 4.13 shows that the children aged 12-23 months had a higher mean percentage calorie intake of RDA from sorghum and finger millet while children aged 6-11 months had the lowest. The other age groups had their sorghum/finger millet caloric intakes being about a third of their RDA.

Sorghum/finger millet protein intake was highest (77% of RDA) also among children aged 12-23 months. It was lowest among those aged 6-11 months whereby the sorghum/millet protein intake was about a third of the protein RDA.

4.8 Nutritional Status

Assessment of the nutritional status showed that 32.3% of the study children were stunted, 18.1% were underweight while a relatively small proportion (4.3%) were found to be wasted. As shown in the table 4.14.

Table 4.14 Malnutrition rates among the study children

Indicators	Nutritional status (N=260)		
	<-3sd (severe) (%)	<-2sd (moderate) (%)	>-2sd (normal) (%)
Height-for-age z-score (HAZ) (Stunting)	6.2	26.1	67.7
Weight-for-age z-score (WAZ) (weight)	3.5	14.6	81.9
Weight-for-height z-score (WHZ) (wasting)	1.2	3.1	95.8

The mean values of the three malnutrition indicators among the study children are shown in the table 4.15.

Table 4.15 Mean of malnutrition indicators among the study children

Malnutrition indicators	Mean (N=260)
Weight-for-height (wasting)	-0.2957 ± 1.1
Weight-for-age(underweight)	-1.0747 ± 1.07
Height- for- age (stunting)	-1.3405 ± 1.3

There was no significant difference ($p>0.05$) in the mean for all malnutrition indicators; stunting, wasting and underweight between the boys and girls. Table 4.16 shows the proportions of malnourished girls and boys.

Table 4.16 Distribution of malnutrition among girls and boys.

Sex of index child	Malnutrition rate (N=260)		
	Stunted (haz<-2) (%)	Wasted (whz<-2) (%)	Underweight (waz<-2) (%)
Boys (n=120)	50	54.5	48.9
Girls (n=140)	50	45.5	51.1

Prevalence of stunting among children aged between 12-23 months was significantly higher ($p<0.05$) than children of other age groups.

Prevalence of underweight was significantly higher ($P<0.05$) among children aged 36-47 months compared to the other groups as shown in the figure 4.19

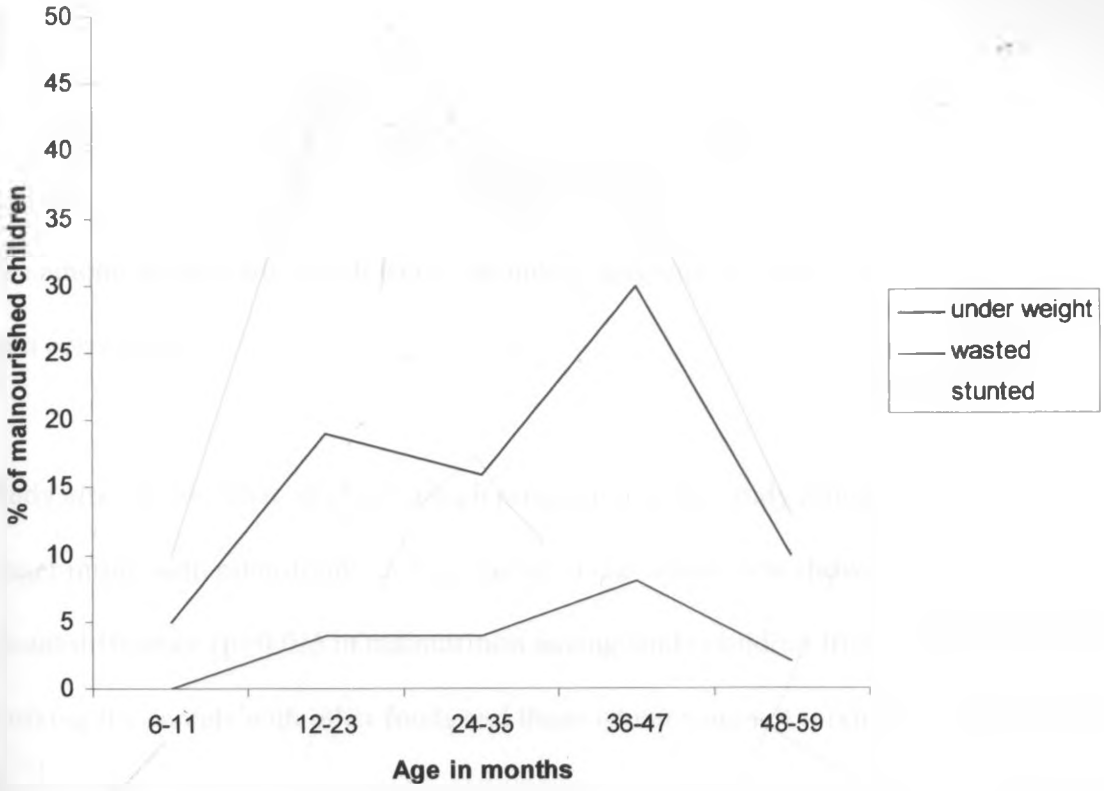


Figure 4.19 Levels of malnutrition among study children by age.

4.8.1 Child nutritional status and production of small grain cereals

There was no significant difference ($p>0.05$) in wasting, stunting and underweight among children between households producing and those not producing sorghum. Wasting and stunting also did not show any significant difference ($p>0.05$) among children in households which produced and those which did not produce finger millet. However underweight was significantly higher ($p<0.05$) in households that produced than those which produced finger millet.

Some of the malnutrition indicators showed some positive correlation ($p<0.05$) with the acreage under which the small grain cereals were grown by the households. There was a correlation

between the acreage of sorghum and wasting and also between stunting and acreage of finger millet.

4.8.2 Child nutritional status and utilization of the small grain cereals.

It was observed that there was no significant difference ($p>0.05$) in malnutrition of the study children among households which were consuming sorghum and finger millet and those which were not consuming.

The study also showed that although a high proportion of the study households mixed sorghum and finger millet with other foods as seen earlier, a chi- square test showed that there was no significant difference ($p>0.05$) in malnutrition among study children from households which were mixing the cereals with other foods and those which were not mixing. In addition, no significant difference ($p>0.05$) in malnutrition was established between children in households consuming sorghum and finger millet and those which were not consuming.

4.8.3 Child nutritional status in relation to contribution of sorghum/finger millet to calorie and protein dietary intake

The study revealed that the weight- for-age (underweight) and weight-for-height (wasting) malnutrition indicators correlated negatively with the amounts of calorie and proteins provided by sorghum and finger millet. Height-for-age did not show any correlation with calorie and protein intakes from sorghum and finger millet as shown in table 4.17 below.

Table 4.17 Correlations between malnutrition and sorghum and finger millet calorie and protein intake among study children.

Nutrient	Correlation indices		
Calorie	Waz	Whz	Haz
	r=-0.418	r=-0.352	r=-0.261
	p=0.011	p=0.035	p=0.124
protein	r=-0.0396	r=-0.369	r=0.217
	p=0.017	p=0.027	r=0.200

CHAPTER 5

5.0 Discussion

5.1 Demographic and Land Ownership Characteristics

The population of males and females in the study area were 48.8% and 52% males and females respectively. This is almost similar to the general Kenyan population which constitutes 49% males and 51% females (KDHS, 2003).

The proportion of children aged below 5 years is comparable to a normal distribution of the same in developing country population whereby they constitute about 20% of the total population. The higher proportion of persons in the young age groups than in the older age group is similar to the national distribution as revealed in the KDHS, 2003. This results to high dependency ratio which may lead to negative effects on the economy. Available resources including food are shared among a high number of persons and hence a low per capita. Low food per capita consumption may result to malnutrition in the study population.

The mean household size of 5.5 ± 1.7 is slightly higher than 4.4, the national mean household size in Kenya (KDHS, 2003). A high proportion (58.8%) of the households had 5-7 household members. Chaudry (1986) found an association between household size and the daily intake of nutrients by the members of the households. This implies that the large household size in the study area can result in low daily food intake which is an intermediate cause of malnutrition.

It is clear from the results that most of the study population has low levels of secondary and higher education and this could have contributed to few permanent occupations among the study

population. There might also have been lack of industries in the area to give employment opportunities.

Low secondary and higher education results from economic and socio-cultural factors which include, inability to pay non-tuition fees, lack of interest in schooling and failure to achieve sufficient grades in primary school. Pregnancies and early marriages also contribute to school drop outs (Gok/Unicef 1992). Mothers with higher levels of education have been reported to have better nourished children than those with low levels of education (chaudhuryi 1986) as most of them are aware of the nutritional needs of the members of the household.

Very few mothers were in permanent occupation the only means of livelihoods. This could mean that the contribution of maternal income to the household income is substantially low, and indicate that a majority of the mothers in the study area have very little control over household expenditures. Income that is controlled by the mothers has been reported to improve nutrition security of households as more of it is availed for food purchase (chaudhuryi, 1986).

5.2 Land ownership and crop production

While majority of the study households indicate to own some land where they were doing some farming, most of the land is still under communal ownership. Communal land ownership results to poor farming management as one may not be able to undertake long term projects on the land due to lack of security of land ownership. This contributes to low food production and hence household food insecurity.

It was realized that sorghum and finger millet are grown by majority of the study households while bulrush millet is almost completely abandoned. Sorghum accounts for about 9% of the total cultivated land, a result slightly higher than that reported by Reardon *et al* (1989) where sorghum accounted for about 4% of the cultivated land. Maize occupies most of the cultivated land, an indication that the study households prefer to grow maize more than the small grain cereals. Finger millet accounts for less (5%) of cultivated land than sorghum showing that sorghum is produced more than figure millet by the study households.

The two main reasons for lack of production of the two small grain cereals is small land size and finger millet is labour intensive. The same has been found elsewhere (FAO 1997). It is clear from the results of the focus group discussions that labour might be a major issue in production of the crop.

Children used to provide labour on the farms when school attendance was low and not very important in the past. Presently, most children attend school and their unavailability might have contributed to low production of the small grain cereals. Further more it is clear from the study that the population prefers growing maize indicated by the way the study households ranked the foods according to preference. This results in less production of the small grain cereals.

5.2.1 Amount harvested

A positive correlation of amount harvested and the acreage under which small grain cereals are grown indicates that, due to small acreage under small grain cereals, amounts harvested are very low. In addition, small grain cereals are planted on areas of the land with the most infertile soils

an indication that they are considered after most of the other crops or may be they are best suited for such areas.

5.3 Consumption and utilization

There appears to be no other innovative ways of utilizing the small grain cereals as the households consume them mainly as porridge which is utilized mostly by the young children. Other household members consume them as snacks because probably they do not consider them as main or staple food in the study area. This results to less consumption of the small grain cereal foods.

The study population considers finger millet porr dge as an important weaning food but its unavailability limits its consumption as a complementary food. The study households mixes sorghum and finger millet with maize in order to improve the taste of the cereals which might indicate that the small grain cereal foods produced are not very palatable and this results to their low consumption. Few also mixed with legumes in order to improve taste and quality for sorghums and finger millet respectively.

A small proportion of the study households mixes the small grain cereals with legumes indicating that a high proportion of the study population is not aware of the fact that the legumes can be used to improve the nutritional value of the cereals.

5.3.1 Fermentation of the small grain cereals

Fermentation of the small grain cereals is not commonly practiced by the study households. Less than a quarter of the study households produce fermented porridge in order to improve the taste and others in order to improve the keeping quality of the product.

Fermentation was practiced more in the past and that it has declined with the younger generations. Similar findings were reported in Korea where the consumption of fermented Kimchi'has declined with the younger generation (Korean Demographic and Health Survey, 1998.)

Fermentation has been associated with a reduction of occurring plant toxins (Antony *et al*, 1998). It also reduces the content of anti-nutritional factors such as phytates and tannins found in the cereals and is therefore likely to enhance mineral absorption (Lorri & Svanberg, 1995). Fermentation also increases the protein digestibility of cereal based gruels. The concentration of non-digestible oligosaccharides also usually decreases organic acids while other metabolites of fermentation contribute to the taste and aroma of fermented products. Increased use of non fermented cereals may therefore result to low nutrient value of the small grain cereal foods and decreased palatability which results into low consumption.

5.4 Dietary Intakes.

The study results indicate that more than two thirds of the study children consume calories that are below the recommended daily allowances (RDAs). Low intakes could occur because

possibly the survey was conducted at a time when there was a series of famine in the study area and hence household food insecurity.

Total calorie and protein intake shows no direct relationship with land size which is contrary to FAO, 1986 as it reports that there is usually a direct relationship between land holding size and per capita food consumption. This could be explained by majority of the households depending on the market for their food supply during the study period.

The study children aged 12-35 months have total protein intake which is apparently adequate. However, the protein is mainly of plant origin with low nutritional value. Food and Agriculture Organisation data show that the biological value (BV) of eight proteins of plant origin (cereals and legumes) is 61.2±2.65 as compared with 81.6±7.05 for five animal proteins. Although in theory, proteins from different plants in the right proportions can give amino acid profiles comparable to those of animal proteins (Muroki, 1990), this is not the case when a high proportion of the protein comes from cereal. The community however has a lot of poultry which is available in most of the households and could improve the amino acid balance in their diets. In advising the community, it should be pointed out that the diet should be adequate in energy, since energy spares protein (Passmore et al, 1986).

More than half of the children aged 6-11 months have protein intakes less than 100% adequacy. This may usually happen in the young baby below 12 months mainly due to inadequate diet. The mother may not have enough breast milk and the baby, if given other foods which it may not be able to assimilate due to its delicate digestive functions (Sehmi, 1993). Children aged 36-59

months may not have enough of protein intakes because of their higher physical activity requiring higher protein intakes.

Calorie intake from sorghum/finger millet is significantly low as compared to other foods among study children aged 36-59 months. This could be explained by the fact that children in this age group feed from the family pot. They no longer have the privilege of being fed often with the finger millet porridge.

Protein intake from sorghum/finger millet by all the study children is significantly lower than that from the other foods. This could be because of relatively low consumption of the small grain cereals. However, protein intake from sorghum/finger millet and other foods by children aged 12-35 months has no significant difference as children of this age are fed more on the small grain cereals as complementary food. Protein intake from small grain cereals by children aged 36-59 and 6-11 months is significantly low. This could be explained by the fact that children of this age groups are fed with less of the complementary foods.

5.5 Nutritional Status.

The prevalence (32.3%) of stunting among the study children implies a similar past nutritional experience. The stunting levels observed are slightly lower than the 32.7% reported in the 2004 Kenya Demographic and Health Survey for Eastern province and almost similar with those estimated by World Health Organisation (WHO) for developing countries (43%) (Zoakah et al, 2000). Stunting is generally associated with low socio-economic status (Jooste *et al*, 1997), which is the case in the study area. Generally, the prevalence of stunting is high but the

prevalence of wasting is low in the study area as is usually found in non emergency situations (Jooste *et al*, 1997).

Prevalence of malnutrition does not show any significant difference between households consuming and those not consuming small grain cereals. This could be explained by the fact that the mean intake of calories and proteins from the small grain cereals for those who consume the small grain cereals are significantly low compared to the intakes from other foods.

However, a negative correlation between wasting and consumption of small grain cereals could be explained by a general food shortage in the study area resulting in consumption of poor quality and quantity of the other foods.

It is noted that studies on association between nutritional status and sorghum/finger millet energy and protein intake for children aged 6-59 months are not available in literature and therefore more of such studies would be required to confirm findings of this study.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion.

From the study findings, it is concluded that the general consumption and production of the small grain cereals has considerably reduced in the study area. Small land size is the main factor for low production of sorghum while finger millet is not grown because of it being labour intensive. Bird infestation has completely discouraged the production of bulrush millet.

The amounts harvested are usually low and hence there is usually very little available at household level. This contributes to low consumption at household level.

Those cereals are usually considered after maize and are no longer used as staple food in the study area. Their importance is realized only as a weaning food usually utilized as a thin gruel referred to as 'porridge'. There are no innovative ways of utilization of the small grain cereals.

The fact is that production of the small grain cereals is on the way to extinction unless something is done and this has also reduced their consumption. The nutritious small grain cereal products are almost disappeared and this might have negative effect on the nutrition of the populations. It may also worsen the drought situation in the area since the coarse grains could stand the harsh climate better than maize hence ensure some harvest when rains are low and erratic.

It is also concluded that fermentation is almost a practice of the past in the study area and therefore the use of unfermented porridge would have negative effects on the nutrition of the study populations since its nutritional value is lower than that of the fermented products.

It is also concluded that the small grain cereals contributes low amounts of energy and protein intakes of most of the study children mainly because of low consumption of the same.

However, the hypothesis that, there is no relationship between dietary energy and protein intake, production and utilization of small grain cereals and the nutritional status of children aged 6-59 months is confirmed.

6.2 Recommendations

A combined effort by the government, Non-governmental organizations and the community at large is of ultimate importance in encouraging the production and utilization of the small grain cereals. It is recommended that;

1. Households are encouraged to increase the acreage under which small grain cereals are grown.
2. Utilization of small grain cereals should be promoted and the households trained on their nutritional importance. Variation of products of the cereals should also be explored.
3. The population should also be trained on better weaning formulations of the cereals.
4. Varieties resistant to bird infestations should be developed especially for bulrush millet which is already completely abandoned due to this problem.
5. There should be advocacy for workload easing for the women to create time for the production of those cereals.
6. Fermentation of small grain cereals should be encouraged to help improve the nutritional quality of the cereal foods.

REFERENCES

ntony U, T. Chandra (1998). Antinutrient reduction and enhancement in protein, starch and ineral availability in fermented flour of finger millet (*Eleusine coracan*). J. Agric. Food chem. 6: 2578-2582.

leiberg F.M, T. Brun, J.Goihman (1980). Duration of activities and energy expenditure of emale farmers in dry and rainy seasons in Upper Volta. British journal of Nutrition 43: 71-82.

harles M, J. Kikafunda (2003). Production and consumption of Bushera. *African journal of ood, Agriculture and Nutrition Development*.3 (1). 11.

haudhury (1986). Determinants of nutrient adequacy in a rural area of Bangladesh.

Doggett, H. 1988. Sorghum Londres, Longman Scientific and Technical.

Elimadfa , A. Konig (2001). Modern Aspects of Nutrition, present knowledge and future perspectives. *17th International Congress of Nutrition.* Vienna. 222-225.

Ernando (1981). Traditional and Non Traditional Foods. Roma.

Food and Agriculture Organisation (2001). World Agriculture towards *2015 / 2030.* London.

Food and Agriculture Organization/World Health Organization/United Nations University (1985). Report of joint expert consultation on energy and protein requirements. Technical Report Services no. 724. Geneva.

Food and Agriculture Organization (1986). The dynamics of rural poverty. FAO. Rome.

Food and Agriculture Organisation (1995). Sorghum and Millets in human nutrition. Rome. http://www.fao.org/DOCREP/TO818e/TO818E00.htm#contents.

Food and Agriculture Organisation (2005). Helping to build a world without hunger. Rome. http://www.fao.org /spfs/.

Fisher, Laing , T. Send (1991). Handbook for family planning operations research. Population council. New York, USA. 43 -46

Getahun A (1995). The role of wild plants in native diet in Ethiopia.In agro-ecosystems 1. 45-46.

G.O.K (2003). Kenya demographic & health survey. 22

G.O.K (2002). National Development Plan. 25

G.O.K (1987). Fourth Rural Child Nutrition Survey .18-19.

G.O.K (2004). Economic survey. 125

G.O.K (2001). Machakos District Development Plan. 7.

Gujt I. (1995). The hidden harvest – the value of wild resources in Agricultural systems. London. 4.

Harlan J. & D. Wet (1972). A simplified classification of cultivated sorghum. Crop Sci., 12: 172- 176.

Heyer J (1990). Poverty and food deprivation in Kenya's smallholder agricultural areas. The political economy of hunger. Clarendon press. Oxford. 237-279.

Jean A, S. Ritchie (1983). Nutrition and Families (Macmillan Press).London. 25-30.

Jooste P, L. Langenhoven, J. Kriex, E. Kunneke, M. Nyaphusi, B. Sharp (1997). Nutritional status of rural children in the Lesotho highlands. *East Africa Medical journal*. 74 (11). 680-688.

King F. and Burgess (1922). Nutrition for Developing Countries. Oxford University.

Korean Demographic and Health Survey. (1998).

Kennedy E, T. Rearden (1994). Shift to Non Traditional grains in the diets of East and West Africa. Role of women opportunity cost of time.

Lorri, U. Svanberg (1995). An overview of the use of fermented food for child feeding in Tanzania: *Ecology of food and nutrition*; 34. 65-81.

Latham M (1979). Human Nutrition in Tropical Africa. Cornell University, New York, USA.

Muroki N.M (1990). Improvement of the nutritional value and organoleptic and keeping quality of unfermented and fermented rice "uji" (porridge) with haricot bean (*Phaseolus vulgaris*) tempe. Research Report. Bogor, Indonesia: Nutrition Research and Development Centre.

Passmore R, M. Eastwood (1986). Human nutrition and dietetics. Hong Kong: Longman Group. 279-91.

Paula Giese (1997). Traditional food, health and nutrition. http://www.kstram.net/isk/food/food menu.html.

Ruth Oniang'o (2000).Benefits of traditional foods. *African Journal of Food, Agriculture, Nutrition and Development* 3 (1). 46-49

Schmi J.K (1993). National food composition tables for planning successful diets in Kenya. Nairobi: Public Health Laboratories, Ministry of Health.

Sebit M.F (1994).The potential role of traditional food plants in improving nutrition and broadening the food base in Uganda. A thesis submitted in fulfillment for the degree of Master of Science in applied human nutrition, University of Nairobi.

Susan M, P. Ann (1988). Tropical and Sub-tropical Foods. (London and Basingstoke). 222-224.

Slow Food (2004). Challenges to meet food and nutrition security in the new millennium. Turin, Italy. http://www.terramedra2004.org.

vanberg U. (1998). Dietary bulk in weaning foods and its effects on food and energy intake. ttawa, Canada IDRC. 272-287.

UNICEF (1994). The state of the world's children. Oxford, UK: Oxford university press.

UNICEF (1998). Situation Analysis of Children and Women in Kenya. 144-145.

UNICEF (1998). The State of the World's Children. Oxford University Press. New York

World Health Organization (1983). Measuring change in nutritional status. Guidelines for ssessing the nutritional impact of supplementary feeding programmes for vulnerable groups. WHO. Geneva.

Wood B.J.B (1994). Technology transfer and small grain fermented foods. Food research nternational. 269.

Zoakah A, I. Idoko, M. Okoronkwo and O. Adeleke (2000). Prevalence of malnutrition using Z- scores and absolute values in children under five years of age in Utan village, Jos, plateau tate, Nigeria. *East African Medical Journal*. 77 (3). 123-126.

APPENDIX 1

QUESTIONNAIRE

UTILIZATION OF SMALL GRAIN CEREALS AND THEIR CONTRIBUTION TO THE DIETARY ENERGY AND PROTEIN INTAKE IN CHILDREN AGED 6 TO 59 MONTHS IN YATHUI DIVISION, MACHAKOS DISTRICT.

Questionnaire No. _____

Date of Interview: _____ (dd/mm/yy) Name of index child

Name of Interviewer: _____ _____

Name of household head: _____ Index Child Serial No.

Name of Respondent: _____ _____

Relation to HH Head: _____

HOUSE HOLD COMPOSITION

Kindly let me know the names of the people who have been living with you for the last three months

No.	Name	1. Relation to HH Head	2. Sex	3. Age (years)	4. Age (months)	5. Marital status	6. Education level	7. Occupation
01								
02								
03								
04								
05								
06								
07								
08								
09								
10								

CODES

Relation to hhh	Religion	Sex	Marital status	Education Level	Occupation
1. Self	1. Christian	1.Male	1. married	1.Nursery	1. Student
2. Spouse	2.Traditional	2.Female	2.separated	2. Lower Primary	2. Casual
3. Son	3.Other (specify)		3.Divorced	3. Upper primary	3. Business
4. Daughter			4.Single	4. Secondary	4. Farming
5. No relation			5. Widow(er)	5.College	5. Housewife
6. Others (specify)			6.N/A	6.University	6. Permanent
			7.Others(specify)	7. None	7. N/A

Questionnaire No. _____

PRODUCTION AND CONSUMPTION OF SMALL GRAIN CEREALS

9. Do you own any land? 1 = Yes 2 = No

10. If yes, what type of land ownership?
1= Communal 2 =Rented 3 = Individual ownership

11. What acreage?
Communal_____ Rented_____ Owned_____

12. Do you grow the following food crops? 1 = Yes 2 = No

13. If the answer is [No] ask why?

Crop	1 or 2 (12)	13. Reasons
Sorghum		
Finger Millet		
Bulrush Millet		
Maize		
Pigeon Peas		
Green grams		
Beans		
Cow peas		
Cassava		
Sweet potato		
Others (specify)		

Code for No. 13
1 = seed availability 3 = diseases 5 = birds 7 = other (specify)
2 = land size 4 = labour intensive 6 = pests

14. What was the acreage for each crop last short rain season

Questionnaire No. _____

Do you plant these foods every year? 1 = Yes 2 = No

If No, give reasons [– multiple answers are allowed]

	1 or 2 (15)	16. Reasons
Sorghum		
Finger Millet		
Bulrush Millet		
Maize		
Pigeon Peas		
Green grams		
Beans		
Cow peas		
Cassava		
Sweet potato		
Others (specify)		

Code for No. 16

1 = seed availability 3 = diseases 5 = birds 7 = other (specify)
2 = land size 4 = labour intensive 6 = pests

Do you consume the following foods? 1 = Yes 2 = No 3 = Yes, only to small extend.

If No or to a small extend, why?

	1, 2 or 3 (17)	18. Reasons
Sorghum		
Finger Millet		
Bulrush Millet		
Maize		
Pigeon Peas		
Green grams		
Beans		
Cow peas		
Cassava		
Sweet potato		
Others (specify)		

Coding for No. 18

1 = Bad taste 2 = Not available at home 3 = Not available at market place
4 = Expensive 5 = Considered low class food 6 = others (specify)

Range the following food in order of preference (1= Most preferred)

Sorghum ☐ Finger millet ☐ Bulrush millet ☐ Maize ☐

Cassava ☐ Sweet Potato ☐ Rice ☐

Questionnaire No. _____

0. What products do you prepare from these foods? [Multiple answers allowed]

Crop	Product
Sorghum	
Finger Millet	
Bulrush Millet	

Coding

1 = Porridge 2 = Ugali 3 = Cake 4 = Mandazi 5 = Chapatti
6 = Beverage 7 = Brew 8 = Pilau 9 = Githeri 10 = Others (specify)

1. Among these products which ones do you prepare for sale. [Use coding as No. 17 and multiple answers are allowed]

Crop	Product
Sorghum	
Finger Millet	
Bulrush Millet	

2. Do you mix these foods with other foods when preparing? 1 = Yes 2 = No

3. If Yes, which ones?

Crop	1 or 2 (22)	Food mixed with (23)
Sorghum		
Finger Millet		
Bulrush Millet		

Code for No. 23

1 = beans 2 = cow peas 3 = pigeon peas 4 = green grams 5 = maize
6. Other (specify)_____

4. If you mix, why?

Crop	Reason
Sorghum	
Finger Millet	
Bulrush Millet	

Coding

1 = Improve nutritional quality 2 = Improve taste 3 = Other specify_____

Questionnaire No. _____

Do you ferment these foods? 1 = Yes 2 = No

[If Yes] what fermented products do you make? Multiple answers allowed

Crop	25	26. fermented product
Sorghum		
Finger Millet		
Bulrush Millet		

Coding for No. 26
1 = Porridge 2 = Brew 3 = Others (specify)_____

If you ferment, why? Multiple answers allowed

Crop	Reason
Sorghum	
Finger Millet	
Bulrush Millet	

Coding
1 = Improve taste 2 = Improve keeping quality 3 = Others specify_____
_____

Who consumes these foods most?

Crop	Person
Sorghum	
Finger Millet	
Bulrush Millet	

Coding
1 = Children 2 = Women 3 = Men 4 = The old 5=Others specify___
_____

When do you commonly consume the following foods?

Crop	Time
Sorghum	
Finger Millet	
Bulrush Millet	

Coding
1 = Dry season 2 = Wet season 3 = Throughout the year 4 = Others specify___
_____

Questionnaire No. _____

30. Are there special occasions when the foods are consumed as special food? 1=Yes 2=No

31. If Yes, which ones?

Crop	(30) 1 or 2	(31)Occasion
Sorghum		
Finger Millet		
Bulrush Millet		

Coding for No. 31. 1= Wedding 2= Birthday Parties 3= Other Specify

32. From the yield of last short rain season, please answer the following by filling in the table.

	32. Harvest		33. Consumption		34. Sales		35 Given out.		36. Fed to poultry		37. Post Harvest Losses		38. In store	
	unit	Amount	unit	Amount	unit	Amount	unit	Amount	unit	Amount	unit	Amount	unit	Amount
Sorghum														
Finger Millet														
Bullrush Millet														

Coding for unit

1= 2Kgs goro goro
2= Debe (18Kg)
3= 50Kgs Sack
4= 90Kg Sack

Questionnaire No. _____

39. **FOOD FREQUENCY CHECKLIST:**

Below is a list of foods. Please indicate how many times the food is consumed.

FOOD FREQUENCY CHECK LIST

Type of food	Days Per Week	Days Per Month	Days in a Year	Never. (Tick)
Maize				
Sorghum				
Finger Millet				
Bulrush Millet				
Cassava				
Sweet Potatoes				
Rice				
Sukuma Wiki				
Spinach				
Cabbage				
Cowpeas Leaves				
Pumpkin Leaves				
Cassava Leaves				
Tomatoes				
Onion				
Beef				
Chicken				
Eggs				
Beans				
Pigeon Peas				
Green grams				
Others- List				

Questionnaire No. _____

PARTICULARS OF INDEX CHILD
BREAST FEEDING AND FEEDING PRACTICES

40. For how long did you exclusively breast feed your child?

_____

41. How often does (name of index child) breastfeed if still breastfeeding?

_____

42. What complementary foods did you start with?
1 = millet porridge 2 = sorghum porridge 3 = bulrush millet porridge 4 = maize porridge
5 = fruit mash 6 = mashed food 7 = milk 8 = others specify 9 = multipurpose

43. How many times does (name of index child) feed in a day?

_____

IMMUNIZATION STATUS AND VITAMIN A SUPPLIMENTATION

	Types of Immunization	1=Yes 2=No 3=N/A
44	Tuberculosis (BCG Vaccine) - Check for Scar	
45	Diphtheria/Whooping cough/Tetanus (DPT)	
	• DPT I	
	• DPT II	
	• DPT III	
46	Oral Polio Vaccine	
	• OPV I	
	• OPV II	
	• OPV III	
	• OPV IV	
47	Measles	
48	Last Vitamin A Supplementation Received Date: (dd/mm/yy)	

Morbidity

49. Has the child been sick in the last 2 weeks? 1 = Yes 2 = No

50. [If No, go to 51. if Yes ask] which sickness?
1 = Diarrhea 2=Malaria 3=Cough and common cold 4=Skin Disease 5=Others

_____

51. Does the Index child sleep under a mosquito net? 1 = Yes 2 = No

Questionnaire No. _____

24 HOUR RECALL

From the time the child woke up yesterday to the time the child woke up today morning what foods has the child eaten?

Time	Name of food	Source	Total volume of dish	Name of ingredients	Amount of ingredients in dish (Units of measure)	Amount of food served to child (a) (Vol)	Amount left over by child (b) (Vol)	Amount consumed by child (a-b) (Vol)
52a. B/fast								
52b. Snack								
52c. Lunch								
52d. Snack								
52e. Supper								
52f. Breakfast								

Source Code
1. Home prepared 2. Purchased ready to eat 3. Others_____

Questionnaire No. _____

ANTHROPOMETRY

Name of child: _____

Sex: 1 = Male
2 = Female

Age in months: _____

Date of Birth: _____ dd / mm / yy

Measurement	First Reading	Second Reading	Average
53. Weight (kg)			
54. Height (cm)			

55. Presence of Oedema 1= Yes 2=No

APPENDIX 2

FOCUS GROUP DISCUSSION GUIDE

1. What were the commonest food plants available?
2. What small grain cereals do you produce and utilize?
3. Are the small grain cereals available and used as before?
4. What products do you make from small grain cereals?
5. What products did you use to make in the past?
6. Which of these products are made for the young children?
7. Are the small grain plant readily available in the markets
8. what problems do you encounter in production of these small grain cereals
9. Are these foods considered inferior to other food?
10. Who are the main producers of these food small grain cereals?
11. Do these foods have any importance to you during famines?
12. What is your general attitude towards the small grain foods

APPENDIX 3

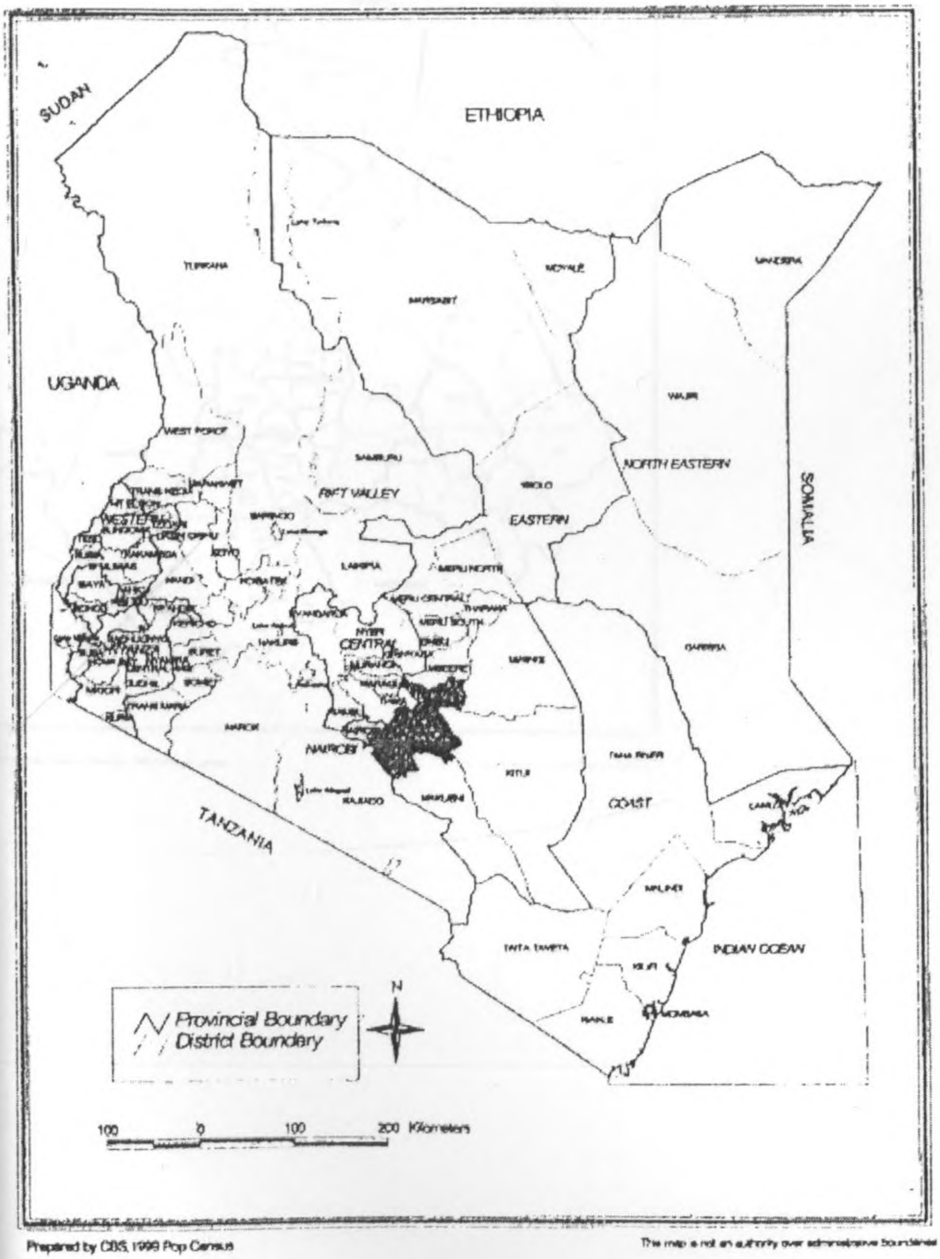
24 HOUR RECALL CALCULATION FORM

Time	Food	Total volume of dish (vol)	Ingredients in total dish (g)	Amount of food eaten by child (vol)	Ingredients eaten by child (g)
B/fast					
Snack					
Lunch					
Snack					
Supper					
B/fast					

APPENDIX 4

MAP 1

LOCATION OF MACHAKOS IN KENYA



Prepared by CBS, 1999 Pop Census

The map is not an authority over administrative boundaries

MAP 2

MACHAKOS DISTRICT (Administrative Boundaries)