

**COMPARATIVE STUDY OF RICE BRAN UTILIZATION AND
ANTHROPOMETRIC PROFILES OF CHILDREN AGED 6-59
MONTHS IN RICE-GROWING COUNTIES KIRINYAGA,
KISUMU AND KWALE IN KENYA**

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DEGREE OF MASTER OF SCIENCE IN HUMAN NUTRITION
AND DIETETICS OF KENYA METHODIST UNIVERSITY**

SEPTEMBER, 2024

DECLARATION

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

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DEDICATION

This thesis is dedicated to my family, Husband Mr Mutuku, son Declan, Parents Mr. & Mrs. Odingo, Mrs Grace Mwilu and my Aunty, Beatrice.

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ABSTRACT

Undernutrition is a critical global health issue, responsible for over half of all deaths among children under five. In developing countries, an estimated 143 million children are underweight, with Kenya reporting 82,000 annual deaths, significantly affecting vulnerable rural populations. This study provides a baseline assessment of the nutritional status of children aged 6-59 months in the rice-growing regions of Kirinyaga, Kisumu, and Kwale counties in Kenya. The study aimed to establish the prevalence of undernutrition and to determine whether rice bran could be utilized in complementary feeding practices within these communities. This baseline data is crucial for designing and introducing a rice bran feeding trial to potentially improve child nutrition outcomes. Simple random sampling selected 30 households with children under five years in each cluster. Using a cross-sectional study design, data collection involved semi-structured questionnaires administered to caregivers per region. A total of 1,218 children were assessed between January and March 2023, with sample sizes including about 423 (34.7%) children in Kirinyaga, Kisumu (32.3%), and Kwale 401 (32.9%). Anthropometric measurements of weight, height and mid upper arm circumference (MUAC) were taken using standardized equipment. The ENA for SMART application was used to analyze anthropometric data, interpreted using WHO standards (2006). Comparing underweight prevalence of this study with the Kenya Demographic Health Survey (KDHS) 2022 report, Kwale had 14%, Kirinyaga 6%, and Kisumu 4%, while this study's prevalence was 9.6% in Kwale, 4.7% in Kirinyaga and 1.5% in Kisumu. Severe stunting rates were also slightly lower: Kirinyaga (12.1%), Kisumu (11.1%), and Kwale (17.1%) compared to the reported KDHS 2022 severe stunting prevalences of Kirinyaga 11%, Kisumu 9% and Kwale 23.0%. For severe wasting, Kirinyaga was 3.7%, Kisumu 2.2% while Kwale gave 5.2% prevalence. High rates of malnutrition were observed, particularly in Kwale, where severe stunting affected 17.1% of children, severe wasting was present in 5.3%, and edema was recorded in 12.9% of cases. In all the three selected rice growing areas the male children had a significantly higher frequency of stunting, compared to female children. Further results indicate that while awareness of rice bran is relatively high in some regions—77.6% in Kirinyaga and 70.8% in Kisumu—it is overwhelmingly perceived as animal feed rather than as a food supplement for humans. A minority of participants across all regions agree that rice bran is a nutritious food product with significant health benefits. Only 19.6% of the total respondents agree with this statement, while 34.0% remain neutral, and a substantial 46.7% disagree. Regionally, Kwale has the highest agreement (27.4%), followed by Kirinyaga (24.6%) and Kisumu (6.1%). This indicates a general lack of recognition of the health benefits of rice bran among the communities. A majority of respondents perceive rice bran as best suited for feeding animals, with 55.3% agreeing with this statement. County governments in Kirinyaga, Kisumu, and Kwale should implement agricultural policies promoting rice bran awareness and its nutritional importance among farming households and consumers. Further research is recommended to explore the long-term effects of rice bran consumption on child nutrition and to identify the most effective strategies for its integration into local diets.

Keywords: *Nutritional status, Child malnutrition, Rice-growing regions, Anthropometric measurements, Kenya health survey*

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LIST OF ABBREVIATIONS AND ACRONYMS

HAZ	Height for Age Z score
KDHS	Kenya Demographic and Health Survey
NRF	National Research Fund
MUAC	Mid Upper Arm Circumference
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
WAZ	Weight for Age Z score
WFP	World Food Program
WHO	World Health Organization
WHZ	Weight for Height Z-score
FGDS	Focus Group Discussions
FAO	Food Agriculture Organization
H/A	Height for Age
HAZ	Height for Age Z score
USAID	United States Agency for International Development

OPERATIONAL DEFINATION OF TERMS

- Anthropometry:** The study of and method for taking measures of the body, particularly when used for categorization or comparison. In essence, the measurement of the unique human being in order to comprehend the physical difference among humans.
- Rice bran** A nutrient-rich byproduct of milling rice is rice bran (RB). It is made up of the nucellus, aleurone layer, seed coat, and pericarp. Protein, fat, dietary fiber, vitamins, minerals, and phytochemicals (mostly oryzanols and tocopherols) are abundant in RB.
- Dietary diversity:** is used to describe how many different foods or food types are ingested in a specific amount of time.
- Food access:** A measure of the household's ability to acquire food over a reference period
- Household:** refers to an individual living alone or a collection of people, related or not, who share meals or gather together to make common supplies for food and other necessities of life.
- Indicator:** is a scale that displays weight for height or age, for example, or an index that has cut-off values that indicate if a kid is malnourished or underweight.
- Nutrition status:** A person's health can be determined by their nutrition, their body's nutrient levels, and their regular metabolic processes.

Under five:	A child between 0 – 59 months
Underweight:	refers to being underweight for one's age, usually as a result of acute or chronic malnutrition (WAZ)
Wasting:	describes how a crippling illness causes fat and muscular tissue to "waste" away.
Z score or standard deviation:	The difference between a child's anthropometric value(s) and the reference population's median value.

CHAPTER ONE

INTRODUCTION

1.1 Background information

Rice as a cereal constitutes of several by products and Rice bran has been categorized as one of those by-products of agricultural that is as a result from the milling process as well as it constitutes approximately 10% of the total whole grain weight (Kinyuru et al., 2015). Kenya has recently produced white rice which has led to production of around 5,000 metric tons (MT) of rice bran produced per year (Kinyuru et al., 2015). It has numerous source of nutrients with effective health promoting benefits and this could eventually directly treat and reverse malnutrition, in young Kenyan children (Kinyuru et al., 2015). Apart from it being a rich source of one nutrient, rice bran also contains a variety of biochemical components that are important and essential in promoting gut health (Kinyuru et al., 2015). These biochemical components include; oligosaccharides, non-starch carbohydrates, phenolics and sterols (Kinyuru et al., 2015).

However, there are some effects of rice bran that has been shown on the immune response specifically protection against enteric bacterial pathogens to infectious diseases such as diarrhea have majorly been studied in animal models and only few in humans (Borresen & Ryan, 2014), therefore little is known on the effectiveness of rice bran in the prevention of diarrhea caused by enteric pathogens. Diarrhea is the second leading cause of health lost to illness compared to other medical conditions, (Kiptoo et al., 2013). 90% of all gastrointestinal infection that are diarrhea-related diseases that occur in children under five years age living in low and middle-income countries (Kiptoo et al., 2013). Also diarrhea caused by enteric pathogens has been

highlighted as a top killer of children in developing nations (Kiptoo et al., 2013). Statistics from recent studies have shown that about 80% of childhood deaths as a result of enteric diseases occur mainly in Asia and Africa with Kenya being ranked the tenth as the worst hit countries by childhood diarrhea (Mulatya & Ochieng, 2020; World Health Organization [WHO], 2017).

A relevant aspect of human health has been highly related to the intestinal microbiota (Rodríguez et al., 2015). There is an essential function that the microbial population assists with essential functions in the body system such as aiding in development of the immune system and also providing defense against enteric infection (Moore & Townsend, 2019). In line with these recent studies have demonstrated the prebiotic effect of rice bran in promoting the gut microbiota and consequently reducing enteric pathogens which aids in the prevention and treatment of infectious diarrhea in children under five years (Zambrana et al., 2019).

1.2 Problem Statement

Rice has been categorized as one of the most important foods supplying about half of the daily calories in the diet in developing countries. However, processing of rice alters its nutritional content. This therefore has an impact in a negative way in the overall nutritional status of children. Several plant compounds have been identified poor source of antioxidants and white rice is one of the plants. 90% of all diarrhea-related deaths have been shown to take place among the children who are under five years of age living in both low and middle income countries (McCormick & Lang, 2016). Rice bran has a rich source of known nutrients and powerful phytochemicals that has got wide range of health benefits and could directly tackle malnutrition, across the lifespan of the under five-year children. Kenya has recently produced white rice

which has led to production of five thousand MT of rice bran produced annually; most of which is utilized as animal feed and has therefore not received any attention by advocates of food and nutrition security programs that are capable of utilizing that into creating awareness. (Kinyuru et al., 2015). The FAO Rice Monitor report carried out in April 2018 issue that was to analyze and forecast the world rice production, utilization, and global rice inventories in 2017/2018 and 2018/19 season failed to include any information on rice bran.

1.3 Purpose of the Study

The purpose of this study was to do a comparative analysis of utilization of rice bran and analysis of anthropometrics profile among children 6 – 59 months in selected rice growing areas in Kenya.

1.4 Objectives

1.4.1 General Objective

Comparative study of rice bran utilization and Anthropometric profiles of children aged 6-59 months in rice-growing counties Kisumu, Kirinyaga and Kwale in Kenya.

1.4.2 Specific Objectives

1. To assess the methods, knowledge and preferences for rice bran utilization among care givers of children aged 6 to 59 months in Ahero, Mwea and Kwale.
2. To determine the rice and rice bran consumption patterns among children aged 6 to 59 months in Ahero, Mwea and Kwale.
3. To Measure the anthropometric profiles of the children aged 6 to 59 months of Ahero, Mwea and Kwale.
4. To Perform comparative analysis of the anthropometric profiles among children aged 6-59 months in Ahero, Mwea and Kwale.

1.5 Research questions

1. What are the rice bran utilization methods, knowledge and preferences among care givers of children age 6 -59 months in Ahero, Mwea and Kwale?
2. What are the rice and rice bran consumption patterns of children aged 6 to 59 months in the selected rice growing area of Ahero, Mwea and Kwale?
3. What are the anthropometric profiles of the children aged 6 to 59 months in Ahero, Mwea and Kwale?
4. What is the comparative analysis of the anthropometric profiles among the children aged 6 to 59 months in Ahero, Mwea and Kwale?

1.6 Significance

The study aimed at improving and assist in mitigating infectious diarrheal diseases. This is because rice bran components have shown beneficial effects on the immune response. Also, since rice bran is globally accessible, affordable and abundant it can be incorporated into the diet of children under five years and consumed as a food product, as it represents a promising and practical diet-based solution for increasing the innate resistance in infants and young children under five years against enteric pathogens that in large scale may cause diarrhea., because of its immune stimulatory functions, it can be used potentially as a vaccine adjuvant for enteric pathogen infections.

1.7 Limitation

There were restrictions on the availability, security, and access of household heads. The villages' community health workers were used to combat this.

1.8 Delimitations of the study

The socioeconomic and demographic traits of the homes with children aged 6 to 59 months were examined in the study. The study also examined the dietary diversity, nutrient intake, and nutrition status of children aged 6-23 months in 40 villages located in the selected rice-growing areas of Ahero, Mwea, and Kwale in Kisumu, Kirinyaga, and Kwale Counties in Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The literature review insights on previous studies that have been done by other researchers in relation to comparative analysis of anthropometric profiles among children of 6 to 59 months in the selected rice growing areas. It reviews rice bran consumption patterns, utilization and preferences, and compares anthropometric profiles of children 6 to 59 months in these selected rice growing areas.

2.1 Rice and rice bran consumption pattern of children who are 6 to 59 months' old.

Under nutrition is very prevalent in the countries which are perceived to be of low- and middle-income and this has caused under growth and development in children in their early years of development (WHO, 2017). Rice bran is accessible food with different prebiotics and phytochemicals that induce different non-specific immune responses (Linn et al., 2014). However, in some parts of the world this is not the case and more so in Kenya where people prefer rice consumption to rice bran. But with the healthier food products, rice bran could remain high (Kiptoo et al., 2013). Global rice bran market has been estimated to be 1.2 million tons by 2015 (Tan & Norhaizan, 2020) with production mostly concentrated in Thailand, India, Japan, China and Vietnam. However, rice bran consumption rate in Kenya is limited to almost zero because it has not been embraced fully by rice growers in Ahero, Mwea and Kwale.

To identify rice bran consumption pattern and outcome, there was a six-month randomized controlled dietary intervention that was carried out in a cohort of weaning six months old infants in Nicaragua. The outcome of the intervention was that rice bran consumption influences stool metabolome (Zambrana et al., 2021).

On the contrary, the dietary interventions that provide vitamins, zinc and iron has not been successful in improving growth outcomes in children with environmental enteric dysfunction that affects nutrient absorption. (Smith et al., 2014). However, In Kenya this consumption pattern of rice bran in rice growing areas is not well outlined yet and therefore studies need to be conducted to highlight the consumption of rice-bran under five-year-old children.

Most Kenyans living in the rural areas grow basmati, Pishori and aromatic varieties of rice. Consumption of rice remains limited. The primary basic grain, maize, is consumed at a rate of 1% annually and wheat at 4%, but there is a 12% increase. In actuality, this is linked to a steady shift in eating patterns. Consuming rice bran affects a number of metabolites linked to development and growth promotion. It also supports nutrient absorption, as shown by variations in the GLP-2 level in the serum of newborns from Nicaragua (Zambrana et al., 2019). Thus, the purpose of this study is to ascertain how rice bran is consumed in the regions of Ahero, Mwea, and Kwale.

2.2 Utilization methods, knowledge and preferences among the children of 6 to 59 months

More over half of the world's population still produces and consumes rice, making it one of the staple foods. After sugarcane and maize, it is the third most elevated agricultural crop; the continents that grow rice are Asia, Africa, and America.

Similarly, rice byproducts remain underutilized in these countries as people majorly prefer rice to rice bran and this can be answered by 678 million of tons of rice being produced in the year 2014 in these continents. Even though Africa has not embraced rice bran fully, Latin American pre-school going children are taking rice bran drink because of its nutritious nature.

Latin Americans use rice bran to make various types of drinks and beverages such as isotonic drinks, frosted tea drinks, upgraded juices, mineral supplements and sports refreshments (Tubiello et al., 2013). This is in contrast with African situation specifically Kenya where rice is produced but farmers still do not see the importance of bran in the lives of under-five year-old children. In fact, rice bran is majorly treated as just one of the byproducts of rice just like rice husk. Bran is used to feed broilers from day 1 to 21 (Ebling et al., 2015). Several studies have highlighted bran as anticancer agent because it produces phenols that exhibit induced apoptosis of cancer cells (Bodie et al., 2019). It would be interesting to see how rice bran in Kenya can be converted in useful means, not only used as chicken feed but also to be used as food for under 5-year-old school going children due to its nutritional value.

It will be of high interest to examine the responses of colonic microbes to the presence of rice bran in the digestive system and if diarrheal cases would be prevented among 6-59 month old children within Ahero, Mwea and Kwale because several studies have suggested that rice bran can also prevent several chronic diseases and it is rich in dietary fiber which helps to maintain a healthy weight and prevent overeating and providing a feeling of fullness during consumption (Gul et al., 2015). This because there are limited studies on this topic that have conducted in these three areas. Therefore, this study seeks to determine rice bran utilization and

preferences in 6 to 59-month-old children and their comparison with their anthropometric profiles in these areas of study.

2.3 Anthropometric profiles among children of 6 to 59-month-old

Anthropometric assessments are the most efficient, simple, direct, and generally non-invasive ways to evaluate and determine nutrition status (Duren et al., 2008). According to Mei et al. (2002), these anthropometric measurements primarily characterize body mass, body size, and body shape, but they also provide relative indices of fatness. Weight, height, waist circumference, skinfold thickness, and BMI-for-age are the most used anthropometric-based measurements and indices in children (Duesenberg et al., 2016; Ejlerskov et al., 2015; Hoffman, 2000). Anthropometric profiles, together with measurements of height, weight, waist circumference, and BMI for age, are widely utilized in Kenya.

Rice bran from the rice, is a food with various important and essential macro and micronutrients that keep the body safe from invasion viral and bacterial pathogens that cause diarrhea and can lead to stunted growth (Linn et al., 2014). Some studies show that there is enough evidence based direct relationship between environmental enteric dysfunction and growth deficits in children and their growth spurts (Guerrant et al., 2016). Similarly, other studies also suggest that rice bran can also prevent several chronic diseases and it massive richly availability of dietary fiber which helps to maintain a healthy weight and prevent overeating and providing a feeling of fullness during consumption (Gul et al., 2015). Therefore, prevention of over eating among young children of under 5 years can also prevent overweight at this tender age. So, it would be of interest to do comparisons of these anthropometric measures

to see whether rice bran will add value to the lives of children in these rice growing areas.

Children are classified by the bodies that assess nutrition of populations according to wasting, stunting and overweight (De Onis et al., 2019). Height, weight, head circumference, body mass index (BMI), body circumferences (waist, hip, and limb) to measure adiposity, and skinfold thickness are the main and most often used anthropometry profiles (Casadei & Kiel, 2019).

Therefore, it would be necessary and better to understand the relationship between these anthropometric measures and rice bran consumption. GLP-2 is an intestinotrophic hormone secreted by enteroendocrine L cells in the gut in intestinal epithelium and it increases epithelial proliferation, inhibit apoptosis, increase digestion, blood flow and nutrient absorption (Brubaker, 2018). There have been several studies that has demonstrated direct relationship between tryptophan in rice bran and obesity where they reported that there was a linear growth in infants at 8 and 12 months (AACR Project Genie Consortium et al., 2017). However, there is still limited information on the relationship between rice bran components and BMI. Therefore, this study seeks to find out comparisons of anthropometric measures of 6- to 59-month-old children these rice growing areas.

The essential information needed for the evaluations includes the child's age, sex, weight, height/length, MUAC measures, and clinical symptoms of evident wasting and bilateral oedema. These measurements are used to assess acute malnutrition in children aged 6-59 months. Measurements of length or height are always dependent on the age and physical condition of the child; children under the age of 24 months,

such as those who are 23.9 months and under, have their length measured, and children over the age of 24 months have their height measured.

When a child's age is unknown for any reason, the child's measured length (which is also measured for children under 87 cm) and height (which must be more than or equal to 87 cm) should be utilized. A child's length should be measured if it has been established or is known that the child is too ill or weak to stand. Anthropometric markers WFH and MUAC can be used separately to diagnose acute malnutrition. A kid's or adult's WFH Z-score computed for them shows or conveys precisely how many standard deviations in weight the child or adult has from an adult of the same height in the WHO GS.

Accordingly, a positive WFH Z-score indicates that the measurement of the individual is greater than the weight value that was measured and recorded for an individual of the same height in the WHO GS, whereas a negative WFH Z-score indicates that the measurement was less than the weight value that was recorded for an individual of the same height.

Child morbidity and crude mortality rates can increase twenty times over, even in areas that were previously healthy. Child death rates can climb from two to seventy times higher than usual. Adequate nutrition and care of children has been highlighted as one of the main variables to enhance child health and stability and baby and young child feeding. As a result, support has grown to be a prominent approach in managing to reduce child morbidity and mortality.

2.4 Nutritional composition of rice bran and its potentials benefits

11–17% protein, 12–22% oil, 10–15% moisture, 6–14% fiber, and 8–17% ash is all present in rice bran. Rice bran contains a variety of vitamins and minerals, such as calcium, magnesium, zinc, phosphorus, aluminum, iron, chlorine, manganese, niacin, vitamin E, and thiamine. Significant levels of nutraceutical chemicals, mostly natural antioxidants including oryzanol, tocopherols, and tocotrienol, are also present in rice bran, with about 4% of it being unsaponifiable. Because rice bran has a highly digestible protein that is rich in important amino acids, particularly lysine, it can be employed in a variety of culinary applications to prepare a wide range of dishes and cuisines. The widely accessible fiber in rice bran can be employed as both a functional and nutritious ingredient because of its antioxidant characteristics, which also make it a suitable supplement to boost food storage durability. Using rice bran will allow you to make low-fat, high-fiber baked goods. In industrial settings, rice bran is added to meat emulsions and batter mixtures to enhance their nutritional content. Given the potential of rice bran, the focus of this research is on its usage in the food sector. Specifically, the nutraceuticals, nutritional makeup, and application in rice bran can affect the population, particularly children under five. Since rice is a staple food for 25% of the world's population, its significance for the nutritional needs of the population as well as its cultural significance are clearly demonstrated.

Plant-based natural products have long been utilized as a main source of preventative medicines for the treatment and prevention of illnesses in both humans and animals (Bagchi et al., 2006). Phytochemicals and other nutraceuticals are thought to present some of the best chances for enhancing human health (Camire et al., 2003, Gul et al., 2015). Because they have the potential to counteract a variety of health conditions,

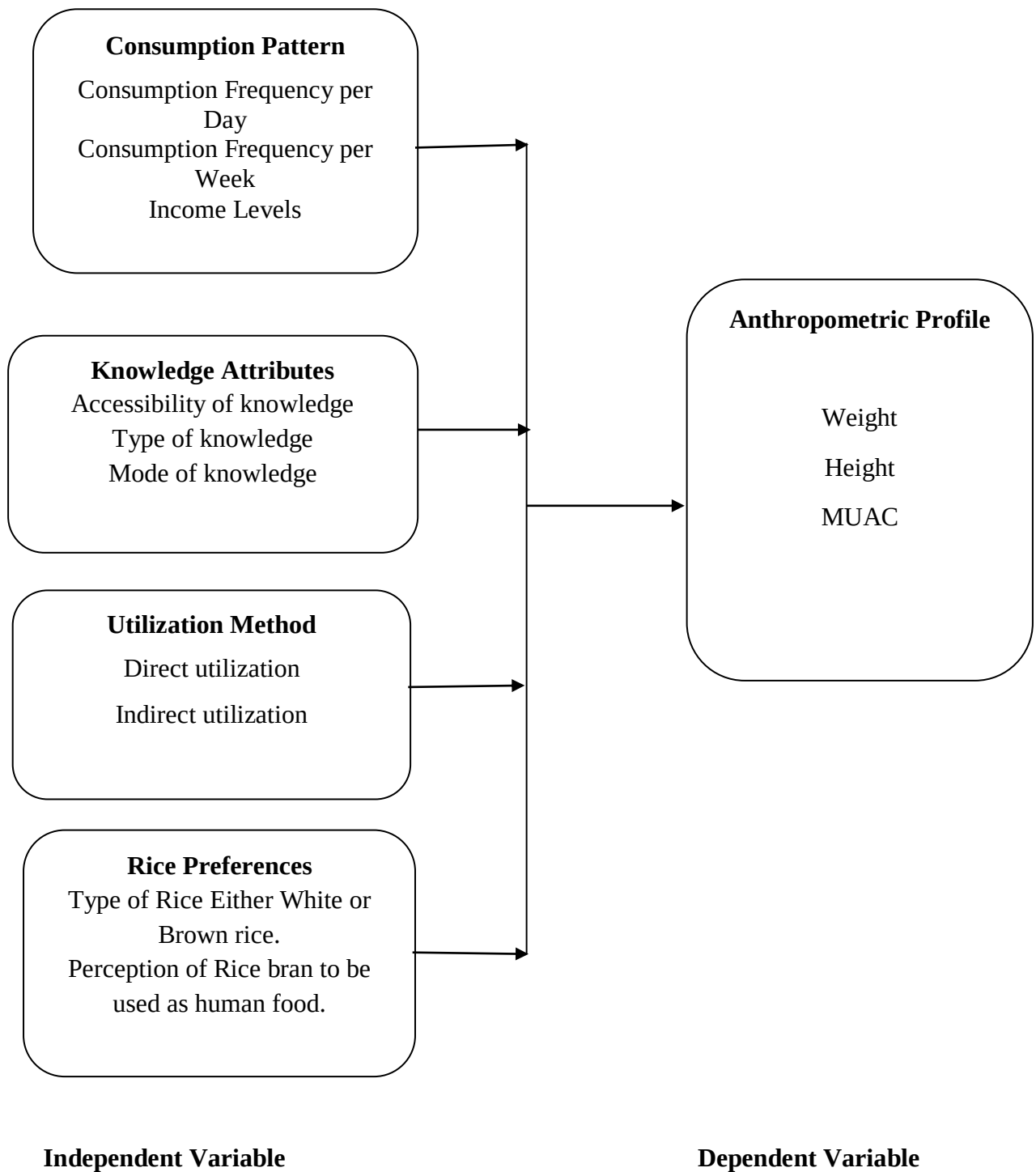
phytochemicals, both dietary and non-dietary, have recently been the focus of research. Because rice bran contains phytochemicals that are dietary in nature, it is important to continue research on these phytochemicals in order to combat and counteract life-threatening health conditions.

2.5 Conceptual Framework

An analytical technique that can be utilized to gain a thorough knowledge of a phenomenon is a conceptual framework. It can be applied in several professional domains and is also useful for providing a visual explanation of important ideas or variables as well as illustrating the connections between them that can be researched (Poehlmann & Eddy, 2013).

Figure 1

Conceptual Framework



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The methodological techniques applied in the data gathering and analysis will be covered in this chapter. This includes a detailed discussion of the research design, study location, study population, sample size and technique, research tools, data collection methods, analysis, and presentation of the findings. The validity and reliability of the research tools utilized, as well as the ethical considerations that were considered both before and after the study, are also explained in this chapter.

3.2 Research design

In order to create a comparative analysis of rice bran utilization and nutritional profile analysis among children aged 6 to 59 months in Kirinyaga, Kisumu and Kwale counties, this study used a cross-sectional research methodology. Both quantitative and qualitative data collection was made possible by the design.

3.3 Study Variables

The variables in this study were divided into two categories: dependent and independent variables. The weight-for-height z-score (wasting), weight-for-age z-score (underweight), and MUAC were the parameters used to measure the child's anthropometric profiles, which were the dependent variables. The study's independent variables were categorized into three categories: immediate, socio-economic, and demographic influences. These categories included consumption patterns, knowledge levels, utilization patterns, and individual preferences.

3.4 Study Area

The study was carried out in the three selected rice growing areas, in the counties of Kirinyaga specifically in Mwea, Kisumu specifically in Ahero and Kwale county specifically in Lunga lunga (Appendix I). Kirinyaga county which is located the south of Mount Kenya. The county's capital is Kutus and its largest town is Wanguru. According to 2019 KNBS, the county's population was at 610,411 people and an area mass of 1,478.1 km² and agriculture was and is the main economic activity in the County. The county is best known for rice production from the Mwea Irrigation Scheme, where this study was carried out. The study area was carried out in the sub-counties of Mwea East, Mwea west and Mwea and in the Constituency of Mwea.

Kisumu County is located in the areas of western regions of Kenya and Its headquarters is Kisumu City which is the third largest city in Kenya after the capital Nairobi and the coastal city of Mombasa. The county's population is at 1,155,574 according to the 2019 National Census. The land mass area of the County is at 2085.9 km². Rice is grown In Ahero under irrigations schemes in the Kano Plains that is located 20 kilometers east of the county capital city and where also the Nyando River flows through central Ahero that is in constant flow to irrigate its many rice fields. The study area was carried out in the sub-counties of Ahero in the constituency of Nyando.

Kwale County is located in what was once Kenya's Coast Province. Although the major town is called Ukunda, the capital is Kwale. The county of Kwale is divided into six sub-counties: Matuga, Kinango, Msambweni, Samburu, Lunga Lunga, and Shimba Hills. The county's land mass is 8,960 km², and its population, based on 2023 KNBS projections, is 944,000. In the livestock farming zone, the primary

sources of revenue are animal production, firewood collection and burning, and casual waged work. Three different revenue streams are produced in the mixed farming livelihood zone: food crops, cash crops, and livestock. The Kwale sub-counties of the Lunga Lunga constituency served as the study area.

3.5 Study Population

This study had a population study of 1218 children who were aged 6-59 months in the selected households in the selected rice growing areas in Kirinyaga, Kisumu and Kwale counties. The house heads provided information on the social and economic characteristics, child care practices, dietary practices and details on family agricultural activities. The Anthropometric Profiles were done from the study of the children for establishing the nutritional status that they had.

3.5.1 The Target population

The target population was children who were aged 6-59 months old in the three-rice growing selected areas in Kenya.

3.5.2 Inclusion Criteria

The inclusion criteria involved those Children within the age of 6 to 59 months living in this specific selected rice growing areas. The children with no known history of food allergies, no use of anti-inflammatory drugs or traditional medication during the week before the study commences, as well as no use of gastrointestinal medication, probiotics, prebiotics or antibiotics and no current dietary restrictions. Written informed consent was obtained from their caregivers of all eligible children before enrollment.

3.5.3 Exclusion Criteria

The exclusion criteria involved Children who were less than 6 months and those above the age of five years and/or those with a known history of food allergies or major dietary restrictions. Children taking cholesterol-lowering medications or Non-Steroidal Anti-inflammatory Drugs (NSAIDs), antibiotic or probiotic within the last month prior to the beginning of the study.

3.6 Sample Size determination

According to Mugenda & Mugenda (2003), the target population should possess certain observable features, from which the study hopes to generalize the findings. According to Blumberg et al. (2014), a target population is the entire collection of elements about which we aim to draw conclusions. As a result, the sample size for this study was determined using the Cochran (1977) formula, as indicated below;

$$no = z^2pq/e^2$$

Where, no is the sample size,

z= the standard normal deviation which is 1.96 at 95% confidence interval,

p = the (estimated) proportion of the population which has the attribute in question,

$$q = 1 - p$$

Hence; p = proportion (prevalence) of children 6-59 months with malnutrition in Kenya is estimated at 30.2 %

$$q = 1 - p; 1 - 0.302 = 0.698$$

e = the desired level of precision (the margin of error) of +/-5% = 0.05

Therefore; $n = (1.96)^2(0.302)(0.698) / (0.05)^2 = 1218$

The sample size of 1218 children 6 to 59 months was divided into the three (3) selected rice growing areas. And adding a non-response rate of 10% of the sample 1218 children and then the final total sample size will be 1250 children. This is due to natural Attrition that may occur e.g., Death, Accidents, Severe Pandemic or epidemics, kidnapping or theft.

Thus;

$406 \times 10/100 = 41$ children $406 + 41 = 447$ children under five years for each rice selected areas.

Each area will have a sample size of 447 children 6 to 59 months old.

Ahero in Kisumu County 447 children

Mwea in Kirinyaga county 447 children

Lunga Lunga in Kwale County 447 children

3.7 Sampling Method

Both Cluster random and Purposive sampling method was used to select the participants in the three counties selected for this study, Kiriyanga, Kisumu and Kwale in Kenya because of prior information on the irrigation schemes in their areas, whereby, the villages were listed in these counties and then there was balloting, then the researcher chose randomly the first ten villages from the whole sample. The Locations consisted of 1218 households which provided the sampling frame. Each of the 1218 households was assigned a unique identifier according to the survey question (SQ#) which was Survey questionnaire numbers depending with the

counties 002, 020 and 042 and a simple random sampling technique was used to select 1218 households that were included in the study. The method offered every household an equal chance of being included in the sample.

3.8 Data collection tools.

Data was gathered in households using a questionnaire form that was produced in English and given to the respondents in Swahili during a planned, structured interview that included both open-ended and closed-ended questions. The questionnaire tool comprised questions about the parents' and guardians' education, occupation, monthly income, religion, and knowledge about the production, consumption, and utilization of rice and rice-bran, as shown in appendices B. The questions were designed to assess the sociodemographic and social-economic status of the children's households. Relevant questions pertaining to the study's aims were taken into consideration when creating the questionnaire.

The questions made sure that data related to the research variables were gathered. A 24-hour recall method was utilized for the dietary assessment, which evaluated the food consumption of the study participants and ascertained the nutritional sufficiency of the children aged 6-59 months.

For the Anthropometric profile, a wooden stadiometer and a calibrated bathroom scale were used to measure each child's height and length. A MUAC tape was used to measure the mid upper arm circumference, while a calibrated length board and scale were used to measure weight in kilograms. The questionnaire was used to capture all of the determined readings in order to calculate the nutritional status of the youngsters. The researcher and the research assistants also noted each child's date

of birth and gender in this section. and the child's immunization record or birth certificate to determine their age.

Discussion materials for focus groups and key informants were employed. They concentrated on the attitudes of caregivers regarding the nutritional status of their children, the different food sources, the coping mechanisms employed during natural catastrophes, and the attitudes toward the usage of brown rice and rice bran.

3.9 Data collection Procedure

In order to ensure quality work, there was a need for Research assistants who were recruited and were trained on the various methods of data collection and therefore the Data was collected by the researcher with the help of the research assistants. The researcher was able to administer the introductory and consent letters to the children under five Years's care-givers during the study. Data collection was done on children whose care givers had given consent and also participated voluntarily. The research also had an introductory letter from the area chief which was presented to the village area leaders in respective villages.

Five- to six-month-old children were subjected to an anthropometric measurement in order to compare their nutritional status with respect to rice and rice bran consumption. The following anthropometric measurements were made of the children: length, weight, sex, age, and mid-upper arm circumference (MUAC). Using pediatric MUAC tape, measurements were obtained for children who did not have grade II or III edema upon presentation. Using a portable bathroom scale, the weights were measured to the nearest 0.1 kilos. For kids who were unable to stand on their own, the weight was ascertained using a hanging Salter Scale, and for kids who

could stand on their own, a digital bathroom scale that was set up on a flat surface and leveled to 0.00Kg. We took weight without shoes and with very little clothing on. The unit of weight measurement was 100g (0.1kg). Weight and length were measured anthropometrically to determine the child's nutritional health. The raw anthropometric data were converted and evaluated as Z-scores and subsequent nutrition indices using the WHO Anthro version 3.2.2, 2011 software. Unstructured interviews were conducted with key informants and structured interviews were conducted with parents and caregivers at the household level.

3.10 Recruitment and Training of Research Assistants

While assistant supervisors held degree certificates, research assistants were chosen based on their possession of a minimum Kenya qualification of Secondary Education (KCSE) qualification. Depending on the study regions we visited, the research assistants and assistant supervisors were both locals who spoke fluent English, Swahili, Kikuyu, and Luo. The principal supervisor gave them two days of instruction on the goals and aim of the study as well as the several instruments used to gather data. Prior to the actual data collection activity, they received training in self-presentation, administering questionnaires, and gathering anthropometric measures. Clarity and content mastery of the questionnaire were prioritized during training.

3.11 The Data quality assurance

Each of the five data collection teams/groups in each county was made up of one assistant supervisor who doubled as the researcher and five research assistants. A supervisor oversaw all five teams that collected data. Prior to moving on to the next home, the research assistant reviewed the questionnaire to ensure it was accurate and

comprehensive after gathering data from the household. After that, the assistant supervisor reviewed the surveys to make sure the data was accurate and consistent. To make sure that the responses were consistent, the supervisor conducted sporadic random spot checks during the data collection. Every day, the supervisor reviewed the day's events in a quick meeting with the enumerators and assistant supervisors.

3.12 Data analysis and presentation

The gathered data was coded, loaded into a database created with Microsoft Excel, and then sent to IBM SPSS (Statistical Package for Social Sciences) version 20 for analysis. The frequencies were obtained using descriptive statistics to ascertain the data outcomes. The data on anthropometric profiles for the children aged 6-59 months were analyzed using the SMART for ENA program, 2008, and the nutritional status was interpreted using the cutoffs. For stunting (HA), underweight (W/A), and wasting (W/H) without edema, a Z-score of ± 2 SD was utilized to represent nutritional status. A child was classified as moderately malnourished if their Z-score was between -2 and -3 SD, and as severely malnourished if it was less than -3 SD.

A child with a MUAC cut off of less than 13.5 cm was considered to be well-nourished; a child with a MUAC of between 12.5 and 13.5 cm was considered to be mildly malnourished; a child with a MUAC of between 11.5 and 12.5 cm was considered to be moderately malnourished; and a child with a MUAC record of less than 11.5 cm was considered to be severely malnourished in this study. Tables and charts were used to display the data. A two-tailed Chi-square test was used to compare the three groups in the various rice-growing locations that were chosen, and a P value of less than 0.05 was deemed statistically significant for the nutritional state of the children and the caregivers' education.

3.13 Ethical considerations

Data was collected after approval from the Kenya Methodist University Scientific Ethics Review Committee (KeMU) and approval letter was issued them and also A research permit was obtained from the National Commission for Science, Technology and Innovation (NACOSTI). A Written consent was sought from the parent(s)/ guardian(s) of the care givers and the purpose of the study was clearly explained to the mother/ caregiver and confidentiality of their response was also assured and before interviewing the participants, the local administration was notified. There were no incentives given in order to participate in this study and no mother/ caregiver will be forced to answer question they do not wish to answer. The identity of the children was kept private and confidential by giving out a mechanization system of serializing the questionnaires. There was no any harm whatever was done or impacted to any child, either physically or emotionally as the procedures were none invasive. Relevant information on the outcomes of the study was agreed upon that it will be given to the ministry of health in the national level and county level in the three respective selected rice growing areas where the study was carried on.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Introduction

In this chapter, the study results are presented in accordance with the goals of the investigation and the pertinent talks that have taken place. Based on the results, recommendations and conclusions will be made.

The study was to do a Comparative Analysis of Utilization of Rice Bran and Analysis of Anthropometrics Profile Among Children 6 - 59 Months in Selected Rice Growing Areas in Kenya, whereby the chosen areas were Kirinyaga county, Kisumu County and Kwale county.

The study had a total sample size of 1218 participants in all the three counties where the research was undertaken, i.e., 34.7% Kirinyaga county the sample size participants were 423, for Kisumu County 32.3% sample size participants were 394 and finally, Kwale county 32.9% sample size Participants were 401 children of 6-59 months.

Table 4.1

Total sample size in every county selected for the study in Kenya

Counties	Frequency	%
Kirinyaga	423	34.7
Kisumu	394	32.4
Kwale	401	32.9
Total	1218	100.0

4.2 Socio Demographic and Economic Characteristics of the Households

4.2.1 Demographic Characteristic of Households/Participants

The demographic and socio-economic characteristics of study participants' households in the three counties where the research took place generally are presented in tables Below.

4.2.1.1 Household Heads and their Age range

Most 73.2% (891) of the households' participants interviewed were headed by fathers (Males) and 26.8% (327) by mothers (Female). The mean Age of the whole household participants interviewed was 37.74, while the minimum age was 14 years and the maximum age of the household was 87 years old. The highest number (53%) of the male heads of the household were between 25-47 years with a mean age of 38.293 ± 4.86 years. The youngest household male head was 17 years and the oldest 80 years. The highest number (74%) of the female heads of the household was between 21-43 years with a mean age of 36.25 ± 2.70 years. The youngest household female head was 14 years and the oldest 87 years.

Table 4.2

Gender and age ranges of Household Head

Gender	Frequency	%	Mean Age	Minimum age	Maximum age	Median age
Male	891	73.2	38.29	17	80	37
Female	327	26.8	36.25	14	87	33
Total	1218	100.0	37.74			

4.2.1.2 Socio-Demographic and Economic Characteristics in the three counties.

The socio-demographic and economic characteristics of the respondents in this study reveal a diverse yet distinct profile (Table 4.3). The majority (56.1%) of participants are aged between 31 and 50 years, placing them in their prime working age. The

gender distribution of household head is skewed towards males, who make up 73.2% of the respondents, suggesting a possible male dominance in decision-making related to agriculture and food practices in these regions. This gender imbalance could affect the community's readiness to integrate rice bran into the diet, particularly if women, who are often primary caregivers, are underrepresented in the decision-making process. A significant majority of the respondents are married (79.2%), which may imply stable household structures that could support the introduction of new dietary practices. Religious affiliation is predominantly Christian in Kirinyaga and Kisumu, while Kwale has a significant Muslim population (66.6%). This religious diversity may impact the acceptance and promotion of rice bran as a food supplement, as dietary practices often intersect with religious beliefs. Education levels among respondents vary, with the majority (60.2%) having completed primary education, followed by secondary education (24.6%). This educational distribution suggests that awareness and educational campaigns about the benefits of rice bran may need to be tailored to different literacy levels to ensure effective communication. Occupationally, the respondents are primarily engaged in farming (33.8%), casual labor (24.0%), and business (19.1%), with only a small percentage in formal employment (8.2%). This occupational profile reflects the rural and agrarian nature of the study areas, which could be advantageous for the re-integration of rice bran into the food system, given the direct involvement of the population in agriculture. Income distribution shows that a large portion (61.7%) of the respondents earns less than 10,000 KES while only 5.1% earn more than 20,000 KES monthly, highlighting economic challenges that could impact their purchasing power and ability to adopt costly nutritional supplements.

Table 4.3*Socio-Demographic and Economic Characteristics of Respondents*

Characteristic		Kirinyaga	Kisumu	Kwale	Total
		n (%)	n (%)	n (%)	n (%)
Age (Years)	13-30	164 (43.7)	103 (27.5)	108 (27.5)	375 (31.6)
	31-50	213 (31.9)	216 (32.4)	238 (35.7)	667 (56.1)
	51-87	35 (24.0)	64 (43.8)	47 (32.2)	146 (12.3)
Gender	Male	250 (28.1)	340 (38.2)	301 (33.8)	891 (73.2)
	Female	173 (40.9)	54 (16.5)	100 (30.6)	327 (26.8)
Marital Status	Single	63 (50.8)	30 (24.2)	31 (25.0)	124(10.5)
	Married	305 (32.7)	325 (34.8)	303 (32.5)	933(79.2)
	Divorced	31 (42.5)	5 (6.8)	37 (50.7)	73(6.2)
	Widowed	12 (25.0)	24 (50.0)	12 (25.0)	48(4.1)
Religion	Christianity	412(97.4)	392(99.5)	115(28.7)	919 (76.5)
	Islam	0 (0)	0 (0)	267 (66.6)	267 (22.2)
	Others	8 (1.9)	1 (0.2)	6 (1.5)	15 (1.3)
Education Level	No formal schooling	10 (2.4)	12 (3)	64 (16)	86 (8.5)
	Primary	164 (38.8)	182 (46.2)	266 (66.3)	612 (60.2)
	Secondary	116 (27.4)	89 (22.6)	45 (11.2)	250 (24.6)
	Tertiary	28 (6.6)	29 (7.3)	12 (2.9)	69 (6.8)
Occupation	Formal Employment	27 (27.0)	28 (28.0)	45 (45.0)	100 (8.2)
	Business	76 (31.4)	59 (24.4)	107 (44.2)	242 (19.1)
	Farming	159 (38.7)	145 (35.3)	107 (26.1)	411 (33.8)
	Casual Labor	113 (38.8)	102 (35.1)	76 (26.1)	291 (24.0)
	Unemployed	28 (31.8)	38 (42.2)	24 (26.7)	90 (7.4)
	Others	20 (24.7)	22 (27.2)	39 (48.1)	81 (6.7)
Monthly Income (KES) [\$1=KES 78]	>20,000	30 (49.2)	18 (29.5)	13 (21.3)	61(5.1)
	10,000- 20,000	106 (32.5)	126 (38.7)	94 (28.8)	326 (27.1)
	<10,000	255 (34.3)	231 (31.1)	257 (34.6)	743 (61.7)
	None	32 (42.7)	16 (21.3)	27 (36.0)	75 (6.2)

4.2.1.3 Monthly income for the respondents in the three selected rice growing areas

At least 61.7% (743) of the total respondents had some source of income which ranged from KES.1<10,000. While 27.1% (326) earned a monthly income ranging KES.10,000-20,000, the respondents who earned nothing because of lack of employment or due to lack of equal opportunities were 6.2% (75), in addition, the

study found out that only 1.3% (16) earned a monthly income of between KES.30,000-40,000 and 0.7% (8) earned a total of above KES.40,000.

Table 4.4

Monthly income for the respondents in Kirinyaga, Kisumu and Kwale counties

Amount KES.	Frequency	%
None	62	5.1
<10,000	741	60.6
10,001- 20,000	326	27.1
20,001- 30,000	44	3.7
30,001- 40,000	16	1.3
> 40,000	8	.7
Total	1208	100.0

4.3 Rice bran Utilization method, Consumption pattern, Knowledge and Preferences

To determine the rice and rice bran production, knowledge, utilization, consumption patterns and their preferences. The participants had to answer the interviewer through one of the data collection tools which was the questionnaire.

4.3.1 Rice bran knowledge and utilization among the participants.

4.3.1.1 Knowledge of rice bran and its utilization of the rice bran at the family level

More than half of the participants 67.0% (816) said they have ever heard of Rice bran and they know it, compared to 33% (402) who said they didn't know what Rice bran was.

Table 4.5

Participants knowledge of a rice bran

Kirinyaga, Kisumu and Kwale Counties	Frequency	%
No	402	33.0
Yes	816	67.0
Total	1218	100.0

In Kirinyaga county, out of the 423 participants 77.5% (328), responded positively that they knew what rice bran was, compared to 22.4% (95) who said they didn't know what rice bran was. In Kisumu, out of the 394 participants 70.8% (279) said they have ever heard of Rice bran and they knew it, compared to 29.2% (115) who said they didn't know what Rice bran was, and in Kwale, out of 401 participants 51.5% (207) knew what rice bran compared to 48.5% (195) responded by saying they didn't know what rice bran was. Out of the three selected rice growing areas, Kirinyaga county had most of the participants with the knowledge what rice bran was, 77.5%.

Table 4.6

Knowledge based of rice bran by the respondents, if they have ever heard of Rice bran

Kirinyaga	Yes (%)	No (%)
	328 (77.6)	95 (22.4)
Kisumu	279 (70.8)	115 (29.2)
Kwale	207 (51.5)	195 (48.5)

4.3.1.2 Rice Bran Utility at home

For the 1218, (67.0%) total participants who said they knew what rice bran was, 96.2% (1,171) mentioned that they used the rice bran for feeding domestic animals, while 2.8% (34) said they used the rice bran for complementary feeding for their children and the 1.1% (13) agreed that they used the rice bran for household consumption.

Table 4.7*Utilization of rice bran at home by the respondents*

Form of Utilities	Frequency	Percent
For domestic animals	1,171	96.2
For complementary feeding of children	34	2.8
For household consumption	13	1.1
Total	1218	100.0

4.3.1.3 Selected rice growing areas and their Rice bran utility at Home.

In Kirinyaga county, for those participants who had said they knew what rice bran was, 88.6% (375) said they use the rice bran to feed their domestic animals at home and 8.7% (37) said they use it for complementary feeding of their children and 2.6% (11) used the rice bran for household consumption.

In Kisumu County, 93.4% responded by saying their rice bran they feed it to the domestic animals, while 5.6% used it for complementary feeding of their children and finally, 1.0% said they use the rice bran for household consumption purposes.

In Kwale county, 91.8% of the respondents use rice bran for their domestic animal feeding, while 5.7% of them use the rice bran for complementary feeding for their children and 2.5% used the rice bran for household consumption once in a while.

Table 4.8*Utilization of rice bran at home in the rice selected areas, Kirinyaga, Kisumu and Kwale*

County	Domestic animals	Complementary feeding of children	Household consumption	Total
Kirinyaga	375 (88.6)	37 (8.7)	11 (2.6)	423
Kisumu	366 (93.4)	22 (5.5)	4 (1.0)	394
Kwale	367 (91.8)	23 (5.7)	12 (2.5)	401
Total = 1218				

4.3.1.4 knowledge on the importance of Rice bran and its health benefits

In the three selected rice growing areas, Kirinyaga, Kisumu and Kwale counties, the participants were asked if they knew that rice bran was a nutritious food product with healthy benefits, if rice bran should be given to animals, rice bran should be utilized in making food for both the children and the adults, rice bran should be consumed by people with chronic health conditions and if rice bran should be consumed by all people young and old, those with good healthy and with health conditions. And their responses were informed of whether they agreed, Neutral or if they Disagreed.

Table 4.9

Perceptions and Utilization Preferences of Rice Bran in the Selected Counties

	Agree (%)	Neutral (%)	Disagree (%)
Rice bran is a nutritious food product with healthy benefits	238 (19.6)	413 (34.0)	567 (46.7)
Rice bran should be given to animals.	673 (55.3)	243 (20.0)	302 (24.8)
Rice bran should be utilized in making food for the children	213 (17.5)	347 (28.5)	658 (54.1)
Rice bran should be consumed by people with chronic health conditions	205 (16.8)	336 (27.6)	678 (55.5)
Rice bran should be consumed by all people young and old, those with good healthy and with health conditions,	191 (15.7)	333 (27.3)	694 (57.0)
Rice bran should be utilized in making food for the adults	189 (15.5)	347 (28.5)	682 (56.0)

n=1218

In Kirinyaga county, out of the 423 participants 47.9% (202) disagreed that rice bran was a nutritious food product with healthy benefits while 27.5% (116) were neutral with their response and 24.6% (104) agreed that rice bran was a nutritious food

product with healthy benefits. In Kisumu County, out of the 394 participants 49.2% (194) disagreed that rice bran was a nutritious food product with healthy benefits while 44.7% (176) were neutral with their response and 6.1% (24) agreed that rice bran was a nutritious food product with healthy benefits. In Kwale county, out of the 402 participants 42.1% (169) disagreed that rice bran was a nutritious food product with healthy benefits while 30.4% (122) were neutral with their response and 27.4% (110) agreed that rice bran was a nutritious food product with healthy benefits.

Table 4.10

Rice bran is a nutritious food product with healthy benefits

County	Agree (%)	Neutral (%)	Disagree (%)
Kirinyaga	104 (24.6)	116 (27.5)	202 (47.9)
Kisumu	24 (6.1)	176 (44.7)	194 (49.2)
Kwale	110 (27.4)	122 (30.4)	169 (49.2)
Total	1218		

4.3.1.5 Rice bran Consumption by animals and its utilization in making food for children

In Kirinyaga county, out of the 423 participants 11.3% (48) disagreed that rice bran should be given to animals while 10.6% (45) were neutral with their response and 78% (330) agreed that rice bran was good to be given to animals. The participants in this county, 17.7% (75) Agreed that rice bran should be utilized in making food for their children, as 20.1% (85) they were neutral to their responses while 62.2% (263) disagreed on rice bran to be utilized in making food for their children. In Kisumu County, out of the 394 participants 33.0% (130) disagreed that rice bran should be given to animals while 30.2% (119) were neutral with their response and 36.8% (145) agreed that rice bran was good to be given to animals. The participants in this county, 2.5% (10) Agreed that rice bran should be utilized in making food for their children, as 42.9% (169) they were neutral to their responses while 54.6% (215)

disagreed on rice bran to be utilized in making food for their children. In Kwale county, out of the 402 participants 30.9% (124) disagreed that rice bran should be given to animals while 19.7% (79) were neutral with their response and 49.6% (200) agreed that rice bran was good to be given to animals. The participants in this county, 32.0% (128) Agreed that rice bran should be utilized in making food for their children, as 23.5% (94) they were neutral to their responses while 45.0% (180) disagreed on rice bran to be utilized in making food for their children.

Table 4.11

Perceptions on Rice Bran Consumption

Rice bran should be mostly be consumed by animals	Agree	Neutral	Disagree	Total
Kirinyaga	330 (78.0)	45 (10.6)	48 (11.4)	423
Kisumu	145 (36.8)	119 (30.2)	130 (33.0)	394
Kwale	200 (49.6)	79 (19.7)	124 (30.9)	402
Total				1218
Rice bran should be utilized in making food for children.				
Kirinyaga	75 (17.7)	85 (20.1)	268 (62.2)	423
Kisumu	10 (2.5)	169 (42.9)	215 (54.6)	394
Kwale	128 (32.0)	94 (23.5)	180 (45.0)	402
Total				1218

4.3.1.6 Utilization of rice bran after it has been processed from the milling

In the three selected rice growing areas, the participants out 1218 of them, 61.5% (749) responded by saying after milling their rice, the rice bran is left in the millers, 28.9% (353) said they carry the rice bran product after milling back to their homes for domestic use, while 9.6% (117) responded by saying they do both, either leave the rice bran at the millers' place or sometimes they carry the rice bran back home for domestic use.

In Kirinyaga county, this study investigated that the participants 61.1% (258), left behind the rice bran at the millers' place after their rice had been milled, 26.3% (111) carried their rice bran products back home for domestic use after the milling process while 5.7% (24) found themselves doing both, leaving the rice bran with the millers or sometimes carry their rice bran back home for domestic uses.

In Kisumu County, the participants 67.8% (267), left behind the rice bran at the millers' place after their rice had gone through the milling process, 22.3% (88) carried their rice bran product back home for domestic use only after the milling process while 9.9% (39) found themselves doing both, leaving the rice bran with the millers or sometimes carry their rice bran back home for domestic uses.

The participants in Kwale county, this study investigated that the 55.7% (224), discarded their rice bran at the millers' place after their rice had been milled, 38.6% (155) carried their rice bran product back home for domestic use after the millers had finished with the process of milling their rice product, while 5.7% (23) found themselves doing both, leaving the rice bran with the millers or sometimes carry their rice bran back home for domestic uses.

Table 4.12

The Utilization of Rice bran after Milling in Kirinyaga, Kisumu and Kwale counties

Utilization of Rice bran after Milling in the three Combined Counties.	(1) Leave It at The Miller (%)	(2) Carry Back for Domestic Use (%)	Both 1 And 2 (%)	Total
Combined counties	749 (61.5)	353 (28.9)	117 (9.6)	1218
Utilization of Rice bran after Milling in each County				
Kirinyaga	258 (61.1)	111 (26.2)	54 (5.7)	423
Kisumu	267 (67.8)	88 (22.3)	39 (9.9)	394
Kwale	224 (55.7)	153 (38.6)	24 (5.7)	401
			Total	1218

4.3.1.7 Brown rice utilization and its importance to health and its benefits Healthwise in the community and at household level.

The participants in the selected rice growing areas, the three counties were asked whether they would agree, disagree or be neutral on acknowledging that Brown rice is a nutritious food, brown rice is a healthy food that should be consumed by people with chronic illnesses like diabetes, also that brown rice is a good food for children below 5 years and that brown rice should be consumed by every family member.

4.3.1.7.1 Brown Rice is a Nutritious Food

Majority of them, out of the total 1218 participants 43.5% (530) agreed that Brown rice is a nutritious food, but 23.1% (281) disagreed and 33.4% (407) were Neutral to their responds.

In Kirinyaga county the participants, 66.7% (282) agreed that brown rice is a nutritious food, 22.7% (96) disagreed while 10.6% (45) were neutral, they didn't know whether brown rice is nutritious or not. In Kisumu County the participants, 22.6% (89) agreed that brown rice is a nutritious food, 32.2% (127) disagreed while 45.2% (178) were neutral, they didn't know whether brown rice is nutritious or not. In Kwale county the participants, 39.6% (159) agreed that brown rice is a nutritious food, 27.3% (110) disagreed while 33.1% (133) were neutral, they didn't know whether brown rice is nutritious or not.

Table 4.13

Perception of response or respondents as to whether Brown Rice is a Nutritious Food

Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total (%)
Brown rice is a Nutritious Food				
Agree	282 (66.7)	89 (22.4)	159 (39.6)	530 (43.5)
Neutral	96 (22.7)	178 (44.7)	133 (33.1)	407 (33.4)
Disagree	45 (10.6)	127 (31.9)	109 (27.2)	281 (23.1)
				1218(100)

4.3.1.7.2 Brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes and by every family member in a household.

out of the total 1218 participants in the three counties, 48.8% (594), and 40.0% (487) agreed that Brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes and also by every family member in a household respectively, but 22.8% (278) and 27.7% (337) disagreed while 28.4% (346) and 32.3% (393) were Neutral to their responds.

In Kirinyaga county the participants, 79.0% (334) agreed that brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes and also 67.4% (285) agreed that brown rice should be consumed by every family member in a household, 5.9% (25) disagreed while 15.1% (45) were neutral. In Kisumu County the participants, 28.4% (112) agreed that brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes and also 20.3% (80) agreed that brown rice should be consumed by every family member in the household as, 33.8% (133) disagreed while 37.8% (149) were neutral, they didn't respond.

In Kwale county the participants,36.8% (148) agreed that Brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes and also 30.7% (123) agreed that brown rice should be consumed by every family member in a household,30.1% (121) disagreed while 33.1% (133) were neutral, and they didn't agree neither disagree.

Table 4.14

Brown Rice is a healthy food that should be consumed by people with chronic illness

Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total
Brown Rice is a healthy food that should be consumed by people with chronic illness like diabetes				
Agree	334 (79.0)	112 (28.4)	148 (36.8)	594 (48.8)
Neutral	45 (15.1)	149 (37.8)	133 (33.1)	346 (28.4)
Disagree	25 (5.9)	133 (33.8)	121 (30.1)	278 (22.8)
				1218
Brown rice is healthy and should be consumed by every family member in a household				
Agree	285 (67.4)	80 (20.3)	123 (30.7)	487 (40.0)
Neutral	72 (17.0)	178 (37.8)	143 (35.6)	393 (52.3)
Disagree	66 (15.6)	136 (35.0)	135 (33.6)	337 (27.7)
				1218

4.3.1.7.3 Brown Rice is good food for children below 5 years of age.

The participants from the three selected rice growing areas responded to the question if Brown rice preparation and if it should be given to children below five years for consumption was good as food, and 36.1% (440) agreed, while 29.0% (353) disagreed that brown rice can be good food for the children under five years and 34.9% (425) were neutral, didn't agree nor disagree. The participants in Kirinyaga county,59.6% (252) agreed that brown rice was good food for children under five years,17.3% (73) disagreed while 23.2% (98) were neutral to their responds, neither did they agree nor disagree. In Kisumu County, only 15.2% (60) agreed, as 38.8%

(153) disagreed that brown rice was good food for children under five years, while 45.9% (181) were neutral in their responses' participants in Kwale County, 32% (129) agreed, 13.7% (127) disagreed while 36.4% (146) were neutral.

Table 4.15

Brown rice is good food for children below 5 years of age

Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total
Brown rice is good food for children below 5 years of age.				
Agree	252 (59.6)	60 (15.2)	128 (31.9)	440 (36.1)
Neutral	98 (23.2)	181 (45.9)	146 (36.4)	425 (34.9)
Disagree	73 (17.3)	153 (38.8)	127 (31.7)	353 (29.0)
Total				1218 (100)

4.3.2 Rice and Rice bran consumption and preferences for the participants of the selected rice growing areas in Kenya, Kirinyaga, Kisumu and Kwale counties.

In Kirinyaga county, out of the 423 participants 62.2% (263) disagreed that rice bran should be utilized in making food for both the children and the adults, as 63.1% (267) disagreed that rice bran should be consumed by people with chronic health conditions while 20.1% (85) and 18.9% (80) were neutral with their response respectively and 17.7% (75) agreed that rice bran should be utilized in making food for both the children and the adults, while 18% (76) agreed that rice bran should be consumed by people with chronic health conditions.

In Kisumu County, out of the 394 participants 54.6% (215) disagreed that rice bran should be utilized in making food for both the children and the adults, and 55.7% (219) disagreed that rice bran should be consumed by people with chronic health conditions while 42.9% (169) and 40.5 (159) were neutral with their responses

respectively and 2.5% (10) agreed that rice bran should be utilized in making food for both the children and the adults, while 3.8% (15) rice bran should be consumed by people with chronic health conditions.

In Kwale county, out of the 402 participants 44.5% (178) disagreed that rice bran should be utilized in making food for both the children and the adults, and 47.4% (190) disagreed that rice bran should be consumed by people with chronic health conditions while 23.5% (94) were neutral with their response and 32.0% (128) agreed that rice bran should be utilized in making food for both the children and the adults, while agreed 28.4% (114) that rice bran should be consumed by people with chronic health conditions.

Table 4.16

Utilization of Rice bran to the children, adults and people with chronic health conditions

Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total (%)
Rice bran should be utilized in making food for adults				
Agree	72 (17.0)	109 (27.2)	8 (2.0)	189 (15.5)
Neutral	80 (18.9)	99 (24.7)	168 (42.6)	347 (28.5)
Disagree	271 (64.1)	194 (48.1)	218 (55.3)	683 (56.0)
				1218
Rice bran should be consumed by people with chronic health conditions.				
Agree	76 (18.0)	15 (3.8)	109 (27.2)	200 (16.4)
Neutral	80 (18.9)	159 (40.5)	91 (22.7)	330 (27.1)
Disagree	267 (63.1)	219 (55.7)	201 (50.1)	687 (56.5)
				1218
Rice bran should be utilized in making food for children.				
Agree	75 (17.7)	10 (2.5)	128 (32.0)	213 (17.5)
Neutral	85 (20.1)	168 (42.9)	94 (23.5)	347 (28.5)
Disagree	263 (62.2)	215 (54.6)	178 (44.5)	656 (54.0)
				1218

4.3.2.1 Rice bran should be consumed by young people, old people, healthy people or people with health conditions (by all people).

Participants of the selected rice growing areas in Kenya, Kirinyaga, Kisumu and Kwale counties responded to whether they agreed, disagreed or being neutral to if Rice bran should be consumed by all people young and old, those with good health and with health conditions, and for the participants in Kirinyaga county, out of the total of 423, 17.5% (74) agreed, 17.0% (72) were Neutral to respond and 65.5% (277) disagreed. In Kisumu County, out of the 393 participants, 2% (8) agreed, 43.1% (170) were neutral and 54.8% (216) disagreed. While in Kwale county, out of the 402 participants, 27.2% (109) agreed, 22.7% (91) were neutral to their responses and 50.1% (201) disagreed.

4.3.2.2 Once in a life time the Rice bran has ever been used to feed the whole family

The question which the participants in this research study were supposed to answer, was whether in their life time on feeding rice, if they have ever fed their families Rice bran as a meal, out of the total participants 1218, those who responded YES, they had once ever fed their family with rice brand were 35.2% (428) and those who Declined by responding NO, and said they have never fed their family rice bran were 64.9% (790).

In the selected rice growing areas, Kirinyaga county, the participants who have once ever used rice bran to feed their whole family were 22.3% (94) and those who have never fed them even once were 77.8% (329). In Kisumu 28.5% (112) participants who have once ever used rice bran to feed their whole family while 71.6% (282) are those who have never fed them even once were. In Kwale county, the participants who have once ever used rice bran to feed their whole family were 55.2% (222) and those who have never fed them even once were 44.5% (179).

Table 4.17

<i>Consumption of rice bran by the whole family once in their life time</i>				
Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total (%)
Rice bran has ever been used to feed the whole family				
Agree	94 (22.3)	112 (28.5)	222 (55.2)	428 (35.2)
Disagree	329 (77.8)	281 (71.5)	179 (44.8)	790 (64.8)
				1218

4.3.2.3 Rice consumption in the selected rice growing areas and their most preferred type of rice

Generally, the three selected rice growing areas of Kirinyaga, Kisumu and Kwale counties, out of the total participants 1218, those who consumed rice in their households were 97.9% (1193), while those who didn't consume any type of rice were 2.1% (25). The participants who consumed Rice had their own frequency of the rice consumption in a day and in a week, as shown in the tables below, those who consumed rice once a day were 36% (425), those who consumed the rice twice a day were 47.3% (564), for those who consumed thrice a day were 16.1% (185) and those who consumed four times and more were 1.6% (19). The participants' rice consumption in days in a week were: those who consumed one day a week 17% (199), those who consumed two days a week 25.1% (303), those who consumed three days a week 29.9% (357) and those who consumed four days and above in a week 28% (334).

4.3.2.4 Rice consumption in the household and those didn't consume rice in the household and their Preferred choice of rice, Brown rice or White rice.

In Kirinyaga county, out of the 423 participants, those who consumed rice in their households were 99.7% (422), while those who didn't consume any type of rice were 0.2% (1). In Kisumu county, out of the 394 participants those who consumed rice in

their households were 95.9% (378), while those who didn't consume any type of rice were 4.1% (16). and Finally in Kwale county, out of the total participants of 402, those who consumed rice in their households were 98.0% (394), while those who didn't consume any type of rice were 2.0% (8).

For those who preferred to consume rice, they had their chosen preference between white rice and brown rice. in the three counties, the total consumers of white rice were 89.3% (1088) and those who chose brown rice they were 10.7% (130).

For the Kirinyaga county, out of the total 422 participants who said they consume rice, 96.6% (407) preferred to consume white rice while 3.4% (15) preferred to consume brown rice. Those who consumed Rice once a day were 22.7% (96), those who consumed twice a day were 60.5% (255), those who consumed three times a day were 14.7% (62) and those who consumed four times and more in a day were 2.1% (9). The participants also had frequency of days in a week they could consume the rice and therefore 2.1% (9) consumed their rice one day in a week, 7.6% (32) consumed their rice 2 days in a week, 32.4% (136) consumed their rice 3 days only in a week and those who consumed their rice four days and more were 57.9% (245).

In Kisumu County, out of the total 378 participants who said they consume rice, 84.3% (323) preferred to consume white rice while 15.7% (71) preferred to consume brown rice. Those who consumed Rice once a day were 33.2% (131), those who consumed twice a day were 52.8% (208), those who consumed three times a day were 11.7% (46) and those who consumed four times and more in a day were 2.3% (9). The participants also had frequency of days in a week that they could consume the rice and therefore 24.6% (97) consumed their rice one day in a week, 25.9% (102)

consumed their rice 2 days in a week,38.3% (151) consumed their rice 3 days only in a week and those who consumed their rice four days and more were 11.2% (44).

For the Kwale county, out of the total 394 participants who said they consume rice,88.8% (350) preferred to consume white rice while 13.2% (42) preferred to consume brown rice. Those who consumed Rice once a day were 58.5% (231), those who consumed twice a day were 37.3% (150), those who consumed three times a day were 4.0% (12) and those who consumed four times and more in a day were 0.2% (1). The participants also had frequency of days in a week they could consume the rice and therefore 33.8% (134) consumed their rice one day in a week,37.6% (151) consumed their rice 2 days in a week,16.9% (66) consumed their rice 3 days only in a week and those who consumed their rice four days and more were 11.7% (43).

Table 4.18

Consumption frequency, preference of rice and the preference of white or brown rice

Statement	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total
Those who Consumed and didn't Consume rice				
Consumed rice	422 (99.8)	378 (95.9)	394 (98.0)	1194 (98.0)
Did Not Consume rice	1 (0.2)	16 (4.1)	8 (2.0)	24 (2.0)
				1218
Rice consumption Rates per Day				
Once	96 (22.7)	131 (32.9)	231(58.0)	458 (38.4)
Twice	255 (60.5)	208 (52.8)	150 (37.0)	613 (51.3)
Thrice	63 (14.7)	46 (11.6)	12 (3.0)	121 (10.1)
4 and above	9 (2.1)	9 (2.3)	8 (2.0)	26 (2.2)
				1194
Rice consumption Rates per Week				
Once	9 (2.0)	97 (24.6)	123 (30.6)	229
Twice	39 (7.6)	108 (25.9)	157 (37.6)	304
Thrice	137 (32.4)	152 (38.3)	68 (16.9)	357
4 and above	241 (57.9)	42 (11.2)	41 (11.7)	334

Total	422 (100)	378 (100)	389 (100)	1194
Rice Preference, either White or Brown Rice				
White	407 (96.7)	323 (84.3)	350 (88.8)	1080 (88.7)
Brown	15 (3.4)	71 (15.7)	52 (11.2)	138 (11.3)
Total	423 (100)	394 (100)	401 (100)	1218 (100)

4.3.2.5 The major purpose for Rice production in the selected rice growing areas in Kenya, In Kirinyaga, Kisumu and Kwale counties.

Most of the total participants 1218, in the three counties, 45.5% (557) said they are in rice production for the sale purpose of their rice in the market and the agricultural government agencies, 12.2% (148) were in rice production for the purpose of Domestic consumption while 42.3% (516) were in the rice production for both sales and domestic consumption. The purpose for rice production in Kirinyaga county, the participants, 53.7% (227) practiced the production for sales purposes, 4.7% (20) produced rice for the purpose of domestic consumptions while 41.6% (176) produce rice for both domestic consumption and for sales in the markets.

In Kisumu County, the participants practiced rice production for the purpose of, 33.7% (135) sales in the markets, 1.8% (7) produced rice for domestic consumption, while 64.5% (254) practiced rice production for both domestic consumption and also for sales in the markets.

Rice production in Kwale county was mainly for sales in the markets by the participants with 48.5% (195), whereas 30.1% (121) practiced rice production for domestic consumption, while 21.4% (86) practiced Rice production for the purposes of both domestic consumption and to do business of sales in the markets.

Table 4.19*Purpose for Rice production in the selected rice growing areas*

Region	Kirinyaga (%)	Kisumu (%)	Kwale (%)	Total (%)
Purpose for Rice production in the selected rice growing areas				
For sale	227(53.7)	135(33.7)	195(48.5)	557
For Domestic use	20(4.7)	7(1.8)	120(30.1)	(45.5)
				148
				(12.2)
For both, Sale and Domestic use	176(41.6)	252(64.5)	86(21.4)	516
				(42.3)
				1218

4.4 The Anthropometric profiles and comparisons

A typical method for determining a child's nutritional status is anthropometry. The child's growth indicators were reported using anthropometric measurements in the rice-selected growing locations. The WHO Child Growth Standards reference population (WHO 2006) was compared to the height and weight distribution of children under the age of five.

In the three chosen rice-growing counties of Kirinyaga, Kisumu, and Kwale, the three indices—height-for-age, weight-for-height, and weight-for-age—were reported as standard deviation units (z scores) from the median of the reference population. Malnutrition was defined as values that were more than two standard deviations below the median of the WHO Child Growth Standards.

4.4.1 Anthropometric results on Distribution of age and sex of sample for Children

under five years in Kirinyaga county, Kisumu County and Kwale County

Distribution of age and sex of sample for Children under five years(6-59 Months)in

Kwale county for both boys and girls as a total (32.3%) was higher than for both the

counties of Kirinyanga and Kisumu (31.1 and 29.6%) respectively. The sample for Boys was higher in all the counties compared to that of the girls where, in Kwale they were 205, in Kirinyanga were 196 and in Kisumu they were 191 boys.

The highest number of both the boys and the girls in all the three Counties, Kirinyanga, Kisumu and Kwale was found in the ages 6-17 months whereby they were 343 (30.3%) while the lowest sample of both the boys and girls in the three counties was in ages 54-59 months which was 47 (4.2%).

Table 4.20

Distribution of age and sex for Children under five years in Kirinyanga Kisumu and Kwale

Distribution of age and sex of sample for Children under five years (6-59 Months)	Kirinyanga		Kisumu		Kwale	
Age (Months)	Boy (%)	Girls (%)	Boy (%)	Girls (%)	Boy (%)	Girls (%)
6-17	39(42.9)	52(57.1)	59(54.6)	49(45.4)	72(50.0)	72(50.0)
18-29	50(51.0)	47(49.0)	54(57.4)	40(42.6)	63(51.2)	60(48.8)
30-41	53(58.9)	37(41.1)	43(50.6)	42(49.4)	49(57.0)	37(43.0)
42-53	44(59.5)	30(40.5)	28(45.9)	33(54.1)	18(54.5)	15(45.5)
54-59	11(39.3)	17(60.7)	7(58.3)	5(41.7)	3(42.9)	4(57.1)
	196	183	191	169	205	188
Total (%)	379 (31.1)		360 (29.6)		393 (32.3)	

4.4.2 Prevalence of acute malnutrition based on weight-for-height z-scores (and/or oedema) by sex for Children under five years in Kirinyanga, Kisumu and Kwale counties.

The Prevalence of acute malnutrition based on weight-for-height z-scores by Sex for the children under five years (6-59 Months) was high in Kwale county (16.4%) as for severe malnutrition (<-3 z-score and/or oedema) (5.2%) for the Prevalence of moderate malnutrition (<-2z-score and >=-3zscore, no oedema) and (21.6%) as for the global malnutrition (<-2z-score and/oedema) compared to Kirinyanga and Kisumu

Counties with (12.7) and (11.7%) for global malnutrition (<-2z-score and/oedema) and for the severe malnutrition (<-3 z-score and/or oedema) both counties presented (6.8%) and (7.7%) respectively. The prevalence of oedema in the three selected rice growing counties, Kisumu was with the higher rates of 12.5%, followed by Kwale county 5.4% and the least was Kirinyanga county with 2.9%.

Table 4.21

Prevalence of acute malnutrition based on Sex for weight-for-height z-scores (and/or oedema)

Counties Gender	Kirinyanga		Kisumu		Kwale	
	Boys(%)	Girls(%)	Boys(%)	Girls(%)	Boys(%)	Girls(%)
Prevalence of global malnutrition (<-2z-score and/oedema)	(19) 9.9 %	(28) 15.7 %	(19) 10.2 %	(22) 13.4 %	(44) 21.9 %	(38) 20.9 %
Prevalence of moderate malnutrition (<-2z-score and >= -3zscore, no oedema)	(8) 4.2 %	(14) 7.9 %	(7) 3.8 %	(7) 4.3 %	(8) 4.0 %	(12) 6.6 %
Prevalence of severe malnutrition (<-3 z-score and/or oedema)	(11) 5.8 %	(14) 7.9 %	(12) 6.5 %	(15) 9.1 %	(36) 17.9 %	(26) 14.3 %
Total	379		360		393	
The prevalence of oedema in %	2.9 %		12.2 %		5.4 %	

4.4.3 Prevalence of acute malnutrition by age, (Underweight) based on weight-for-height z-scores and/or oedema for Children under five years in Kirinyanga county, Kisumu and Kwale counties

Prevalence of acute malnutrition by Age, based on weight-for-height z-scores and oedema for Children under five years.

Table 4.22

Prevalence of acute malnutrition by age, based on weight-for-height z-scores and oedema

County		Severe wasting (<-3 z-score)	Moderate wasting (>= -3 and <-2 z-score)	Normal (> = -2 z score)	Oedema
Kirinyanga	Total	No.(%)	No.(%)	No.(%)	No.(%)
Age (Months)					
6-17	85	3 (3.5)	8(9.4)	77(85.9)	1(1.2)
18-29	97	3(3.2)	5(5.3)	86(88.3)	3(3.2)
30-41	89	2(2.2)	2(2.2)	83(93.3)	2(2.2)
42-53	77	5(6.9)	5(6.9)	60(79.2)	5(6.9)
54-59	30	1(3.9)	13(7)	25(92.6)	0(0.0)
Total	379	14 (3.7)	33 (.7)	331 (87.5)	11 (3.0)
Kisumu					
Age (Month)					
6-17	105	4(3.8)	8(6.8)	95(90.5)	1(1.0)
18-29	94	3(3.4)	9(7.1)	81(86.5)	5(5.6)
30-41	84	1(1.2)	3(3.6)	79(85.7)	8(9.5)
42-53	63	0(0.0)	5(5.7)	56(93.1)	3(5.2)
54-59	13	0(0.0)	0(0.0)	9(81.8)	2(18.2)
Total	360	8 (2.2)	13 (3.7)	320 (88.5)	19 (5.5)
Kwale					
Age (Month)					
6-17	138	6(4.3)	4(2.9)	111 (80.4)	17(12.3)
18-29	120	4(3.3)	8(6.7)	96 (80.0)	13(10.0)
30-41	86	5(5.8)	6(7.0)	66 (70.9)	16(16.3)
42-53	29	1(3.4)	2(6.9)	28 (86.2)	1(3.4)
54-59	7	0(0.0)	0(0.0)	7 (71.4)	2(28.6)
Total	393	21 (5.2)	20 (5.1)	304 (78.4)	51 (12.1)

4.4.4 Distribution of acute malnutrition and oedema based on weight-for-height z-scores for Children under five years in Kirinyanga, Kisumu and Kwale counties.

The presence of Marasmic Kwashiorkor and with oedema present was high in children 6-59 months of Kwale county 3(0.8%), while the presence of Kwashiorkor was highest in Kwale 44 (11.2%), Kisumu county with 19 (5.3%) and oedema present for children 6-59 months and Kirinyanga with the lowest prevalence of 10 (2.7%).

Table 4.23

Distribution of acute malnutrition and oedema based on weight-for-height z-scores

Kirinyanga	<-3 z-score	>=-3 z-score
Oedema present	Marasmic kwashiorkor. 1 (0.3%)	Kwashiorkor. 10 (2.7%)
Oedema absent	Marasmic: 17 (4.5%)	Not severely malnourished. 350 (92.6%)
Kisumu		
Oedema present	Marasmic kwashiorkor. 0 (0.0%)	Kwashiorkor. 19 (5.3%)
Oedema absent	Marasmic: 8 (2.2%)	Not severely malnourished. 332 (92.5%)
Kwale		
Oedema present	Marasmic kwashiorkor. 3 (0.8%)	Kwashiorkor. 44 (11.2%)
Oedema absent	Marasmic: 19 (4.8%)	Not severely malnourished. 327 (83.2%)

4.4.5 Prevalence of combined GAM and SAM based on WHZ and MUAC cut off's

GAM was determined by the proportion of children either with SAM or MAM. The children 6-59 months in the selected rice growing areas were classified as SAM if they: had a weight-for-height z-score (WHZ) of <-3 SD, or there was the presence of nutritional oedema. The children were classified as MAM if they: had a WHZ of >= -3 SD and <-2 SD.

The Prevalence of combined **SAM** (WHZ < -3 and/or MUAC < 115 mm and/or oedema) was higher among the children 6-59 months of kwale county with 16.7% where boys presented a (38) 18.4 % (14.0 - 24.6 95% C.I.) and the girls (27) 14.3 % (10.2 - 20.4 95% C.I.) compared to both the children 6-59 months of Kirinyanga and Kisumu county who presented Prevalence of combined SAM (WHZ < -3 and/or MUAC < 115 mm and/or oedema) of less than 10%. The Prevalence of combined **GAM** (WHZ < -2 and/or MUAC < 125 mm and/or oedema) was higher among the children 6-59 months of in Kwale county with (88) 22.2 % (18.7 - 27.0 95% C.I.) followed by the children 6-59 months of Kirinyanga county (58) 15.2 % (12.1 - 19.4 95% C.I.).

Table 4.24

Prevalence of combined GAM and SAM based on WHZ and MUAC cut offs

Counties	Kirinyanga		Kisumu		Kwale	
Gender	Boys (%)	Girls (%)	Boys (%)	Girls (%)	Boys (%)	Girls (%)
Prevalence of combined GAM (WHZ < -2 and/or MUAC < 125 mm and/or oedema)	23 (11.7%)	27 (15.2%)	22 (11.5 %)	25 (15.2%)	45 (22.8%)	40 (21.2%)
Prevalence of combined SAM (WHZ < -3 and/or MUAC < 115 mm and/or oedema)	11 (6.1%)	15 (8.2%)	12 (6.8%)	20 (11.7%)	39 (21.2%)	27 (14.3%)
All	195	184	190	170	204	189
Total	379		360		393	

4.4.6 Detailed numbers for combined GAM and SAM for Children under five years in Kirinyanga, Kisumu and Kwale county.

A population is considered to be suffering from global acute malnutrition (GAM) if both SAM and MAM are present. An emergency is indicated by a GAM value more than 10% percent. In particular, high prevalence rates that deviate from the seasonal norm should be taken seriously. Typical GAM levels include: Frequency of waste, 15% of cases of malnutrition are critical. Severe wasting (WFH < -3 z-score for children 0–59 months or MUAC <115 mm for children 6–59 months) or the presence of bilateral pitting edema are indicators of severe acute malnutrition (SAM).

As a result, the following table displays the totals for the combined GAM and SAM for children under five in the chosen rice-growing regions of Kirinyanga, Kisumu, and Kwale counties. Kwale County has the highest rate of severe malnutrition (16.7%) and SAM cases (16.7%).

Table 4.25

A combined GAM and SAM for Children under five years

Counties	Kirinyanga n=379		Kisumu n=360		Kwale n=393	
Indicators	GAM(%)	SAM(%)	GAM(%)	SAM(%)	GAM(%)	SAM(%)
MUAC	11 (2.9)	2 (0.5)	7 (1.9)	6 (1.7)	5 (1.3)	3 (0.8)
WHZ	33 (8.7)	13 (3.4)	19 (5.2)	7 (1.9)	33 (8.3)	16 (4.0)
Both(MUAC and WHZ)	3 (0.8)	1(0.3)	3 (0.8)	1 (0.3)	3 (0.8)	0 (0.0)
Edema	11(2.9)	11(2.9)	19 (5.2)	19 (5.2)	47 (11.9)	47 (11.9)
Total	58 (15.2)	27 (7.1)	48 (13.3)	33 (9.1)	88 (22.2)	66 (16.7)

4.4.7 Prevalence of stunting based on height-for-age z-scores and by sex for

Children under five years in Kirinyanga, Kisumu and Kwale countys.

In this study, stunting was defined as low length/height for age and was assessed using the Height for Age Z-Score (HAZ). Stunting was indicated by height for age Z-Scores that are less than -2SD of the reference population in each of the three

counties. It indicates a long-term nutritional problem (Demmelmaier et al., 2006). The ENA nutritional software tool was used to calculate the Height for Age Z Scores. According to the table below, 46.1% of children in Kirinyaga County and 40.1% of children in Kisumu County had HFA z scores less than -3 SD, indicating severe stunting. Kwale County had the highest prevalence of severe stunting, at 17.1%.

According to 2022 Kenya Demographic and Health Survey, Children under 5 years who were stunted (11%) (too short for their age) in Kirinyaga county, (9.0%) for the Kisumu children 6-59 months while (23.0%) was the prevalence in Kwale county. Prevalence of moderate stunting (<-2 z-score and >=-3 z-score), Prevalence of stunting (<-2 z-score) and Prevalence of severe stunting (<-3 z-score) affected mostly the boys compared to the girls in all the three counties under the study, Kirinyaga, Kisumu and Kwale counties. In the 2022 (KDHS) Kenya Demographic and Health Survey, indicated that Children under 5 years who are severely stunted (too short for their age), The frequency was 11% in Kirinyaga County, 9% in Kisumu County, and 23% in Kwale County. The prevalence of stunting varies greatly throughout countries. Kisumu and Garissa had the lowest rates of stunting prevalence (9% each), while Kilifi, West Pokot, and Samburu had the highest percentages of stunting prevalence (37%, 34%, and 31%, respectively) based on height-for-age z-scores reported by the Kenya Demographic and Health Survey (KDHS) 2022

Table 4.26

Prevalence of stunting based on height-for-age z-scores and by Sex for Children under five

Counties Indicators (n)	Kirinyaga			Kisumu			Kwale		
	All (379)	Boys (196)	Girls (183)	All (360)	Boys (191)	Girls (169)	All (393)	Boys (205)	Girls (188)
Prevalence of stunting (<-2z-score)	(75) 19.8 %	(44) 35.1 %	(31) 24.2 %	(107) 30.5 %	(61) 32.8 %	(46) 27.9 %	(138) 36.9 %	(82) 42.1 %	(56) 31.3 %
Prevalence of moderate stunting (<-2 z-score and >=-3 z-score)	(64) 17.3 %	(39) 20.4 %	(25) 14.0 %	(67) 19.1 %	(38) 20.4 %	(29) 17.6 %	(71) 19.0 %	(41) 21.0 %	(30) 16.8 %
Prevalence of severe stunting (<-3 z-score)	(46) 12.1 %	(28) 14.7 %	(18) 10.1 %	(40) 11.1 %	(23) 12.4 %	(17) 10.3 %	(67) 17.1 %	(41) 21.0 %	(26) 14.5 %

4.4.8 Prevalence of stunting by age based on height-for-age z-scores for Children under five years

Severe stunting (<-3 z-score) by age based on height-for-age z-scores for Children under five years was recorded highest in Kwale county 67 (17.1%), followed closely with higher records from Kirinyanga county 46 (12.1%) and low records in kisumu county with 40 (11.4%) .

Stunting by age based on height-for-age z-scores was lower in Kiriyaanga county (12.1%),Kisumu (11.4%),Kwale (17.1%.) than the 18% reported by the Kenya Demographic Health Survey of 2022 (Njuguna, 2024).

Table 4.27

Prevalence of stunting by age based on height-for-age z-scores for Children under five years

County	Kirinyaga				Kisumu				Kwale			
Age in Months	n	Severe stunting (<-3z-score)	Moderate stunting (>=-3 and <-2z-score)	Normal (> = -2 z score)	n	Severe stunting (<-3z-score)	Moderate stunting (>=-3 and <-2z-score)	Normal (> = -2 z score)	n	Severe stunting (<-3z-score)	Moderate stunting (>=-3 and <-2z-score)	Normal (> = -2 z score)
6-17	89	4 (4.6)	17 (19.5)	66 (75.9)	104	8 (7.7)	23 (22.1)	73 (70.2)	139	18 (13.1)	21 (15.3)	98 (71.5)
18-29	98	16 (16)	21 (22.1)	58 (61.1)	95	16 (17.6)	15 (16.5)	60 (65.9)	124	29 (24.4)	27 (22.7)	63 (52.9)
30-41	90	18 (20)	12 (13.6)	58 (65.9)	87	13 (15.5)	11 (13.1)	60 (71.4)	83	16 (20.3)	15 (19.0)	48 (60.8)
42-53	75	6 (8.3)	11 (15.3)	55 (76.4)	65	2 (3.3)	16 (26.2)	43 (70.5)	35	4 (12.5)	6 (18.8)	22 (68.8)
54-59	27	2 (7.4)	3 (11.1)	22 (81.5)	9	1 (9.1)	2 (18.2)	8 (72.7)	12	0 (0.0)	2 (28.6)	5 (71.4)
Total(%)	379	46 (12.1)	64 (17.3)	259 (70.6)	360	40 (11.1)	67 (19.1)	244 (69.5)	393	67 (17.1)	71 (19.0)	236 (63.1)

4.4.9 Prevalence of overweight based on weight for height cut off's and by sex (no oedema) for Children under five years in Kirinyanga, Kisumu and Kwale countys.

The Prevalence of overweight (WHZ > 2), severe overweight (WHZ > 3) based on weight for height, for the children of 6-59 months old, Kirinyanga presented the higher prevalence of overweight (WHZ > 2 of 44 (11.9) and Prevalence of severe overweight (WHZ > 3) was high in both Kirinyanga county children 6-59 months presented with (15) 4.1 % (2.5 - 6.6 95% C.I.) and Kisumu county (15) 4.3 % (2.6 - 7.0 95% C.I.) respectively, while kwale county had the lower prevalence of overweight (child obesity) of 2.9%. According to Kenya Demographic and Health Survey (KDHS) 2022, Children under 5 years (6-59 months) who are overweight (too heavy for their age), Kirinyanga county presented 3.0%, Kisumu County 2.0% and Kwale was 2.0% respectively.

Table 4.28*Prevalence of overweight based on weight for height cut off's and by sex*

Counties	Kirinyaga			Kisumu			Kwale		
Indicators	All	Boys	Girls	All	Boys	Girls	All	Boys	Girls
	(379)	(196)	(183)	(360)	(191)	(169)	(393)	(205)	(188)
Prevalence overweight (WHZ > 2)	(44) 11.9 %	(24) 12.6 %	(20) 11.2 %	(39) 11.2 %	(22) 11.9 %	(17) 10.4 %	(36) 9.4 %	(14) 7.0 %	(22) 12.1 %
Prevalence severe overweight (WHZ > 3)	(15) 4.1 %	(12) 6.3 %	(3) 1.7 %	(15) 4.3 %	(10) 5.4 %	(5) 3.0 %	(11) 2.9 %	(2) 1.0 %	(9) 4.9 %

The prevalence of malnutrition among children aged 6-59 months in the rice-growing regions (Table 4.29) highlights significant variations in the nutritional status across the study regions. Kisumu has the highest proportion of children with normal weight (88.9%), followed by Kirinyaga (85.1%), and Kwale (76.8%). This suggests that, comparatively, Kisumu and Kirinyaga have a better overall nutritional status (children with a z-score > -2) among children, compared to Kwale. The prevalence of overweight children is relatively low across all regions, with Kisumu (4.3%) and Kirinyaga (4.1%) having slightly higher rates than Kwale (2.9%). Although the prevalence is low, this indicates that a small percentage of children in these regions are experiencing excess weight, which could be an early indicator of changing dietary patterns or over nutrition. Underweight prevalence is highest in Kwale at 9.6%, which is significantly higher than in Kirinyaga (4.7%) and Kisumu (1.5%). This high rate of underweight children in Kwale reflects severe nutritional deficiencies and highlights an urgent need for intervention to improve infant feeding and nutrition in this region. Severe stunting, an indicator of chronic malnutrition, is most prevalent in Kwale (17.1%). This high prevalence of stunting points to long-term nutritional deficiencies associated child growth and development. Again, severe

wasting, which reflects acute malnutrition, is also highest in Kwale (5.3%) compared to Kirinyaga (3.5%) and Kisumu (2.2%). However, moderate wasting is more prevalent in Kirinyaga (8.5%) compared to Kwale (5.1%) and Kisumu (3.6%). These findings indicate that children in Kwale and Kirinyaga are more vulnerable to acute malnutrition, which could be due to food shortages or illness. The prevalence of edema, a sign of severe malnutrition (often associated with kwashiorkor), is high in Kwale at 12.9%, compared to 5.3% in Kisumu and 2.8% in Kirinyaga. This suggests that Kwale is facing a significant burden of severe malnutrition that requires immediate attention.

Table 4.29

Prevalence of malnutrition based on age in Wasting, Stunting, underweight, Odema and Overweight for children aged 6- 59 months

Characteristic	Kirinyaga (%)	Kisumu (%)	Kwale (%)
Normal	85.1	88.9	76.8
Overweight	4.1	4.3	2.9
Underweight	4.7	1.5	9.6
Severe Stunting	12.1	11.1	17.1
Severe Wasting	3.5	2.2	5.3
Moderate Wasting	8.5	3.6	5.1
Oedema	2.8	5.3	12.9
Normal (> -2 z score); Severe wasting (<-3 z-score); Moderate wasting (>-3 & <-2 z-score)			

In Kwale being stunted and 17.1% being severely stunted, malnutrition prevalence among the children was significant. In comparison to Kirinyaga and Kisumu, Underweight prevalence was 9.6 % highest in Kwale, 4.7% in Kirinyaga and 1.5 % lowest in Kisumu with those children. Comparing the three counties' over-roll underweight prevalence to the KDHS 2022 report, which showed that Kwale had a 14% underweight prevalence, Kirinyaga had a 6% underweight prevalence, and

Kisumu had a 4% underweight prevalence, it indicated they were lower. In this study, the Prevalence of severe wasting observed it was slightly below that reported by the Kenya Health and Demographic Health Survey of 2022 for children aged 6-59 months old in these counties whereby, Kwale was higher with 5.2%, In Kirinyaga with 3.7% and lowest Kisumu with 2.2% compared to KDHS 2022, Kwale had 6%, Kirinyaga 2% and Kisumu 3% respectively. The pattern of wasting and stunting is consistent with the findings of a different study conducted in Nairobi by Korir (2013).

Table 4.30

Comparison of Malnutrition Prevalences with KDHS 2022 Report and this study

Comparison of Malnutrition Prevalences with KDHS 2022 Report						
Counties	Kirinyaga		Kisumu		Kwale	
Anthropometrics	Study 2023	KDHS 2022	Study 2023	KDHS 2022	Study 2023	KDHS 2022
Severe Stunted	12.1	11	11.1	9.0	17.1	23.0
Severe Wasting	3.7	2.0	2.2	3.0	5.2	6.0
Underweight	4.7	6.0	1.5	4.0	9.6	14.0
Overweight	4.1	3.0	4.3	2.0	2.9	2.0

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

5.1.1 Socio Economic and Demographic Characteristics of the Study Population

Children between the ages of 6 and 59 months have different dietary needs depending on socioeconomic and demographic factors. Fathers headed the majority of the families in this survey. This result is consistent with national findings from the Kenya National Bureau of Statistics as well as findings from other studies conducted in rural areas, including Ethiopia. The head of the household has an impact on how the family uses its money, especially how food resources are distributed.

Research has demonstrated that one socioeconomic factor affecting children's nutritional status is income. This is consistent with the 2011–2012 Kenyan Maternity Report, which found that compared to children from wealthy homes, 44% of children from impoverished households were more likely to die before the age of five from malnutrition.

5.1.2 Socio-Demographic and Economic Characteristics

The socio-demographic and economic characteristics of the study population suggest that there is potential for integrating rice bran into the local food system, particularly due to the agrarian nature of the communities and the existing engagement in farming. However, the low income and education levels pose significant challenges, as these factors may limit both the purchasing power and the awareness of the nutritional benefits of rice bran. Additionally, religious and cultural factors must be carefully considered to ensure that the promotion of rice bran is culturally sensitive

and widely accepted. The findings indicate that community readiness for utilizing rice bran as a food supplement will require comprehensive educational campaigns and possibly economic incentives to overcome the existing barriers related to income and education.

One of the most crucial tools for enabling mothers and other caregivers to offer their kids the right kind of care is education, which is crucial for the growth and development of kids. Raising the educational attainment of mothers and other caregivers improved the likelihood that children would receive a healthy diet.

Additionally, a study conducted in Kwale found that high levels of maternal education reduce the levels of child underweight. Most of the 48.3% household heads in the three counties had completed primary level education, 24.8% had completed secondary level education up to form 4. 14.7% had no formal education, 8.2% had gone up to tertiary/diploma/HND level of education, 3.8 % (47) had gone to both tertiary and university level of education. However, in this study there was no association between the levels of education of the mothers and nutritional status of the children.

5.1.3 Rice and Rice bran utilization, knowledge, consumption and Preference.

The findings from this study shows that majority of the participants from Kwale, Kirinyaga and Kisumu have little knowledge about the rice bran and its high benefits to both children and adults which highlighted that the global rice bran market has been estimated to be 1.2 million tons but with its production mostly concentrated in Thailand, India, Japan, China and Vietnam. This could be due to the fact that majority of the rice farmers have preference for rice-to-rice bran and specifically this study showed that the respondents would rather choose white rice over brown rice

and further more neglect the utilization of rice bran to the basis of household and rather use the rice bran to feed their livestock's or leave it at the milling centers.

The results reveal that while there is a relatively high level of awareness about rice bran, particularly in Kirinyaga and Kisumu, its use is predominantly as animal feed. The minimal use of rice bran for complementary feeding and household consumption indicates that the community does not yet recognize its potential as a nutritious food supplement for human consumption. The low figures for rice bran's use in complementary feeding and household consumption suggest that education and awareness campaigns are necessary to shift community perceptions and encourage the adoption of rice bran as a food supplement. Given our aim to re-integrate rice bran into the local food system to improve nutritional outcomes for infants and young children, these findings highlight a critical need for interventions that promote the health benefits of rice bran and its potential to reduce malnutrition. The variation in awareness levels, suggests that targeted outreach efforts in these regions may be important. By increasing knowledge about the nutritional benefits of rice bran and how it can be safely and effectively used in human diets, there is potential to improve the nutritional status of children and reduce incidences of malnutrition.

The results indicate a significant challenge in changing community perceptions and practices regarding the use of rice bran as a food supplement. The majority of respondents across all three regions continue to view rice bran primarily as an animal feed, and there is considerable resistance to incorporating it into the diet of children, adults, or people with chronic health conditions. This widespread skepticism suggests that health campaigns and awareness programs are crucial to shifting community attitudes. The relatively low percentage of participants who recognize the

nutritional benefits of rice bran highlights the need for targeted interventions that demonstrate how rice bran can improve nutrition and health outcomes, particularly in reducing malnutrition among young children. The strong disagreement with incorporating rice bran into human diets, especially in Kisumu and Kirinyaga, where malnutrition indicators such as stunting and wasting are present, points to a disconnect between available nutritional resources and community practices. If rice bran is to be successfully reintegrated into the local food system, these regions will require carefully designed outreach efforts that address cultural and practical concerns, demonstrating both the safety and benefits of rice bran consumption. Without significant shifts in perception, the potential health benefits of rice bran may remain untapped, particularly in regions like Kwale, where the need is most acute. Future comparisons with anthropometric indicators such as stunting, wasting, and MUAC will provide further insight into how rice bran can be effectively introduced as a tool in combating malnutrition.

The study also found out that majority of the participants in these three selected rice's growing areas know rice bran as a source of food for domestic animals with a few responding that it can be used for human consumption. The rice bran accounts for 10% of the weight of the whole grain, which comprises the majority of the nutrients. Most of the time rice bran is used as fuel for cooking purposes or for feeding animal and also, a good quality edible oil could be produced from it as well. Similarly, other studies conducted also show that rice bran is majorly treated as just as rice husk and also used to feed broilers from day 1 to 21.

Majority of them, out of the total 1218 participants 43.5% (530) agreed that Brown rice is a nutritious food, but 23.1% (281) disagreed and 33.4% (407) were Neutral to their responds. In Kirinyaga county the participants, 66.7% (282) agreed that brown rice is a nutritious food, whereby it is the county that had higher percentage of respondents agreeing to that fact, whereby majority of the Kwale residence in comparison to Kirinyaga residence said it is not nutritious. This study also shows that majority of the residence from these three rice's growing areas felt that rice bran does not have any other health benefits on humans. This finding was contrasting other studies that have highlighted rice bran as anticancer agent because it produces phenols that exhibit induced apoptosis of cancer cells. Similarly, various findings have also suggested that rice bran can also prevent several chronic diseases and that it also has high fiber content which also helps to maintain a healthy weight in humans.

Generally, the three selected rice growing areas of Kirinyaga, Kisumu and Kwale counties, out of the total participants 1218, those who consumed rice in their households were 97.9% while those who didn't consume any type of rice were 2.1%. The participants who consumed Rice had their own frequency of the rice consumption per day and per week whereby the participants of Kirinyaga county the study shows are the highest consumers of rice every day and their preferred choice of rice was white rice.

The majority of the caregivers said that rice bran should not be used to feed the under 5 years children even though a six month controlled dietary intervention and randomized study conducted to identify bran consumption pattern together with the outcome in a cohort of weaning six months old infants in Nicaragua found that rice

bran consumption influences stool metabolism. This finding was also contrasting the findings on the benefits of rice bran consumption in that it affects a suite of metabolites that are related to the enhancement of growth and development, while also supporting absorption of nutrients as measured by changes in serum GLP-2 in infants.

5.1.4 Anthropometric profiles and their comparative analysis.

Children's growth and development depend on adequate nourishment, and malnutrition is a sign of underdeveloped social and economic systems. Poor physical and cognitive development is one of the negative repercussions of halting growth, which can have a lifetime impact.

There are three main kinds of malnutrition that this study concentrated on in order to show the children 6-59 months under study their comparisons, these were underweight, stunting, and wasting. Inadequate supplemental feeding can cause malnutrition in newborns and early children, which can worsen cognitive function, reduce productivity, and raise the risk of non-communicable diseases, which raises the possibility of death. The results indicate that Kwale is the most affected region in terms of malnutrition, with the highest rates of underweight, severe stunting, severe wasting, and edema. These findings suggest that children in Kwale are at a much higher risk of both chronic and acute malnutrition, which could have severe implications for their health, growth, and development. Kisumu and Kirinyaga, while showing better overall nutritional status, still have notable levels of stunting, wasting, and underweight children, indicating that malnutrition is a persistent issue in these regions as well. The focus on re-integrating rice bran into the local food system as a supplement could be particularly beneficial in these regions. Given the high levels of

malnutrition, especially in Kwale, promoting the use of rice bran a byproduct with known nutritional benefits could help improve dietary intake and reduce the incidence of malnutrition. These findings underscore the need for targeted nutritional interventions, particularly in Kwale, where the situation is most dire. Nutritional programs aimed at increasing the availability and utilization of nutrient-rich supplements like rice bran, coupled with broader efforts to improve food security and dietary diversity, could significantly enhance the nutritional outcomes for children in these regions. The results also indicate that stunting is a significant issue in all three regions, with the prevalence of severe stunting increasing notably as children age, especially in Kwale. This suggests that chronic malnutrition is taking a toll on the growth and development of children, particularly as they move into the critical months age range, when nutritional needs are high. Kwale stands out as the region with the most severe stunting problem, indicating that children are experiencing prolonged periods of inadequate nutrition. This could be due to a variety of factors, including food insecurity, poor dietary diversity, or inadequate feeding practices. The high rates of stunting in Kwale, coupled with earlier findings of underweight and wasting, suggest a deeply rooted malnutrition issue that requires urgent attention. Stunting in early childhood is associated with long-term consequences, including impaired cognitive development, poor school performance, and reduced economic productivity in adulthood. Given the high levels of stunting observed, integrating rice bran into the local diet could be a key strategy in improving the nutritional outcomes of young children. However, the success of such an intervention will depend on the community's acceptance and the effectiveness of educational campaigns to promote the benefits of rice bran.

The results indicate a substantial burden of acute malnutrition among children under five in these rice-growing regions, with Kwale emerging as the most affected area, particularly with a very high prevalence of severe cases as indicated by the SAM rates and edema prevalence. This suggests that Kwale is experiencing a severe nutritional crisis, which could be due to factors such as food insecurity, poor dietary practices, or a lack of access to healthcare services. Kirinyaga also shows significant levels of GAM and SAM, particularly when measured by WHZ, indicating that while the overall situation may be better than in Kwale, there are still serious concerns about the nutritional status of children.

With 19.0% of the children in Kwale being stunted and 17.1% being severely stunted, malnutrition prevalence among the children was significant. In comparison to Kirinyaga and Kisumu, Underweight prevalence was 9.6 % highest in Kwale, 4.7% in Kirinyaga and 1.5 % lowest in Kisumu with those children. Comparing the three counties' over-roll underweight prevalence to the KDHS 2022 report, which showed that Kwale had a 14% underweight prevalence, Kirinyaga had a 6% underweight prevalence, and Kisumu had a 4% underweight prevalence, it indicated they were lower. In this study, the Prevalence of severe wasting observed it was slightly below that reported by the Kenya Health and Demographic Health Survey of 2022 for children aged 6-59 months old in these counties whereby, Kwale was higher with 5.2%, In Kirinyaga with 3.7% and lowest Kisumu with 2.2% compared to Kwale had 6%, Kirinyaga 2% and Kisumu 3% respectively. The pattern of wasting and stunting is consistent with the findings of a different study conducted in Nairobi, which showed that wasting increased with age and that stunting was most common in children between the ages of 18 and 23 months. Additionally, the underweight

matches the record set and which peaked at 12–17 months. Undernutrition in children has persisted as one of the key problems facing sub-Saharan Africa over time. But because of changes in eating habits and lifestyle, children in the majority of emerging nations are suffering from both overnutrition and undernutrition. The rising rates of obesity and overweight are concerning.

5.2 Conclusion

The results of this study indicates that among the children in the three counties that were chosen in the growing rice areas, malnutrition was comparatively common. High rates of malnutrition were observed, particularly in Kwale, where severe stunting affected 17.1%, severe wasting 5.3%, and edema 12.9% of the children. This Study indicated that while awareness of rice bran is relatively high in Kirinyaga (77.6%) and 70.8% in Kisumu it is overwhelmingly perceived as animal feed rather than as a food supplement for humans. In all the three selected Rice growing areas the male children had a significantly higher frequency of stunting, Compared to female children. While the rates of underweight had shown a small improvement below those of the national tally/rates, the rates of stunting and wasting were marginally above the national means. Barriers exist to re-integrating rice bran into human diets, the study highlights key opportunities for its adoption, suggesting rice bran could significantly help reduce malnutrition if properly integrated.

The study reveals high rates of malnutrition, particularly stunting and wasting, in the rice-growing regions of Kirinyaga, Kisumu, and Kwale, highlighting the need for interventions to improve nutritional status of children. Despite rice bran's potential as a nutritional supplement, significant barriers exist in terms of community perceptions and acceptance. These findings emphasize the need for targeted nutrition

and health education campaigns to promote the benefits of rice bran and address cultural and practical barriers to its adoption. In conclusion, the successful integration of rice bran into the local diet will require concerted efforts to shift community attitudes and practices.

5.3 Recommendations

I recommend that targeted nutrition and health education campaigns be implemented to raise awareness of the nutritional benefits of rice bran and address cultural and practical barriers to its adoption as a food supplement. Additionally, further research should investigate the impact of rice bran consumption on anthropometric indicators such as stunting and wasting to establish its role in combating malnutrition in these regions.

5.3.1 Recommendations for Policy

- 1) The Ministry of Health should scale up education on dietary diversity of rice in the rice growing areas and also the importance of ensuring that children consume a diversified diet involving rice bran targeting all care givers in this rice growing areas and expanding to other areas where they don't grow rice. The government should educate the residents on the importance of consuming Brown rice and its importance in the general well-being of the body and its functionality.
- 2) The government should come up with income generating activities in this rice growing areas to help in reducing poverty levels especially in Kwale county.
- 3) The government needs to move quickly to implement regulations that clearly safeguard rice-growing regions. As of late, global health targets have caused the focus of nutrition surveillance to shift from undernutrition to all kinds of malnutrition, which includes obesity and overweight. By 2025, countries should

aim to achieve no increase in the number of overweight or underweight children, according to the fourth WHO Global Target.

5.3.2 Recommendations for Practice

- 1) People from the rice growing areas should be informed on the importance of rice bran as a source of nutrients for the young children.
- 2) There should be thorough awareness campaign and sensitization on proper preparation, handling and storage of rice bran after rice milling.
- 3) The government should put into place proper mechanisms in rice growing areas on how to support farmers to embrace rice bran besides, brown rice.

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APPENDICES

APPENDIX A: MAPS OF THE THREE SELECTED RICE GROWING COUTIES IN KENYA UNDER THIS STUDY. (KIRIYANGA, KISUMU AND KWALE COUNTIES)

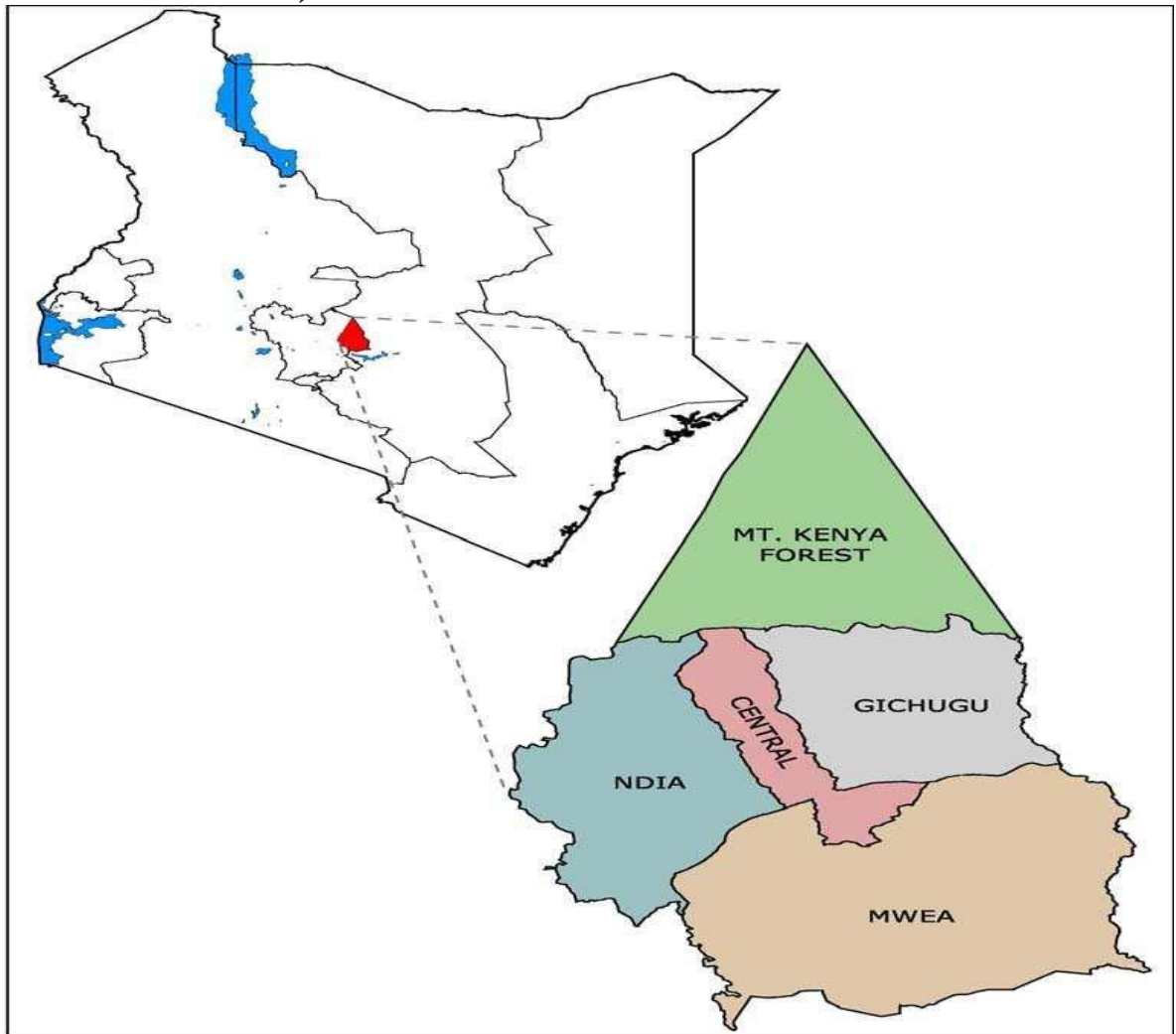


Figure 2: Kiriya county.

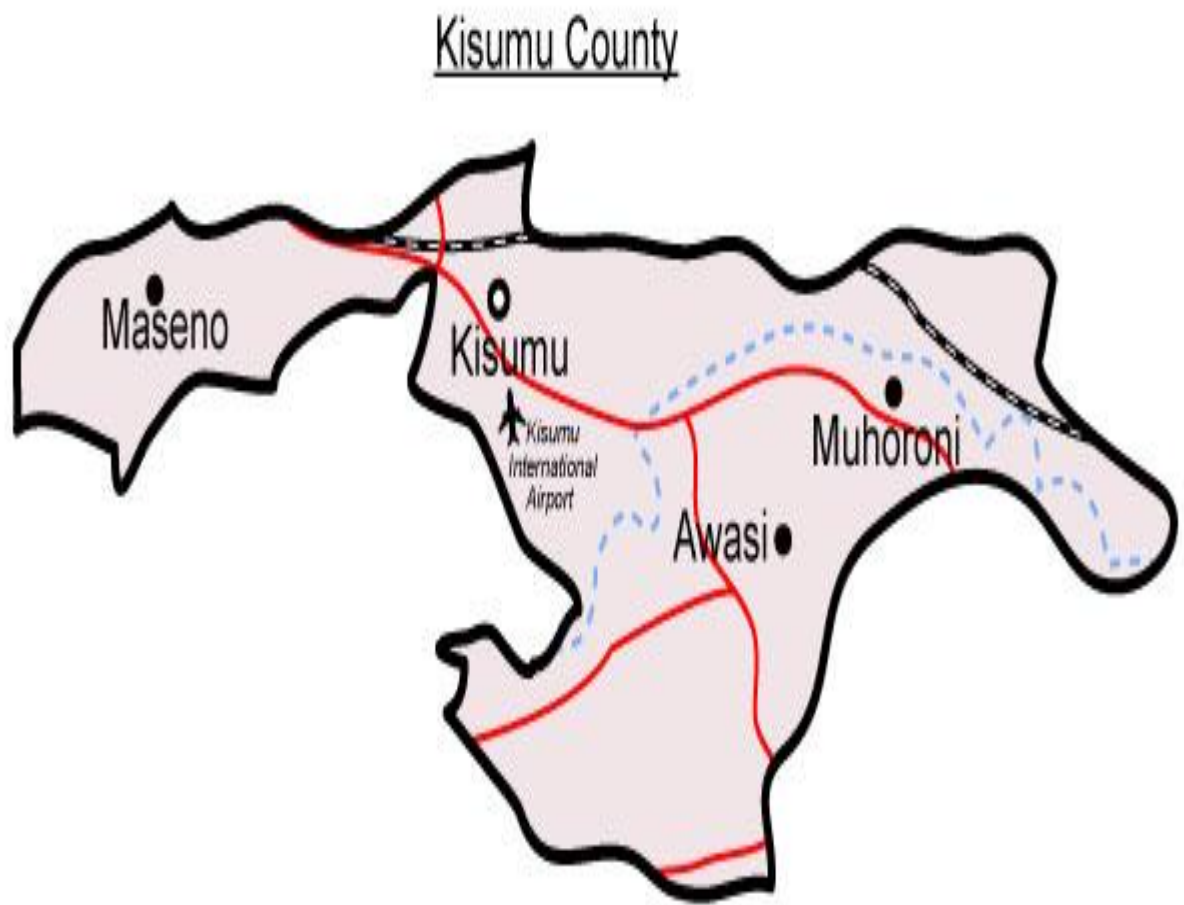


Figure 4: Kisumu County



Figure 5: Ahero Irrigation scheme in Kisumu County

Kwale County

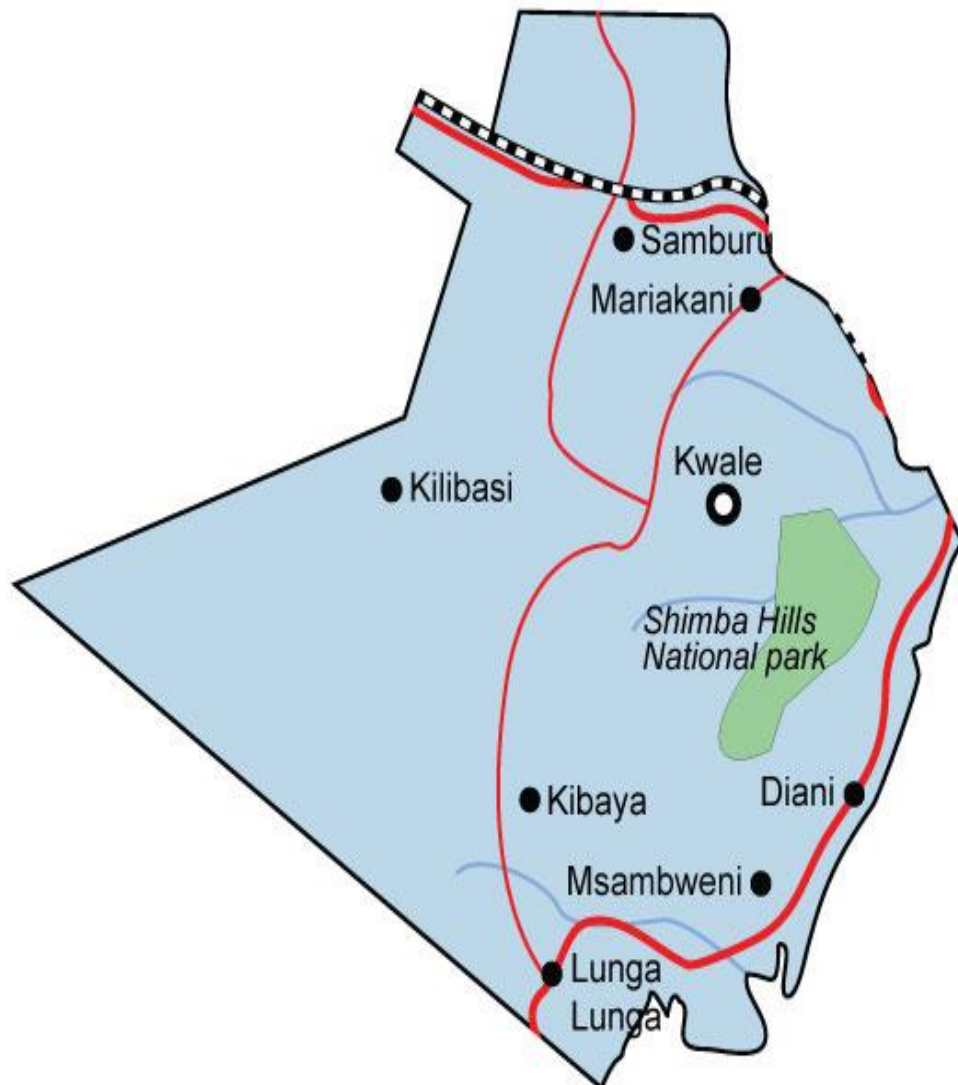


Figure 6: Kwale County

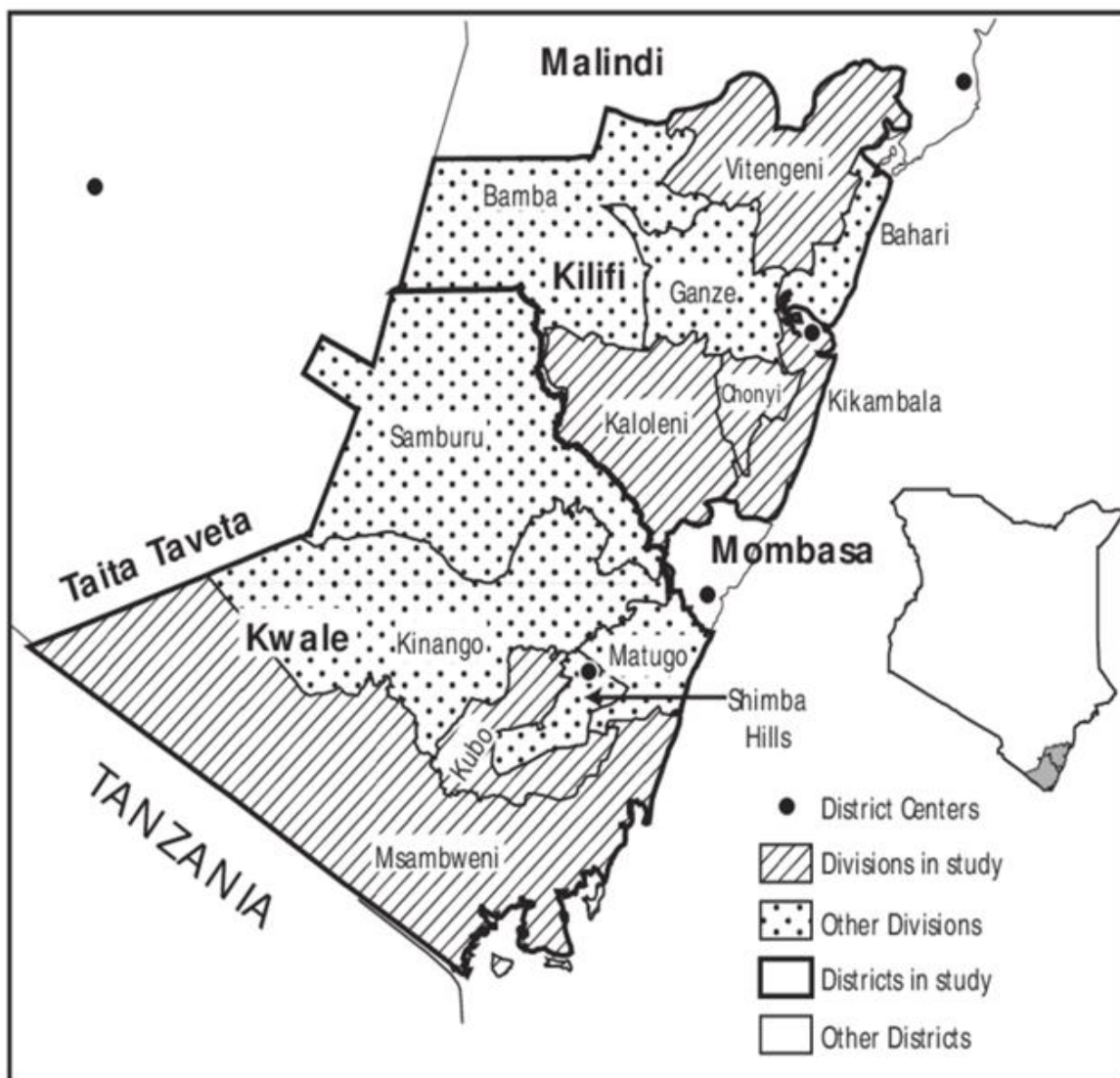


Figure 7: Kwale county and its Constituencies

APPENDIX B: INFORMED CONSENT

I am Odingo Kawai Sylvia and I am studying Master's Degree at Kenya Methodist university. (Master of Science in Human Nutrition and dietetics). I am here to carry out a study on comparative analysis of rice bran utilization and anthropometric profiles among children 6 - 59 months. The information you give will be confidential and will be used by the Ministry of Health to help improve the Nutrition Status of children under five years within this region of Kiriyanga, Kisumu and Kwale in Kenya.

Procedures to be followed:

Participation in this study will require that I ask you some questions and I also examine your child by measuring height, weight and mid upper Arm circumference to determine their current nutritional Status and record the information in a questionnaire.

You have the right to refuse participation in this study. You will get the same care and medical treatment whether you agree to join the study or not and your decision will not change the care you will receive from the clinic today or that you will get from any other clinic at any other time. Please remember the participation in this study is voluntarily. You may ask questions related to the study at any time.

You may refuse to respond to any questions, and you may stop an interview at any time. You may also stop being in the study at any time without any consequences to the services you receive from any clinic or any other organization now or in the future.

Discomforts and Risks:

Some of the questions you will be asked are on intimate subjects and may be embarrassing or make you uncomfortable. If this happens, you may refuse to answer these questions if you so choose. You may also stop the interview at any time.

There is no risk in participating in this survey. There would be a slight discomfort when the field staff visit you at home and engage you in the short interview followed by child anthropometric measurements. However, well trained field assistants will carry the procedure out in order to minimize time spent or any other discomfort.

Benefits

There is no direct benefit. However, information obtained will be used to provide some recommendations to reduce the incidence of malnutrition in your community and in Kenya as a whole.

Reward

If you agree to participate in this study, nutrition education will be done on how to practice dietary diversity within your household to help improve Nutrition status of the family.

Confidentiality

The interviews and examinations will be conducted in your home or a conducive private setting. Your name or the name of your child will not be recorded on the questionnaire. The questionnaires will be kept in a locked cabinet for safe keeping at Kenyatta University. Everything will be kept private.

Contact Information

If you have any questions, you may contact:

A. Dr. Job Mapesa, Supervisor

B. Madam Rose Juma, Supervisor

C. The Kenya Methodist University Ethical Review Committee Secretariat.

Participant's statement:

The above information regarding my participation in the study is clear to me. I have been given a chance to ask questions, and my questions have been answered to my satisfaction. My participation in this study is entirely voluntary. I understand that my records will be kept private and that I can leave the study at any time. I understand that I will still get the same care and medical treatment whether I decide to leave the study or not and my decision will not change the care that I will receive from any clinic today or that I will get from any other clinic at any other time.

Name of participant

Signature or Thumb-print **Date**

Investigators statement

I, the undersigned, have explained to the volunteer in a language she/he understands, the procedures to be followed in the study and the risks and benefits involved

Name of interviewer

Signature or Thumbprint **Date**

APPENDIX C: ETHICAL CONSIDERATIONS

Confidentiality

The participants were informed that any information given to the researchers will be treated with care, respect and strict confidentiality. The information was to be used solely for statistical purposes and records relating to the participants' identity such as name were not be revealed to any community members.

Liability/termination

Participants were informed that participation in the study was voluntary and for this reason, the participant shall release all researchers involved in the study from any liability on any arising issues subsequently occurring in connection with the study. If for any reason they did not wish to participate in the study, they could choose not to.

Autonomy

To avoid bias during sampling, appropriate sampling techniques were used depending on the population to be studied. Every participant had an equal chance of taking part in the study and there was no discrimination whatsoever in those chosen to participate in the study.

Voluntarism

Participants were informed on the purpose of the study and participation was purely on voluntary basis. The study implored the use of participants who were 6-59 months, who were healthy and also whose parents had given consent for them to take part in the study. All this was on a voluntary basis and no one was coerced to take part in the study.

Beneficence

Concerning the study, no rewards were given for one to take part in the study. The respondents were explained to that no benefits would be accrued from the research as it was meant to generate data that could influence future policies and programs. Feedback from the data collected and analyzed will be shared with the relevant stakeholders in the Ministry of health and education, Kiriya County, Kisumu County and Kwale county independently

Appendix A contains a comprehensive consent form that was administered.

APPENDIX D: QUESTIONNAIRE

BASELINE DATA OF HOUSEHOLDS AND CHILDREN 6-59 MONTHS IN RICE GROWING AREAS OF KENYA

A. GENERAL INFORMATION

QUESTIONNAIRE NO _____

Date: ____/____/____

Time Interview Started _____

(Day/Month/Year

Team Number: _____

1. Team Leader:

2. Interviewer:

3. County:

4. Sub-County:

5. Constituency:

6. Ward:

SECTION 1: HOUSEHOLD DEMOGRAPHIC PROFILE

Household Number _____

Person No.	Name	Age		Sex	Marital Status		Relation to HH Head	Education Level	Occupation	Monthly Income	Contribution to HH Income	Religion
		Months	Years									
1.												
2.												
3.												
4.												
5.												
6.												
7.												

<u>CODE</u>	<u>Education Level of Adults</u>	<u>Occupation</u>	<u>Relation to Household Head</u>
<u>Person Number:</u> 1, 2, 3 etc.	0 = None	1 = Formal Employment	1 = Household head
<u>Sex:</u> 1 = Male 2 = Female	1 = Up to Std. 8	2 = Business	2 = Spouse
<u>Marital Status</u>	2 = Up to Form 4	3 = Farming	3 = Parent
1 = Never married	3 = Tertiary/ Certificate	4 = Casual Labourer	4 = Brother/sister
2 = Married	3 = Tertiary/Diploma and HND	5 = Unemployed	5 = Child
3 = Cohabiting	4 = University Degree	6 = Other (Specify)	6 = Niece/ Nephew
4 = Divorced/separated	5 = Post Graduate Degree and above	<u>Monthly income (KES)</u>	7 = Cousin
5 = Widowed	<u>Education Level of Children</u>	0 = none	8 = Other (specify)
<u>Religion</u>	6 = Preschool	1 = 10,000 and below	<u>Contribution to HH Income</u>
1 = Christian	7 = Primary school	2 = 10,001 – 20,000	0 = No
2 = Muslim	8 = High school	3 = 20,001 – 30,000	1 = Yes
3 = Hindu	9 = College – Certificate	4 = 30,001 – 40,000	
4 = Atheist	10 = College (Diploma and HND)	5 > 40,000	
5 = Others	11 = University Degree		

B. SECTION 2: RICE PRODUCTION, KNOWLEDGE AND UTILIZATION OF RICE AND RICE BRAN

1. What is your rice field acreage (ha) _____?
2. How many bags of rice do you produce in a year (or Kgs)
_____?
3. Your rice production is for _____ 1 = For Sale 2 = Domestic Consumption
3 = Both 1 & 2
4. Where do you mill your rice _____?
5. Where do you sell your rice _____?
6. After milling your rice where do you take the rice-bran
_____?
7. What is your annual net income from sale of
rice _____?
8. Do you consume rice in your household? 1= yes (**Go to Question 9**)
2 = No (**Go to Question 12**)
9. If yes, which type of rice? 1 = White 2 = Brown rice
10. How many days do you consume rice in a week? 1 = One day 2 = Two days
3 = Three days 4 > Three days
11. How many times do you consume rice in a day? 1 = Once 2 = Twice
3 = Thrice 4 > Three days
12. Have you ever heard of rice bran? 0 = No 1 = Yes (**Go to Question 13**)
13. If yes, how is it used in your family? 1 = For domestic animals
2 = For complementary feeding of children 3 = For Household consumption
14. Have you ever used rice bran to feed children in your family? 1 = Yes (**Go to Question 15**)
2 = No (**Go to Question 16**)
15. If used as a complementary food for children
 - a. How many days in a week _____?
 - b. How many times in a day _____?

16. Have you ever used rice bran to feed your whole family? 1 = Yes (**Go to Question 17**) 2 = No (**Go to Section 3**)

17. How did you prepare it.....?

18. If used as food for the family

a. How many days in a week_____?

b. How many times in a day _____?

C. SECTION 3: ATTITUDE ON UTILISATION OF BROWN RICE AND RICE BRAN

Please respond to statements below by use of a scale of 1 – 3 where: 1 = Agree 2 = Neutral 3 = Disagree

STATEMENT	Agree	Neutral	Disagree
1. Brown rice is a nutritious food			
2. Brown rice is a healthy food that should be consumed by people with chronic illnesses like diabetes			
3. Brown rice is a good food for children below 5 years of age			
4. Brown rice should be consumed by every family member			
5. Rice bran is a nutritious food product with health benefits			
6. Rice bran should be given to animals			
7. Rice bran should be utilized in making food for children			
8. Rice bran should be utilized in making food for adults			
9. Rice bran should be consumed by people with chronic health conditions			
10. Rice bran should be consumed by all people young and old, those with good healthy and with health conditions			

D. SECTION 4: GENERAL INFORMATION, HEALTH AND NUTRITION STATUS: CHILD IMMUNIZATION AND DEWORMING, VITAMIN A SUPPLEMENTATION AND ANTHROPOMETRY

GENERAL INFORMATION						IMMUNIZATION STATUS, DEWORMING AND VIT. A SUPPLEMENTATION					ANTHROPOMETRY			
E1	E2	E3	E4a	E4b	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
HHD No.	Child Serial No	Child's Intra-House hold ID number and Name Give youngest child in the household ID no 1. If more than one child, record them sequentially by age) Child Intra-	Child's Date of Birth (Use Clinic Cards and Calendar of Events	Enter the Age of child in months (Use Clinic Card s and Calendar of Events	Child Sex 1=M 2=F	How many times has (Name) received Vit. A capsules in the last? 1 Year 2 (Show the mother the Red or Blue, capsules) If none,	Has (Name) been Immunized against measles? * Codes: 1=Yes by Card 2=Yes by Recall 3=No 4=DNK	Has (Name) received OPV 1? Code s: 1=Yes by Card 2=Yes By recall 3=No 4=D	Has (Name) received OPV 3? Code s: 1=Yes by Card 2=Yes By recall 3=No 4=D	Has (Name) taken any deworming drug in the last 6 months? Codes: 1=Yes by Card 2=Yes by recall 3=No 4=DNK	Oedema present? 1=Yes 2=No	Height In cm (Nearest 0.1cm) Write down the decimal & <u>do not round up</u>	Weight In KGs (Nearest 0.1kg) Write down the decimal & <u>do not round up</u>	MUAC In cm (Nearest 0.1cm) Write down the decimal & <u>do not round up</u>

		HHD* * Child's ID No. Name						enter ZER O		=No 4=D NK	NK											
			D	M	Y									1 s t	2 n d	A v e	1 st	2 n d	A v e	1 s t	2 n d	A v e
	1.																					
	2.																					
	3.																					
	4.																					
	5.																					
	6.																					

SECTION 5: COMPLEMENTARY FEEDING PRACTICES OF CHILDREN 6-59 MONTHS

1. Has your child been given the Rotavirus vaccine? 1 = Yes 2 = No
2. If yes, how many doses (number of times) of Rotavirus vaccine?
3. At what age did you introduce other foods and drinks in addition to breastmilk _____?
4. At what age are you supposed to introduce other foods in addition to breastmilk _____?
5. Do you still breastfeed 1 = Yes (go to no. 5) 2 = No (move to no 6)
6. If still breastfeeding, at what age do you intend to stop _____?
7. If not breastfeeding, why did you stop _____?
8. What foods did you introduce to the baby _____?
9. How the foods are prepared _____?
10. When you introduced the other foods how much did you give _____?
11. What drinks do you give _____?
12. What was the frequency of feeding _____?
13. Do you have specific feeding utensils for the child _____?
14. Who feeds the child _____?
15. Where does the child feed from _____?

16. Does the child feed alone or with other family members

Time	GUIDE - TYPE OF MEAL	FOODS/ DRINKS	INGREDIENTS	COOKING METHOD	HOUSEHOLD MEASURE	METRIC MEASURE
	Breakfast					
	Snack					
	Lunch					
	Snack					
	Dinner					
	Snack					
	Any other meal					

?

17. At what age did the child/will the child start feeding from family pot

?

18. Are there any foods that are prohibited for children in your community

1 = Yes

2 = No

19. If yes to 19 above list, the foods

.....

20. Have you had problems with introducing food the infant, if yes list them

.....

.....

.....

.....

SECTION 6. 24-HOUR RECALL QUESTIONNAIRE FOR CHILDREN 6-59 MONTHS

Please describe the foods and drinks taken during the last 24 hours starting from morning to evening with breakfast whether at home or outside the home.

(Researcher to list all foods mentioned, where composite meals are mentioned probe for the ingredients, when respondent is through probe for any meal that might not have been mentioned.)

E. SECTION 7. B: DIET DIVERSITY SCORE FOR CHILDREN 6-59 MONTHS

Que. No. (H1-16)	FOOD GROUP	EXAMPLE	0 = No 1 = Yes
1.	Cereals	Maize, wheat, rice, millet, sorghum and any other grains or foods made from these (e.g. bread, spaghetti, noodles, porridge, ugali, muthokoi/githeri	
2.	Roots and tubers	Irish potatoes, yams, cassava, or other foods made from these (e.g. chips/French fries,	
3.	Vitamin A rich vegetables and tubers	Pumpkin, carrots, squash, orange-fleshed sweet potato, other locally available vitamin A vegetables e.g. red sweet pepper,	
4.	Dark green-leafy vegetables	Dark green-leafy vegetables including wild forms and locally available vitamin A rich leaves such as amaranth, cassava leaves, kales, spinach etc.	
5.	Other vegetables	Other vegetables e.g. tomato, onion, eggplant, green bananas and any other	

		locally available vegetable	
6.	Vitamin A rich fruits	Ripe mango, apricots, ripe pawpaw, ripe banana, avocado, 100% fruit juice and any other locally available vitamin A rich fruits	
7.	Other fruits	Including wild fruits, 100% fruit juice made from this.	
8.	Organ meat	Liver, kidney, heart and other organ meats and blood-based foods.	
9.	Flesh meats	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds and insects.	
10.	Eggs	From chicken, duck, guinea fowl or any other eggs.	
11.	Fish and sea food	Fresh or dried fish	
12.	Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts, green grams, or food made from these e.g. peanut butter	
13.	Milk and milk products	Milk, cheese, mala, yogurt.	
14.	Oils and fats	Oils, fats, margarine or butter added to foods or used for cooking	
15.	Sweets	Sugar, honey, sweetened soda, sugar cane sweetened juice drinks, sugary foods such as chocolate, candies, cookies and cakes,	
16.	Spices, condiments and beverages.	Spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages.	

F. SECTION 8: CHILD DIARRHEAL MORBIDITY AND MORTALITY

1. Has the child been ill for the past two weeks? 1=Yes (**Go to Question 2**)
2=No
2. In the past 2 weeks has the child suffered from
 - a. Diarrhoea /watery stool/bloody stool 1 = Yes 2 = No
 - b. If yes in 2.a, how many times in a day _____?
 - c. How many days did the diarrhea last _____?
 - d. Have you ever use used boiled brown rice water to treat diarrhea? 1 =
Yes 2 = No
 - e. If yes, does it work? 1 = Yes 2 = No
 - f. If yes, would you recommend its adoption for use in diarrhea prevention
1 = Yes 2 = No
 - g. Did you seek treatment for the diarrhea? 1= Yes (**Go to f**) 2 = No (**Go to e**) 3 = others specify.....
 - h. Why did you not seek treatment? (select as all that apply)

1 = Episode was mild

2 = The hospital is far

3= It is expensive to get medical attention

4 = Home remedies work

5 = Others specify.....

- i. Where did you seek treatment for the child?

1 = Government

2 = Private

3 = Mission hospital

4 = Pharmacy

5 = Others specify

j. What treatment was your child given

1 = Zinc Tablets

2 = ORS

3 = ORS and Zinc tablets

4 = Antibiotics

5 = Brown rice water

6 = Others specify

After the treatment, did the diarrhea stop

1 = Yes

2 = No

k. Did the child lose weight loss?

1 = Yes

2 = No

l. If yes to 2.i above record the weight lost _____

m. During the diarrhea period how was the child feeding

1 = Normally

2 = Less than normal

3 = More than normal

4 = Child refused to feed

5 = I did not feed the child

n. During the diarrhea period how did the child take drinks

1 = Normally

2 = Less than normal

3 = More than normal

4 = did not drink

5 = I did not give drinks to the child

o. In the last three months how many diarrheal episodes did the child have _____?

p. Any other disease/
ailment_____?

3. Have you ever lost a child below 5 years of age?

1 = Yes

2 = No

a. If yes above, what was the cause of death

.....

b. Give date of birth

c. Date of death

d. Did the child experience diarrhea? 1 = Yes 2 = No

SECTION 9: WATER, SANITATION AND HYGIENE

9 A: WATER

1. What is/are your major current source(s) of water for household consumption/use during dry season?

1 = River

2 = Dam/ Public pan

3 = Tap

4 = Well (Protected)

5 = Well (Not protected)

6 = Borehole

7 = Tanker

8 = Rain water

9 = Others (specify)_____

2. What is/are your major current source(s) of water for household consumption/use during wet season?

1 = River

2 = Dam/ Public pan

3 = Tap

4 = Well (Protected)

5=Well (Not protected)

6=Borehole

7=Tanker

8=Rain water

9=Others (specify)_____

3. How long does it take to and back from the water source? *Probe for distance from water source (6 steps from the house)*

1. Minutes_____

2. Source on premises

4. How frequently is water available from this source?

1 = Always available

2 = Several hours per day

3 = Once or twice a week

4 = Infrequently

5. Do you buy water from the source?

1 = Yes **(If YES proceed to 6f)**

2 = No **(If NO skip 6f)**

6. How much do you pay for a 20 liter jerrican of water? KES _____If other specify_____

7. Who fetches the water?

8. Which means do you use to fetch water?

1 = Bicycle

2 = Carrying on the back or head

3 = Human carts

4 = Donkey carts

9. How do you store water for future use?

1 = Jerricans

2 = Pots

3 = Drums

4 = Tanks

5 = Others (specify)_____

10. Do you treat your water?

1 = Yes (**Go to Question 11**) 2 = No

11. How do you treat your water?

1 = Chemical- Chlorine, water guard

2 = Filtration/Sieving

3 = Boiling

4 = Decanting

5 = Standing

6= Charcoal

7=Others (specify)_____

9B: HYGIENE AND SANITATION

1. We would like to learn about the places that households use to wash their hands. Can you please show me where members of your household most often wash their hands?

- | | |
|---------------------------------------|---|
| a. Observed, fixed place | 1 |
| b. Observed mobile | 2 |
| c. Not observed, not in dwelling | 3 |
| d. Not observed, no permission to see | 4 |
| e. Not observed, no other reason | 5 |

2. Do you use water and soap to wash your hands? 1 = Yes 2 = No
3. Record if soap and water are available at the toilet 1 = Yes 2 = No
4. Record if soap and water are available at the kitchen 1 = Yes 2 = No
5. When do you wash your hands?
 - 1 = After visiting toilet
 - 2 = Before handling food
 - 3 = Before eating
 - 4 = Before feeding children
 - 5 = After handling dirt
 - 6 = Any other time specify.....
6. What kind of toilet facility does your household have?
 - 1 = Flush toilet
 - 2 = Pit latrine
 - 3 = No facility/ Bush/ Open defecation
 - 4 = Others (Specify)_____
7. Do you share this toilet facility with other household members or neighbors? 1 = Yes (**Go to Question 8**) 2 = No
8. How many other households use this toilet facilities_____?
9. Where do you dispose of the child/ children waste?
 - 1 = Latrine or Toilet
 - 2 = Drain or Ditch
 - 3 = Throw into garbage
 - 4 = Left in the open
 - 5 = Others (specify)_____
9. Do you still practice the COVID-19 handwashing measures? 1 = Yes 2 = No
10. **If yes in 9** above record presence of soap and water 1 = Yes 2 = No

11. Did the COVID-19 handwashing measures prevent diarrhea episodes in the household? 1 = Yes 2 = No

G. SECTION 10: FOOD SECURITY AND LIVELIHOODS

1. What is/are your main livelihood activity/s

- 1 = Housewife
- 2 = Livestock herding
- 3 = Own farm labour
- 4 = Employed (salaried)
- 5 = Waged (Casual)
- 6 = Petty trade
- 7 = Unemployed
- 8 = Student
- 9 = Merchant/trader
- 10 = Mining
- 11 = Domestic help
- 12 = Hunting, gathering
- 13 = Firewood/charcoal
- 14 = Fishing
- 15 = Others (specify).....

2. What is/are your main current source/s of income?

- 1 = Rice Farming
- 2 = Permanent job
- 3 = Sale of livestock
- 4 = Sale of livestock products
- 5 = Sale of crops
- 6 = Petty trading e.g. sale of firewood
- 7 = Casual labour

8 = Sale of personal assets

9 = Remittance

10 = Other-Specify.....

3. Where does the food your family eats usually come from? [Probe then circle all that apply – can have multiple responses]

1 = Market only

2 = Own production

3 = Both: market and own production

4 = Gifts from relatives & neighbors

5 = Relief food

6 = Wild food

7 = Others [Specify].....

4. How far is the nearest shop or market from your household? Minutes.....
Kilometers.....

5. Do you have domestic birds 1 = yes 2 = no (**move to question 8**)

6. If yes to. 5 above list the birds

.....
....

7. Are the birds above on free range 1 = yes 2 = No
.....

8. Are there periods when your household experiences food shortage? 1=Yes 2= No
(**Go to Question 11**)

9. Which times of the year does this happen?

1. Daily

2. Mid-end month

3. Pre harvest period (specify crop)

4. Dry season

5. Other (specify)

10. Give reasons for insufficient food sources? **(Can have multiple responses)**

1 = Poor harvest (probe why) 2 = Livestock Diseases 3 = Lack of farm inputs
4 = Increased food prices 5 = Low purchasing power 6 = Other (specify)

11. Does your household have any stock of food?

1. Yes

2. No (**Go to Question 14**)

12. How much of these food commodities do you currently have in your stores?

Maize _____Kg

Pulses _____Kg

Flour _____Kg

Rice _____Kg

Other (specify type of food) _____Kg

13. How long will this food stock last you?

1 = Less than 2weeks 2 = Between 2weeks-1month

3 = Between 1month-3months 4 = More than 3 months

Coping strategy	Relative Frequency 1 = Never 2 = Hardly at all (<1 times/ week) 3 = Once in a while (1-2 times/ week) 4 = Pretty often (3-6 times/week) 5 = All the time (Every day)
a. Shift to less preferred (low quality, less expensive) foods?	
b. Limit the portion/quantity consumed in a meal?	
c. Take fewer numbers of meals in a day?	
d. Borrow food on credit from the shop/market?	
e. Borrow food on credit from another household?	

f. Consume preserved seeds or meat?	
g. Restrict consumption of adults in order for small children to eat?	
h. Gather wild food or hunt?	
i. Rely on food donations from relatives?	
j. Rely on food donations from the clan/community?	
k. Seek or rely on food aid from humanitarian agencies?	
l. Send household members to eat elsewhere?	
m. Beg for food?	
n. Skip entire days without eating?	
o. Consume spoilt or left-over foods	

14. Have you experienced food shortages in the last one month?

1 = Yes

2 = No (**If No, skip 15**)

15. How often did you use the following coping strategies?

Energy Source

16. Do you ever use rice straw as a source of fuel?

Household Characteristics

17. We would like to learn about the places that households use to wash their hands.
Can you please show me where members of your household most often wash their hands?

18. Do you have a kitchen garden 1 = yes (move to no. 19) 2 = no

19. What do you grow in the garden

.....

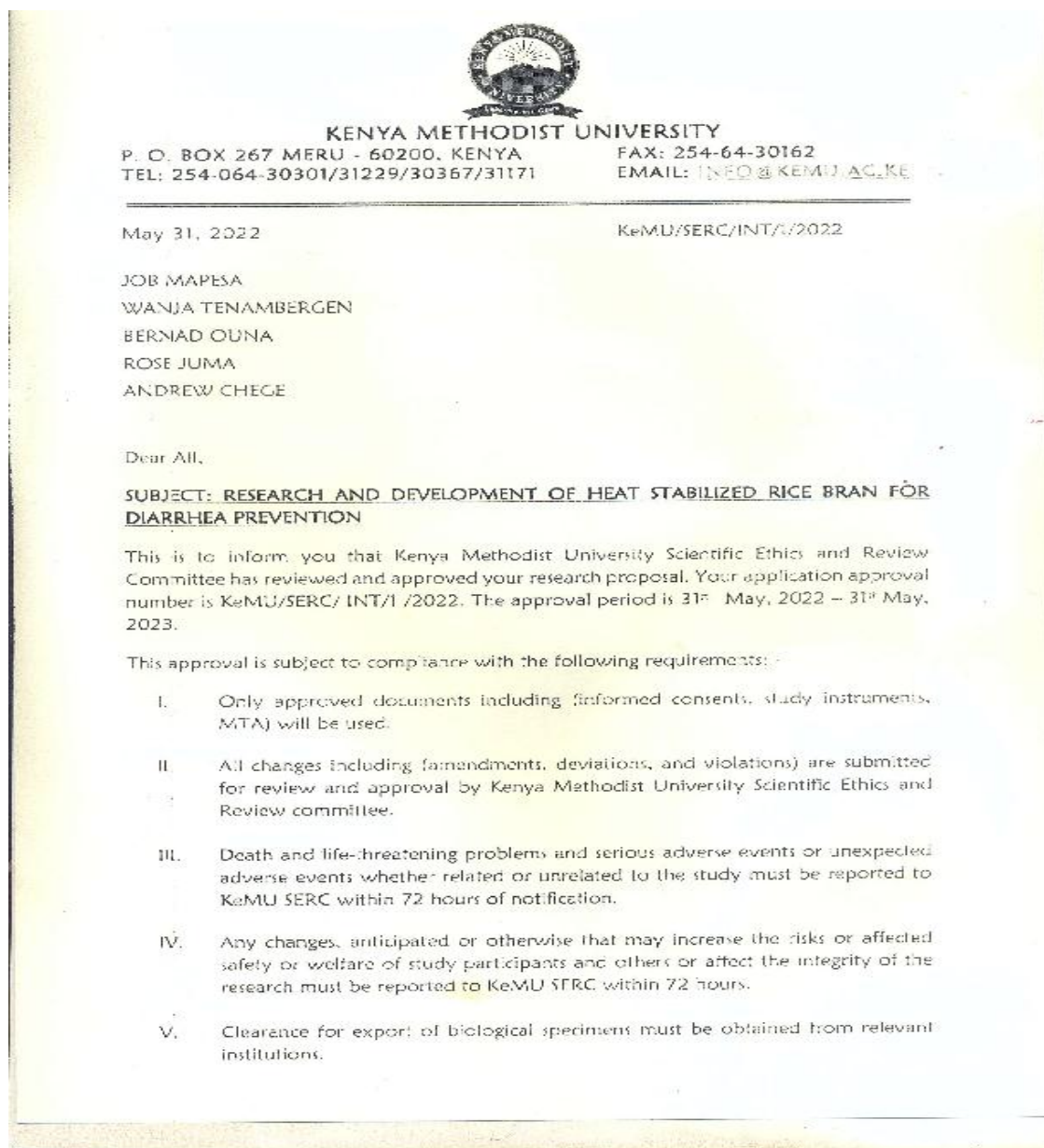
20. Are the crops in the kitchen garden available throughout the year 1 = yes
no =2 (move to 21)

21. What causes lack of supply throughout the year

.....

APPENDIX E: ETHICAL APPROVALS

APPROVAL OF RESEARCH PROPOSAL KENYA METHODIST UNIVERSITY GRADUATE SCHOOL



APPENDIX F: NACOSTI RESEARCH LICENSE/PERMIT

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