THE UTILIZATION OF LOCALLY GROWN PLANT MATERIALS IN PRODUCTION OF AN INTERVENTION FOOD FORMULATION FOR MALNOURISHED CHILDREN IN MARGINAL AREAS – THE CASE OF MAKINDU LOCATION, MAKUENI DISTRICT

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DECLARATION

I, Angela Muthoni Mwaniki hereby declare that this thesis is my original work and has not been presented for the award of a degree in any other university.

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6th August 2003

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DEDICATION

To Him that nourishes not only my body but also my mind and spirit
Who gives seed to the sower and bread for food
To Him be the glory and honour forever and ever
Amen.

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ABSTRACT

Child malnutrition is a major health problem in developing countries. Protein energy malnutrition, vitamin A deficiency and iron deficiency anaemia are the major nutrition problems that occur in pre-school children. In Kenya, 36% of the under fives are malnourished. This problem is more prevalent in the marginal areas, which constitute 80% of the country. Various long-term interventions have been formulated to address malnutrition. This project offered a food-based approach to combat child malnutrition and aimed at contributing towards immediate nutritional intervention through a participatory approach. It links technology to community development.

A study site was selected in one of the marginal areas of Kenya and the study carried out in two phases. The study site selected was Makindu Location in Makueni District, Eastern province. The first was a situation analysis of the area, which doubled up as a feasibility study for the suitability of the project. The second involved development of an intervention product. In the situation analysis, data on socio-economic status, nutritional status and crops grown locally in the area were collected via cross sectional survey using household and key informant questionnaires.

The results showed that the mean household size (5.2) is similar to the country's mean and that 33% of the population is below 5 years. Poverty is rampant in the area, 58% live below the poverty line. The major crops grown are pigeon pea, maize and cowpeas. Unfortunately there exist food taboos linked to use of dry pigeon pea. The nutritional status of the children was not significantly different ($p>0.05$) from the country's. The prevalence of chronic malnutrition was 37.5% while that of stunting was 7%. Based on

computation of energy and nutrient content, the household diets were deficient in their supply of vitamin A, energy and protein Over 80% of the households did not meet their vitamin A requirements, about 40% did not meet their energy requirements and 20% did not meet their protein requirements Household diets were most deficient in vitamin A supply.

In order to meet the community's nutritional needs and based on the results obtained, a food ration, later named 'Makindu Sweet Flour' by the community, was produced using locally grown raw materials that is maize, pigeon pea and orange fleshed sweetpotato This formulation was developed through the three phases of product development: product design, product adjustment and product evaluation The major ingredients were selected from a database containing the composition of all food crops grown in the area using linear programming. Makindu Sweet flour is roasted sweetened flour that provides more than 50 % of the RDA (for a 2 to 3 year old) in terms of energy, protein and vitamin A in 450 ml of the final product. This project linked technology to community needs, leading to sustainable community health through nutrition.

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OPERATIONAL DEFINITIONS

Household Group of people eating from the same pot

Malnutrition Nutritional inadequacy of protein energy and/ or any micronutrient

Poverty The failure to meet people's basic needs, that is, the incapacity to achieve the necessary levels of health, nutrition, housing, education and employment to be able to look forward to a reasonable duration of life

ABBREVIATIONS

ACC/SCN	Administrative Committee on Co-ordination/Subcommittee on Nutrition
CIP	Centre International Potatoes
ICRISAT	International Crops Research Institute for Semi Arid Tropics
IDD	Iodine Deficiency Diseases
KARI	Kenya Agricultural Research Centre
KBS	Kenya Bureau of Standards
MCC	Makindu Children's Centre
MSF	Makindu Sweet Flour
VAD	Vitamin A Deficiency
VITAA	Vitamin A for Africa partnership
SPSS	Statistical Package for Social Sciences

CHAPTER 1

INTRODUCTION

1.1 Background information

Malnutrition is a major health problem that particularly affects children in poor countries. There are many forms of childhood malnutrition, which include protein energy malnutrition (PEM), nutritional anaemia, vitamin A deficiency (VAD) and iodine deficiency. The most prevalent form in developing countries is PEM (Huffman, *et al.*, 2000; Wondimu and Mollenshi 1996; Akapapunam and Sefa-Dedeb, 1995). Most often micronutrient deficiencies are caused by diets limited in their content of foods rich in the micronutrients among others (National Micronutrient survey, 2001).

According to UNICEF's conceptual framework, the causes of malnutrition may be classified into basic, underlying and immediate factors (ACC/SCN, 1997). The immediate causes include disease and inadequate food intake. Inadequate food intake is the major cause of malnutrition in marginal areas, which are characterised by frequent droughts and a limited range of crops that can be grown.

Various long-term interventions have been formulated to address malnutrition including household food security, economic development, improved water supply and sanitation. This project aimed at contributing towards immediate nutritional intervention through a participatory rural approach by promoting the use of appropriate low cost technologies in processing the available food materials so as to meet the community's needs.

1.2 Statement of the problem

The problem simply put is malnutrition of children in marginal areas. Over 150 million children in the world under five years of age are underweight and more than 20 million suffer from severe malnutrition (UNICEF-ESARO, 1993). Most of these children are from developing countries. According to the Kenya Demographic Health Survey (1998), 36% of the under fives in Kenya are malnourished. In addition, malnutrition causes about 40% of deaths that occur in children in this age group. This scenario is worse in marginal areas, which are characterised by erratic rainfall, frequent droughts and of course poverty.

However, each marginal area has within limits unique food resources, which are available and could be used to alleviate malnutrition e g., the cassava in Coast Province, the camel in North-Eastern Province and the pigeon pea in Eastern province. In order to reduce malnutrition sustainably in these areas, it is necessary to develop area-specific rations, which are not only affordable but also developed from raw materials produced at the community level. Nutritious rations can be produced using locally available food materials and a combination of simple technologies.

In this study Makindu, a sub-location in Makueni district in Eastern province was used as a model for the production of area specific rations.

1.3 Justification

Marginal areas, which constitute 80% of Kenya's total land area and support 25% of the country's human population, have erratic food supply, which is more often than not inadequate (CBS, 2002). The areas are economically marginal and there is rampant poverty, which aggravates the situation. Meals consumed at the household level are often wanting in both quantity and quality. This scenario leads to a high prevalence of child malnutrition.

Children in these areas face the problem of inadequate food supply, which results in inadequate nutrient intake especially energy intake. Inadequate total intake is often accompanied by insufficient availability of protein and other essential nutrients, namely, vitamins and minerals. This may be a major cause for the high prevalence of child malnutrition in these areas. There is therefore need to develop nutritious rations that are targeted at children in the marginal areas. In so doing, it is important to ensure that the production process is not only affordable but also sustainable through the use of locally produced foods. It is estimated that more than 60% of Kenyan children suffer from vitamin A deficiency. In order to solve this problem various approaches have been made. The food-based approach has been more sustainable than medical treatment in combating malnutrition. Various organisations such as UNICEF, World Vision, Action Aid and Vitamin A for Africa partnership (VITAA) have used the food-based approach successfully. It is assumed that a project like this will yield sustainable results and lead to a wide range of benefits such as women empowerment through micro-enterprises.

1.4 Beneficiaries of the project

In the long term there will be improved nutrition of not only the children but also the households of Makindu Child malnutrition has short and long term adverse consequences that are of great significance for the individuals affected and for the societies in which they live. Hence, if the nutrition of children is improved, future generations will be healthier and more productive and thus will be an asset for national economic development (Martorell, 1995).

It is also assumed that the project will result in financial empowerment especially of women through commercialisation of the products and that its effects will be sustainable due to the simple technology used and the use of locally available food resources.

1.4 Objectives

1.4.1 Overall developmental objective

To alleviate child malnutrition in marginal areas of Kenya using food rations designed to meet their recommended dietary allowance in terms of vitamin A, protein and energy.

1.4.2 Specific objectives

i. To determine the socio-economic status of households in Makindu location, Makueni District

ii. To determine the nutritional status of children (aged 2 to 5 years) in Makindu

iii. To develop a culturally acceptable ration that meets the nutritional needs of Makindu children (2 to 5 years) in terms of vitamin A, protein and energy using locally grown raw materials.

1.5 Hypothesis

H_O : An intervention food formulation developed from locally grown raw materials will not provide a culturally acceptable and economically feasible solution for alleviating child malnutrition in Makindu

H_1 = An intervention food formulation developed from locally grown raw materials will provide a culturally acceptable and economically feasible solution for alleviating child malnutrition in Makindu

CHAPTER 2

LITERETURE REVIEW

2.1 Prevalence of malnutrition

Malnutrition in general can be defined as the pathological condition brought about by inadequate or excess intake of one or more of the essential nutrients in comparison to the physiological requirements of the body (Tumwet, 1994). The immediate causes of malnutrition are inadequate dietary intake and diseases. Inadequate food intake is a consequence of insufficient food at the household level and improper feeding practices. These causes are linked to a number of underlying factors such as household food security, inadequate maternal and child health care and limited access to basic services like education. The level of knowledge and technology systems at household and community levels and amounts of income and its control affect each of the underlying causes. These are in turn linked to a number of basic causes, the endogenous circumstances within the system including traditional beliefs and practices, national resource base and the political and ideological superstructure (GOK/UNICEF, 1992).

About 150 million children under five years of age are underweight and more than 20 million suffer from severe malnutrition world-wide (UNICEF-ESARO, 1993). It is estimated that 350 million women have nutritional anaemia, some 40 million children suffer from VAD and iodine deficiency diseases (IDD) afflict 200 to 300 million people with goitre and at least 6 million suffer from cretinism. The sub-committee on Nutrition of the United Nations Administrative Committee on Co-ordination (ACC/SCN) estimates that in 1995 29.3% of pre-school children (i.e. < 5 years of age) in developing countries were underweight. This is lower than the 34.3% estimated for 1985. However,

in absolute numbers the number of underweight children changed little over this period, from 163.8 million in 1985 to 157.6 million in 1995.

The prevalence of malnutrition in Kenya is high, with 33 percent of children below 5 years of age being stunted and 6 percent being wasted. Of the children who are stunted, more than a third are severely stunted while about 20 percent of the wasted children are severely wasted (KDHS, 1998). In a healthy, well-nourished population only 1 in 1000 children is expected to be severely undernourished. Thus, the level of severe wasting in Kenya is 10 times that expected in a healthy, well-nourished population and the level of severe stunting is 125 percent times more. In Kenya, chronic malnutrition as reflected by the prevalence of stunting, is a greater nutritional problem than acute malnutrition. The prevalence of acute malnutrition is also high. The prevalence of stunting in Kenya progressively increases with age from 8% among infants below 6 months of age to 18% for children 6-11 months old and peaks at 12-18 months to 40% (KDHS, 1998)

A total of 38 percent of all deaths that occur before age five in Kenya are related to malnutrition. Of this, mild and moderate malnutrition contributes 34 percent of all deaths while severe malnutrition contributes only 4 percent (KDHS, 1998). It is evident that nutrition programmes established to prevent and treat moderate malnutrition, as well as severe malnutrition will have an impact on child mortality.

A number of researchers have observed that although the prevalence of severe malnutrition in developing countries is low (one to three percent), moderately malnourished children constitute about a third of the population of malnourished children and, are in the danger of falling into the severely malnourished category (CBS,

1991; Kalavi, 1995). Besides PEM, VAD and iron deficiency anaemia are the major nutrition problems that occur in pre-school children. Most often they are caused by diets limited in their content of foods rich in these micronutrients among others.

It has been reported that a higher percentage of the children suffer from VAD than adults but a higher percentage is in the moderately malnourished range (National Micronutrient Survey, 2001). They have reported that among children, acute and moderate VAD prevalence was estimated to be 14.7% and 61.2%, respectively. The corresponding VAD prevalence among mothers was 9.1% and 29.6%. VAD in men followed the same trend but men had a slightly lower prevalence than women did. Vitamin A deficiency leads to night blindness, or in its severe form xerophthalmia and keratomalacia (Smith *et al.*, 1996) while sub-clinical deficiency reduces immune functions thereby increasing the risk of a range of secondary diseases (Bates, 1995; Underwood, 1994).

The main strategy for combating VAD has been to distribute capsules (Kennedy and Onian'go, 1993). However, it has been reported that a similar effect could be achieved by increased consumption of beta carotene and vitamin A rich foods (Rahmathullah *et al.*, 1990). Foods providing concentrated pro-vitamin carotenoids can make a tremendous contribution to improved health (Hagenimana *et al.*, 1998). In several Eastern and Southern African countries, between one third and one half of the children are vitamin A deficient. In 1994 Kenya had a prevalence of 33.8 % (Arjan, 2001). It is commonly believed that the major cause of the high rate of vitamin A deficiency is an inadequate diet. A large part of the population does not consume enough food to meet their calorie requirements, while the variety and the nutritional quality of the food is

often poor. In addition, the high frequency of infectious diseases further increases the risk of VAD. The high prevalence of HIV/AIDS in the region can further worsen the situation. Vitamin A deficiency being one of the major nutrition deficiencies in Kenya must, therefore, be addressed in any food formulation.

2.2 *Interaction of malnutrition and dietary intake*

Malnutrition is suggested to be due to an interaction of inadequate dietary intake and infectious diseases (Huffman, 1983). Infection, diarrhoea and malnutrition acting synergistically are primary causes of infant mortality of children below five years in the third world (Habicht, 1983). "Adequate protein-energy status seems particularly important in prevention and management of many diseases notably diarrhoea (especially persistent diarrhoea), measles being the best known", (Tomkins and Watson, 1989).

Vitamin A deficiency is a problem of public health significance in over 70 countries. It affects large numbers of pre-school and school-aged children and women of child bearing age. Over 78 million children under five years of age are affected by VAD putting them at risk in terms of their health and survival (Chakravarty, 2000). In Kenya, the prevalence of VAD remains a significant public health problem. The inferred prevalence of VAD based on S-retinol deficiency among pre-schoolers stands at 14.7% for acute and 61.2% for moderate grades. Vitamin A supplementation for pre-schoolers is usually done during immunisation. It has also been reported that nearly 3 out of 5 mothers deliver at home and that they probably miss the recommended post-partum vitamin A supplementation. In addition to side effects reported by some mothers, the price of the supplements is prohibitive. There is hence need to increase the supply of

vitamin A in the household diets through dietary diversification and promotion of foods locally grown that are rich in vitamin A. Vitamin A deficiency occurs when vitamin A intake or liver stores fail to meet metabolic requirements. The most common cause of VAD is inadequate consumption of foods that are rich in vitamin A or β-carotene. Deficiency also results when absorption, conversion, and utilisation of vitamin A are compromised. This often occurs when levels of infection or disease are high and/or when consumption of fat, oils or proteins is very low. Foods containing fat or oil are needed for proper utilisation. The best sources of vitamin A are animal products such as liver, whole milk, eggs and butter. Animal sources contain preformed, active retinol, which can be used directly by the body. Plants are also important sources of β-carotene a precursor of vitamin A. The rich sources include dark green leafy vegetables, dark orange fruits and vegetables and red palm oil (HKI, 1992).

Protein and energy deficiency leads to PEM. Protein energy malnutrition is one of the major health problems in underdeveloped countries in the world today. It is largely responsible for the fact that in some areas up to half the children born do not live to see their fifth birthday. Protein energy malnutrition occurs less severely in adults. This is because adults do not need protein for growth and in most adult diets, protein provides 10% of the energy (Latham, 1997). Protein energy malnutrition describes a range of clinical disorders. At one end, is marasmus, which is due to a continued restriction of both dietary energy and protein as well as other nutrients. At the other end is kwashiorkor due to a quantitative and qualitative inefficiency of protein but in which energy intake may be adequate. Kwashiorkor and marasmus are extreme syndromes and between them are forms in which the clinical features are due to varying combinations

of deficiency of protein and energy together with deficiencies of minerals and vitamins with associated infections

2.3 *Strategies for prevention of micronutrient malnutrition*

In this project vitamin A deficiency is of major concern. There are three broad strategies in combating micronutrient malnutrition, namely, supplementation through high dose nutrient supply, food fortification, and dietary diversification (Feber *et al.*, 2001). Supplementation involves the distribution of the nutrient usually a micronutrient in a capsule, liquid or tablet form. Food fortification on the other hand involves addition of the nutrient to an already existing food product. Dietary diversification is a food-based strategy that addresses micronutrient deficiencies, such as VAD deficiency by incorporation of foods rich in the micronutrient (Beaton *et al.*, 1993).

2.3.1 Supplementation

By geographic region, the greatest amount of vitamin A supplementation done in sub-Saharan Africa is during national immunisation days (NIDs). The problem that follows is that only one dose of vitamin A is delivered and not two annual doses as required (Ajarn, 2001). In addition, vitamin A supplementation is in many cases not an integral part of sustainable delivery systems. In most countries including Kenya, vitamin A supplementation is funded mainly by donors thus limiting its sustainability.In most cases supplementation is done for only one nutrient. This leads to other nutrients being ignored.

2.3.2 Fortification

Several countries in the region have started or are planning to fortify foods. In Kenya salt is fortified with iodine, soft drinks with vitamin C and fats with vitamins. Most of the supplementary food distributed as part of food aid in the region is fortified with a mixture of nutrients, including vitamin A. Food fortification projects have to deal with several challenges, including quality assurance, community mobilisation, mobilisation and training of manufacturers, distribution of the premix, and sustainability (Ajam, 2001). The problem lies in the fact that there are no restrictions forcing manufactures to fortify their products. In addition, where fortification is done there is no legislation as to the quality and quantity.

Many challenges face food fortification. Firstly, there are only a few countries where centrally produced foods are consumed by a large part of the population. Secondly, in order to have a wide coverage, several products must be fortified. This increases the risk that some people will have a relatively high intake of the nutrient. Finally, monitoring and law enforcement systems are relatively weak in most countries. This creates the need for committed producers which requires early mobilisation and involvement of the private sector (Chopra, 2001).

2.3.3 Dietary diversification

Of the three strategies to combat vitamin A deficiency, dietary diversification seems to have received the least attention during the last 10 years. The aims of this strategy include an increase in the production of, availability of, and access to foods rich in vitamin A and increase in the consumption of foods rich in vitamin A, which can be achieved through nutritional education, promotion, and social marketing (Faber *et al*., 2001). [illegible] about the contribution dietary diversification can make

towards eliminating vitamin A deficiency in the region", (Arjan, 2001). Poverty levels and household food insecurity are very high and so many people are not able to meet their calorie requirements. This causes some challenges should this strategy be used. Firstly, most households do not have access to vitamin A rich foods from animal sources and hence have to depend on plant sources. The bioavailability of carotenoids from dark-green leafy vegetables is low compared with that from supplements, and consequently a large amount of vegetables must be consumed to provide adequate levels of vitamin A. Secondly, consumption of fat or foods rich in fats is low, further reducing the bioavailability of carotenoids. Thirdly, successful promotion of dietary diversification requires a behavioural change in food selection, food production and/or purchase, food preparation and food consumption. Finally, because of the different components of dietary diversification, a multisectoral approach is required.

One potential food based strategy focuses on the promotion of varieties of orange fleshed sweetpotatoes rich in β-carotene as a key entry point for improving vitamin A intake. According to Hagenimana *et al.* (2001) promotion of orange fleshed sweetpotatoes is a logical food-based strategy in Kenya for several reasons. Firstly, they are rich in β-carotene. Secondly, orange fleshed sweetpotatoes have been identified as the least expensive potential year round source of dietary vitamin A. Finally, sweetpotatoes are cultivated by women, who are also the main actors regarding households food security. The goal of improving vitamin A status through enhanced availability, accessibility and utilisation of foods is more likely to be achieved if women control both production and consumption of particular crops.

To implement dietary strategies effectively, knowledge of local dietary patterns, the availability and cost of foods and food beliefs, preferences and taboos is required as well as the ability to change attitudes and practices. To be effective, the dietary strategies must be practical, culturally acceptable, economically feasible and sustainable to the target group. They must not increase the cost or the preparation and cooking time, and hence the workload of the care givers, or include significant changes in the types and quantities of food items commonly consumed Instead, they should be based on existing food consumption patterns and be adapted from local food processing procedures and recipes (Gibson *et al.*, 2000).

2.4 Product Development

The product concept holds that consumers will prefer products that are widely available and inexpensive. In addition, it holds that consumers will favour those products that offer the most quality, performance, or innovative features. New products may be classified in to six categories: new to the world products, new product lines, additions to existing product lines, improvements and revisions of existing products, repositionings and cost reductions (Booz *et al.*, 1982). *New to the market products* are new products that create an entirely new market. *New product lines* are products that allow a firm to enter an established market for the first time. *Additions to existing product lines* on the other hand, are new products that supplement a company's established product lines. They include changes in package sizes, flavors, package design etc. *Improvements and revisions of existing products* are new products that provide improved performance or greater perceived value and replace existing products. *Repositionings* consist of existing products that are targeted to new market segments. Cost reductions are new products

that provide similar performance at lower cost. This project aims at producing a *new product in the improvements and revisions of existing products* category (Kotler, 2000).

New product development is risky and has many challenges. The major risk is the amount of capital required in product development. This may lead to huge losses should the consumers reject the product. Many new products fail to reach the consumer's needs. Some of the reasons of the failure as sited by Kotler (2000) include: pushing of innovator's ideas in spite of negative market research findings, over estimated target population and poor designing of the product. Other new challenges face new product development. Firstly, there may be a shortage of important ideas, which means that there may be few ways left to improve some basic products. Secondly, there are social and governmental constraints under which new products have to satisfy consumer safety. Thirdly, shorter product life cycles. When a new product is successful, rivals are quick to copy it. Finally and most limiting, is the capital shortage.

In order to overcome the shortages in product development one has to develop a unique, superior product. Products with a high product advantage succeed 98 percent of the time, compared to products with a moderate advantage, which have 58 percent success (Kortler, 2000). To ensure success of the product, the product concept must be well defined prior to development. One must carefully define and assess the target market, product requirements, and benefits before proceeding. Other sucess factors are technological and marketing synergy, quality of execution in all stages, and market attractiveness.

A product concept is an elaborate version of the idea expressed in meaningful consumer terms in this project the product idea is to produce food intervention for malnourished children in marginal areas. This product idea must be turned into a consumer concept by answering basic questions such as: who will consume the product? What primary benefit should this product provide? Finally, when will the product be consumed? These questions must be asked at the beginning of the product development and answers sought after if the intended product is to succeed. Answers to these questions were hence sought after in the concept of the intervention product.

CHAPTER 3

MATERIALS AND METHODS

3.1 Research design

3.1.1 Study site

The project aimed at producing a food ration for malnourished children in marginal areas using locally grown food materials. This ensures sustainability. Since each marginal area has its unique combination of available food materials, it was proposed that the rations produced be based on specific marginal areas, to ensure that the rations produced meet the needs of the target population in the specified areas. Due to the time and resource limitation, this project was based on only one such marginal area in the Eastern Province- Makindu Location Makueni District, which will serve as a model for the region. Again the same reasons limited the study site to two sub-locations i.e. Manyatta and Kiu, which were created in the subdivision earlier on of Makindu Sub-location.

Makindu is a location in Makueni district of Eastern province, a province prone to frequent drought and famine. The location was selected due to its accessibility as it is situated along Mombasa road, 230 kilometres from Nairobi. In addition, the location houses Makindu Children's Centre, which has a policy of disseminating information to the community in an attempt to raise their living standards. The centre doubles up as a link between institutions such as AMREF, ICRISAT and KARI, and the community. Makindu location has a total of 9907 households in an area of 880.2 km^2. Kiu sub-location has 416 households and an area of 34.9 km^2 while Manyatta sub-location has

1,663 households and an area of 11.6 Km^2 (CBS, 2001). The area has many amenities. These include two hospitals, a police station, the divisional officers and government administration offices, a law court, a temple, a mosque, various churches, schools (three nurseries, three primary schools and three secondary schools), two shopping centres and two markets.

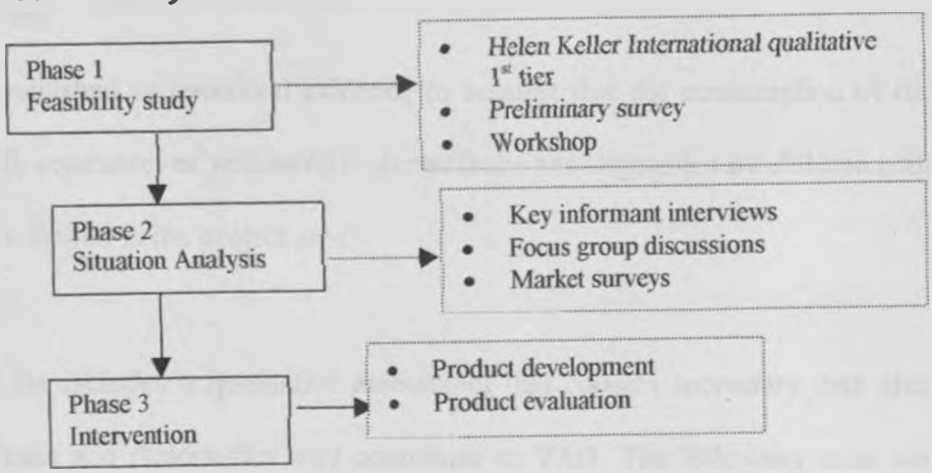
3.1.2 Study population

The study population was households in Eastern province, Makueni district Makindu location with children aged between two to five years and more specifically such households in Manyatta and Kiu sub locations. Supportive data was also collected from the local administration (chiefs & elders), clinical care providers, community health workers, women groups and market vendors.

3.1.3 Study design

The study was carried out in three phases: feasibility study, situation analysis and product development. Each of these phases is discussed in detail in the following sections. A summary of the activities in each phase is given in Figure 3.1.

Figure 3.1: A summary of the research design



3.2 Situation analysis

A survey was carried out so as to establish the status quo This was combined with the first two tiers of Helen Keller International (HKI) qualitative research methods so as to conduct an assessment of vitamin A intake. The first tier permits one to determine at a glance if VAD is a potential problem in the project area. This tier seeks answers to the following questions.

1. Does the program operate in one of the following countries; Bangladesh, Benin, Brazil, Burkina Faso, Chad, Ethiopia, Ghana,, Guatemala, Haiti, India, Indonesia, Kiribati, Malawi, Mali, Mauritania, Nepal, Niger, Nigeria, Philippines, Sri Lanka, Sudan, Tanzania, Vietnam, Yemen, or Zambia?
2. Have prior assessments indicated a VAD problem in the project area?
3. Does evidence of VAD exist in country in a region that is similar in terms of geography, rainfall distribution and food availability to the project area in question?
4. Is there a local term for night blindness in the project area?
5. Is there published or anecdotal evidence to suggest that production of dark green leafy vegetables or yellow/dark orange fruits and vegetables is very limited in the project area?
6 Is there published or anecdotal evidence to suggest that the consumption of dark green leafy vegetables or yellow/dark orange fruits and vegetables by children under six is very limited in the project area?

The second tier includes a qualitative assessment that collects secondary data about vitamin A intake and factors that may contribute to VAD. The following tools were used to collect data in this phase:

3.2.1 Focus group discussions

Four focus group discussions each with an attendance of between eight and twelve members were carried out. The groups consisted of women groups in the area. These were women who acted as local nutritionists, health workers, agricultural agents or primary caretakers and who were familiar with the local nutritional and dietary practices. The focus group discussions were carried out following Appendix 3 as a guide. The objectives of these discussions were: to develop a list of locally available vitamin A rich foods in Makindu; to determine seasonal availability of vitamin A rich foods and to verify information collected from households.

3.2.2 Key informant interviews with clinical care providers

Five key informant interviews were carried out with clinical care providers in Makindu. The contacts included local physicians, nurses and government midwives. This was done using the format in Appendix 1 as a guide. The aim was to document anecdotal or case of evidence of xerophthalmia and to detail local health conditions and priorities.

3.2.3 Key informant interviews with community health workers

Seven key informant interviews with community health workers including local nutritionists, local health workers and traditional birth attendants were carried out. This was done with the objective of detailing local nutritional/dietary practices and to note down the existence of a term/phrase for night blindness. The guidelines appear in Appendix 2.

3.2.4 Household questionnaire

The household questionnaire (Appendix 4) was used to collect data on the demographic and socio-economic status of the households, household food security, nutritional status of the children and their mothers, livestock kept and locally grown food crops. Questionnaires (281) were allocated to clusters at random. The clusters were obtained by putting together villages of similar population density in one cluster and then calculating the proportion of total population in each cluster and allocating questionnaires accordingly. The mode of allocation is shown in Table 3.1. All questionnaires were screened for completeness at the end of each day.

Table 3.1: Allocation of questionnaires to households in Makindu Location

Cluster	Sub location	Village	Number of questionnaires
Cluster A	Manyatta	Misongeni	33
with 35% of total	Manyatta	Manyatta	33
population	Manyatta	Shauri Moyo	33
Cluster B	Manyatta	Ngukuni	21
with 30% of the total	Manyatta	Nguuni	21
population	Kiu	Kalima Ndogo	21
	Kiu	Yinzau	21
Cluster C	Manyatta	Nthilani	14
with 25% of total	Manyatta	Ziwani	14
population	Kiu	Kiambani	14
	Kiu	Katheka Kai	14
	Kiu	Kiwanzani	14
Group D	Manyatta	Makongeni	7
with 10% of the total	Manyatta	Savaani	5
population	Kiu	Vombo	5
	Kiu	Bondeni	5
	Kiu	Kiu Safari	6
	TOTAL		**281**

3.2.4.1 Calculation of Household Sample size

The sample size (281) was obtained from calculating the least sample size using Fishers equation (Fisher *et.al.*, 1991) of least possible sample size as follows:

$$n=Z^2pq/ d^2$$

Where,

n = minimum sample size

Z= the standard normal deviate set at 1.96 for a confidence level of 95%

p = the proportion children below five years who are underweight in Kenya is estimated to be 22 percent (KDHS, 1999)

q = the proportion of children below 5 years who are not underweight in Kenya estimated to be 78 percent (KDHS, 1999).

d = degree of accuracy desired, set at 0.05

Therefore the minimum sample size is:

$$n=(1.96)^2x(.22)x(0.78)/ (0.05)^2$$

$$n=263.68$$

Minimum sample size of households required is 264. To give room for spoilt questionnaires a contingency of 6 percent was taken into account instead of the normal 10 percent due to the cost implications and a total of 281 questionnaires were administered

3.2.4.2 Sampling of the households

To obtain data that is representative of the area, all the villages in the two sub-locations in question were clustered based on their population density. Those with similar

population densities were placed in the same cluster The population densities were estimated by a group of people with knowledge of the area including the sub chiefs and elders of the area The questionnaires were administered purposefully within the clusters to households with children between the ages of two and five years

3.2.4.3 Household food intake

Food intake estimation entails the collection of information on the quantity of individual portions of foods eaten and, using food composition tables to determine values, the computation of the energy and nutrient content of these The use of a single 24 hour recall can easily miss the consumption of certain food items (Faber *et al.*, 2001). Therefore, household food intake was estimated using a 24-hour recall twice such that two days, one special day (Monday the market day) and one ordinary day (a Thursday) were captured The household respondent (mother) was asked to recall and describe the kinds and amounts of all foods and beverages consumed during a period of twenty-four hours (the previous day).

3.2.4.4 Nutritional status of children

Evaluation of nutritional status is based on the rationale that in a well nourished population; there is a statistically predictable distribution of a given age with respect to height and weight The reference population used in this report is the NCHS (US. National Centre for Health Statistics) standard, which is recommended for use by the World Health Organisation (WHO). Three anthropometric indices were used; height for age, weight for height and weight for age. Each of these indices gives different information about growth and body composition used to assess nutritional status.

Height for age is a measure of linear growth. It is a measure of stunting a condition that reflects the cumulative effect of chronic malnutrition. Weight for height describes current nutritional status. It is a measure of wasting, a condition reflecting acute or recent nutritional deficit. Weight for age is a composite index of weight for height and height for age. A child can be underweight for his age because he/ she is stunted, wasted or both stunted and wasted. It is a good overall indicator of a population's nutrition status (KDHS, 1998).

The indices are calculated in standard deviations. A child who is below minus two standard deviations (-2 SD) from the median of the NCHS reference population is moderately malnourished while that below minus three standard deviation (-3 SD) is severely malnourished.

3.2.5 Data analysis

The questionnaires were screened for completeness at the end of each day. The data collected was entered in to suitable packages for analysis i.e. Epi-info for anthropometry data, statistical package for social sciences (SPSS) for demographic and socio-economic data and MS Excel for 24- hour recall

3.3 Intervention product development

After careful situation analysis, the nutritional needs of the children in Makindu were identified and determined. This was followed by appropriate product development. This is in line with any company's strategy of product testing which is stated as "once a

company has segmented the market, chosen its target consumer groups, identified their needs, and determined its desired market positioning, it is ready to develop and launch appropriate new products" (Kortler, 2000). In the design of the product the following questions, which are necessary in testing the product concept were asked,

1. Who will use this product?
2. What primary benefit should this product provide?
3. What form will the product take?
4. When will the target group consume this product?

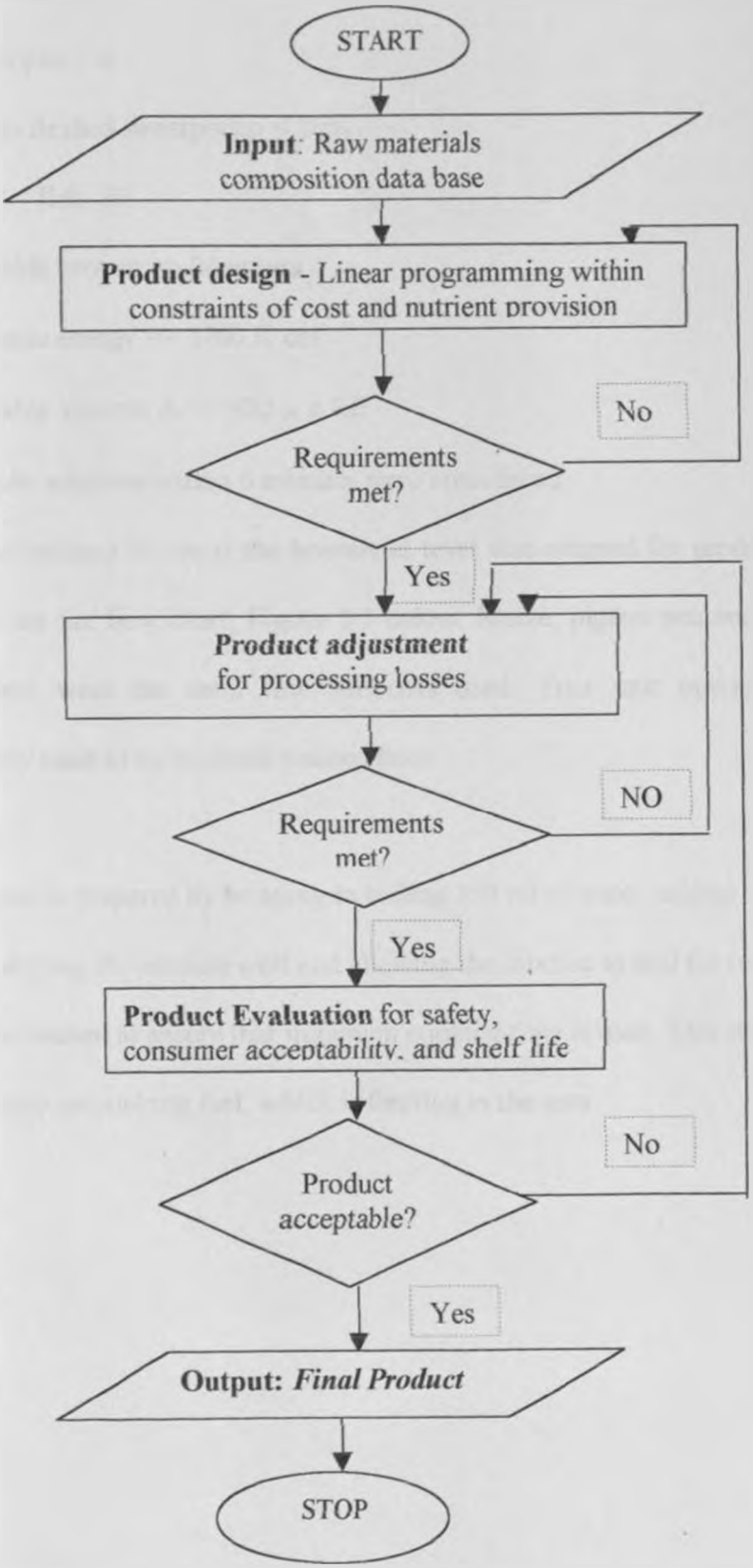
3.3.1 Product design

The product was designed to meet the nutritional needs of children aged between 2 and 5 years, but can be consumed by the whole household. The product is roasted flour, which is to be consumed as a breakfast cereal or snack at 10 o'clock. It may be consumed at home or at school under the school feeding programs. It is designed to provide all the recommended dietary allowance in terms of vitamin A, energy and protein. Its primary benefit is that it provides 50 percent of the recommended dietary allowances in terms of vitamin A, protein and energy in 450ml of the final product. It is thus deigned so as to provide the benefits of a supplementary diet without altering the eating habits of the households

In product development, the product was passed through three major steps, product design, product adjustment and product evaluation. Each of the steps was looped such that only the best possible product was passed on as the final product. A summary of the logic is presented in Figure 3.2.

Raw materials were selected from a list of all the crops grown in Makindu. This ensures that its production is not only feasible but also sustainable. Since maize is the staple crop, then the flour must contain maize for the product to be acceptable. Drawing from the objectives of the project, the product must also contain raw materials that are locally grown. The optimal ratio (least cost ration) was obtained using the Microsoft Excel solver, for linear programming.

Figure 3.2: A summary of the product development process



The food ration was obtained within the following constraints

1 Maize > 0

2 Pigeon pea > 0

3. Orange fleshed sweetpotato < 20%

4 Cost <= Ksh. 50

5 Available protein => 24 grams

6. Available energy => 1700 K cal

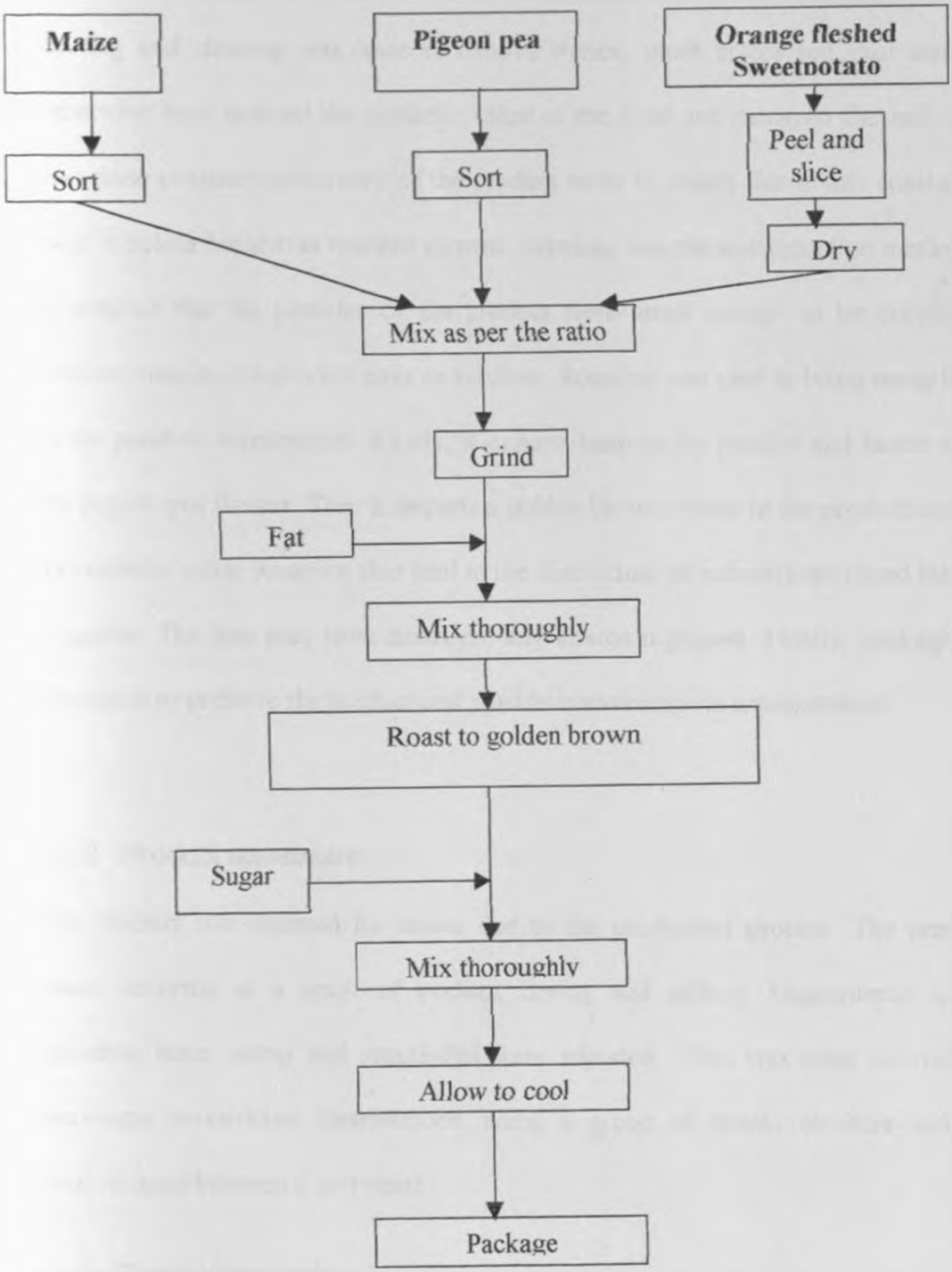
7 Available vitamin A => 500 μ g RE

All possible solutions within 6 minutes were considered.

Simple technology in use at the household level was adapted for product development as shown on the flow chart, Figure 3.3 below. Maize, pigeon pea and orange fleshed sweetpotato were the main raw materials used. Four unit operations were then deliberately used so as to obtain roasted flour.

The product is prepared by bringing to boiling 350 ml of water, adding 100grams of the product, stirring the mixture well and allowing the mixture to boil for two minutes. The product is roasted to ensure that minimum cooking time is used. This saves not only on time but also on cooking fuel, which is limiting in the area.

Figure 3.3: Flow chart for Makindu Sweet flour production



The unit operations used were sorting and cleaning, mixing, grinding and roasting. Sorting and cleaning was done to remove stones, spoilt grains and dust that would otherwise have reduced the aesthetic value of the food and damaged the mill. Mixing was done to ensure uniformity of the product so as to ensure that it was consistent not only in colour but also in nutrient content. Grinding was the size reduction method used. It ensured that the particles of the product were small enough to be consumed by children making the product easy to swallow. Roasting was used to bring many benefits in the product development. Firstly, it imparts taste to the product and hence masking the pigeon pea flavour. Then it imparts a golden brown colour to the product increasing its aesthetic value. Roasting also lead to the destruction of antinutrients found inherently in grains. The heat may have destroyed any aflatoxin present. Finally, packaging was then done to preserve the product and provide convenience in transportation.

3.3.2 Product adjustment

The product was adjusted for losses due to the production process. The production losses occurred as a result of peeling, drying and milling. Organoleptic qualities including taste, colour and mouth-feel were adjusted. This was done informally, to encourage unrestricted contributions, using a group of twenty mothers with their children aged between 2 to 5 years.

3.3.3 Product evaluation

The product was evaluated for 3 main factors, acceptability, nutritional value and safety.

3.3.3.1 Acceptability

The product was evaluated against the maize meal commonly used for the same purpose in the area. This was done using a comparison test for appearance, mouth feel and taste (Appendix 5). The data were collected using a structured questionnaire. This was administered to 180 mothers from the 281 households to which the household questionnaire was administered earlier. Mothers were asked to scale their like/dislike of the product on a 15-cm line with 0 cm being dislike very much and 15 cm being like very much.

3.3.3.2 Nutritional value

The product's nutritional value was determined with reference to the proximate composition and vitamin A content.

3.3.3.2.1 Proximate composition

Moisture content and Total Solids

The moisture content and total solid of the flours was determined according to the AOAC (1984) method outlined for wheat flour.

Crude protein

The crude protein was determined using the micro Kjedhal method as outlined in AOAC (1984). The factor 6.25 was used.

Crude fat or Ether Extract in flour

The crude fat or ether extract as it is sometimes referred to was determined using the method for wheat flour outlined by AOAC (1984).

Crude fibre

Crude fibre was determined as for wheat flour using the method by AOAC (1984).

Ash

The ash was determined using the direct method for determining ash in wheat flour as outlined by AOAC (1984) method.

Soluble carbohydrates

This was determined by difference. All the above components in percentage were added and subtracted from 100 to obtain the percentage soluble carbohydrates

3.3.3.2.2 Vitamin A as ß-carotene

Method No. 44 of the International Federation of Fruit Juice Producers adopted in 1972. A standard curve was obtained by measuring at 450 nm standard solutions of petroleum ether containing 0.05 to 0.25 mg/100 ml of pure ß-carotene. 200 ml of the petroleum ether extract was evaporated under vacuum at about 40^0C to a final volume of approximately 1 ml. The column for chromatography was prepared with aluminium oxide (partially inactivated to 8% H_2O) suspended in petroleum ether into a 25 ml volumetric flask. The volume was brought to the mark with petroleum ether. Absorbance of the eluted ß-carotene was read at 450 nm in a 1 cm cuvette using a spectrophotometer. The concentration was read from the standard curve. The results were reported as mg ß-carotene per 100 g of sample.

3.3.3.2.3 Safety of the product

Evaluation for safety of the product was based on the most likely health hazard for the product, aflatoxin. A qualitative method, thin layer chromatography, was used. Since no

aflatoxin was detected, a quantitative method was not necessary. Extraction of alcohol soluble components, of which aflatoxin is one, was done by grinding 40g of Makindu Sweet Flour mixing this at low speed with 100 ml methanol and 10 ml water for 3 minutes. Another 30ml water was added to the mixture and the speed of mixing increased. Mixing was done for 3 minutes. The mixture was then filtered through a fluted filter into a 100 ml graduated cylinder. 70 ml of the filtrate was transferred into a 250ml separation funnel. The cylinder was washed with 50 ml NaCl solution (550 ml H_2O + 50g NaCl). 50 ml petroleum ether wash added into the separation funnel and the mixture shaken for 2 minutes. The aqueous phase was transferred into another 250 ml separation funnel. 20 ml of water and 90 ml chloroform was added and the mixture shaken for 2 minutes. The chloroform was filtrated through a fluted filter into a round bottomed flask this washed twice with 20 ml chloroform. A rotary evaporator concentrated this at 35 to about 1 ml. The concentrate was transferred into a small test tube. The concentrate was then spotted on a TLC plate and run stopped when the whole plate was saturated with ether. The plate was then examined under a 365 nm UV-light.

3.3.3.2.4 Shelf life

The intervention product was studied for its shelf life characteristics. Due to the limitation of resources an accelerated shelf life study was necessary. The assumption that storage of the product for 24 hours at 55°C was equivalent to a month of storage at 37°C was made. Twelve triplicate samples of Makindu Sweet Flour each of approximately 250g were incubated in sealed glass jars for twelve days following the procedure of Gooding and Duckworth (1957). Three jars of the product were removed daily and the flour analysed for rancidity. Rancidity was used as the indicator for spoilage since most flour products spoil due to rancidity (Pearson,

1976). In addition, the KBS demands that processed cereal-based foods for infants and children be free from rancid flavours and odours (KBS, 1983).The free fatty acid of acid value was determined on light petroleum extract of the flour. This was used as an indicator because free fatty acids rise much faster as the flour deteriorates than the acidity of the aqueous or alcoholic extracts.

3.3.3.2.5 Energy

Energy was determined by calculation using food composition table established in East Africa (Sehmi, 1993)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Socio-economic characteristics

The most important purpose of studying demographic aspects of households and families is to gain knowledge of factors affecting their dimensions and trends. This knowledge is useful in dealing with many questions of policy and formulation of action programmes in the economic and social fields (CBS, 1998). Some of the socio-economic characteristics studied include, age and gender distribution, marital status, mean household size, household headship, sources of income, house structures, and farming practices

The mean household size in Makindu was 5.2. This is the same as the overall mean household size for the country (CBS, 1998). Age distribution and level of education of the Makindu population is shown on Table 4.1. The age distribution is skewed to the left (1.09) with 62.3 percent of the population (sample size 1449 people) having an age equal to or less than 20 years. The male to female ratio stood at about 1:1 with 52 percent of the population being male while 48 percent was female. Twenty six percent of the population was below 5 years of age.

There was a low level of education with only one percent having obtained college education and only 11 percent obtaining secondary level education half of which dropped before completing this level of education. Twenty six percent of the population have obtained no formal education whatsoever

Table 4.1: Age distribution and the education level of the Makindu population

Population Element	Male	Female	Percentage of population	Total
Age distribution				
0- 5	245	235	33.1	480
6-10	105	83	13	188
11-20	103	132	16.2	235
21-30	95	186	19.4	281
31-45	116	87	14	203
45 <	35	27	4.3	62
				n=1449
Formal Education level				
None	98	142	25.8	250
Lower Primary	98	72	16.5	160
Upper Primary	170	206	38.8	376
Secondary	77	83	16.5	160
College	11	12	2.4	23
				n= 969

Poverty lines have been developed as an aid for assessing poverty. They are based on norms and identify the minimum requirements of food and non-food expenditure needed to meet the minimum basic needs This poverty line encompasses both food and non-food basic requirements. In 1997, the food poverty line was established at Kshs. 927.1 per month per adult equivalent for rural areas while for urban areas it was set at 1,253.9. The overall poverty line was established at Kshs 1238.9 per adult equivalent per month (CBS, 1998). Kshs. 927.1 was used as the poverty line because Makindu is a rural area.

Poverty was rampant in Makindu. The average household income stood at 621.2 Kenya shillings per adult equivalent. The results show that 58 percent of the Makindu population lives below the poverty line with 77 percent of the population being non-income generating including children below 5 years, students, housewives and the unemployed This causes a financial strain on the families and may be one of the reasons for the low level of education in the area. In addition, households were affected differently by poverty according to gender, education level and major source of income of the household head as summarised on Table 4.2 below. Households headed by women were more likely to live below the poverty line than those headed by men. Lack of formal education and a permanent job increases the probability of a household being poor.

Table 4.2: Financial status of households based on household head's gender, level of education and major source of income

Characteristic	% above poverty line	% below poverty line
Gender		
Female	14.7	35.5
Male	23.7	22.5
Total	42	58
Level of Education		
None	8.1	32.8
Primary	12	17.6
Secondary	11.5	7.6
Tertiary	7.4	0
Total	42	58
Major Source of income		
Manual labour	8.2	56.5
Business	19 8	1.5
Employment (formal)	14	0
Total	42	58

n= 281 households

House structures and water source for household consumption have been used as poverty indicators for a long time (KDHS, 1998). By identifying the type of house structures in an area, one can estimate the level of poverty by holding other factors constant. In Makindu 32 percent of the houses were grass thatched, 43 percent were made of mud walls and 59 percent had mud floors. Forty one percent of these households rented houses. The main source of water in the area is river water from a tributary of Athi River called "Kiumbe". Eighty nine percent of the households obtained water for consumption from public taps while 7 percent fetched it directly from the river. Most of the tapped water gets to the consumers untreated.

Most (52 percent) of the income was obtained from farming while the next major source of income was casual labour. Both these sources of income are unreliable and depend on very many variables hence causing a lot of financial instability to the families that depend on them. A summary of the occupations in Makindu is given on Figure 4.1.

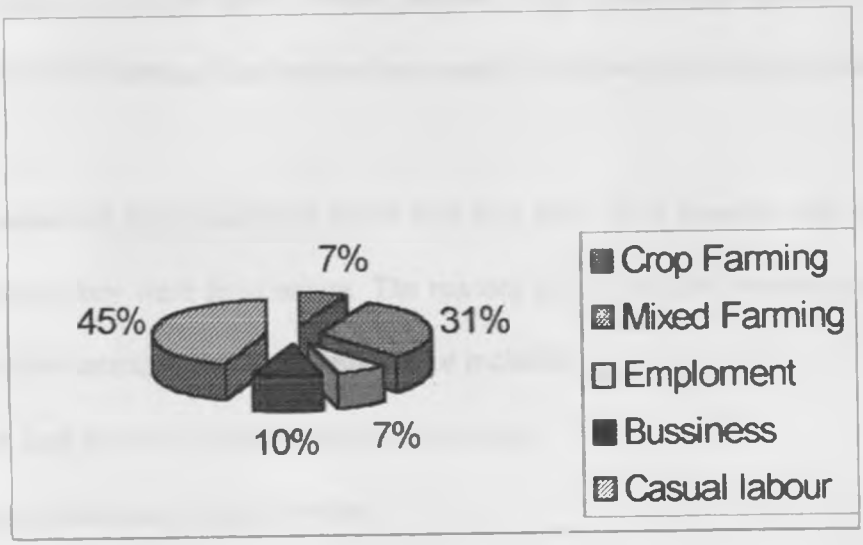


Figure 4.1: Summary of occupations in Makindu

4.2 *Household food security and nutritional status*

4.2.1 Household food security

Traditionally, food security is categorised into three determinants, that is food availability, food access, and food utilisation (Kiess *et al.*, 2001). Food availability refers to agricultural production, including cash crops, livestock and food crops. Food access on the other hand refers to household purchasing power and the ability to secure foods from the market or other sources. Food utilisation incorporates diverse aspects including sufficiency of food intake, food habits and preferences, intrahousehold distribution of food, food safety and caring practices. The results of the study are discussed under the above classifications of food security.

Food availability

The average land ownership in the study area per household was 1.23 acres. Forty one percent of these households did not own land despite a comparatively low price for land of Kenya shillings 15,000 per acre. Twenty percent of the households could not even afford to rent land for farming. The rent per acre was at 500 Kenya shillings per annum.

Ninety five percent of the households stated that they were food insecure and only 5 percent stated that they were food secure. The reasons given for food insecurity at the household level in decreasing order of importance included:

- Inadequate land in terms of availability, affordability
- Inadequate rainfall and low soil fertility
- Insufficient income for purchasing the required inputs
- Season overlap. Labour is a problem due to the fact that harvesting for the last season coincides with the next planting season

- Family structure and size Most households are large and hence are difficult to feed

The households cope with the food insecurity by buying food from the shops

August was voted as the month of highest food scarcity by most (65%) of the households followed by September (18%). March was voted as the month of plenty (39 percent) while December and February followed closely with 25% of the respondents in each month. The harvest months fall in February and March.

Pigeon pea is the major crop grown in the area. Thirty six percent of the households grow it as their major crop. Maize as opposed to millet and sorghum is the major cereal crop grown in Makindu in spite of the fact that it is a semiarid area. The average yield stands at five 90-kg bags per acre. This is because of the higher market price for maize and less labour intensive farming in terms of sowing and keeping the birds away. The proportion of crops grown in the area is shown on Figure 4.2.

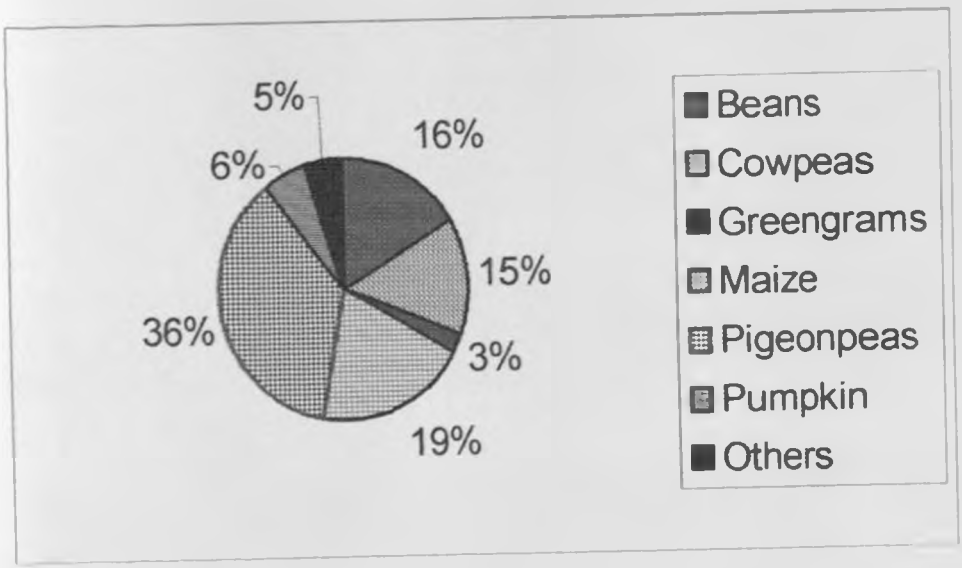


Figure 4.2: Crops grown in Makindu

Food access

According to Engel (1875), the proportion of total expenditure allocated to food increases as income decreases. Due to their low income most (47 percent) of the families spend more than 75 percent of their total household income on food. This leaves very little for other basic needs such as health, shelter and education.

Food utilisation

The results (Table 4.3) show that there exist taboos that hinder the consumption of vitamin A rich foods by infants and expectant women. These foods include eggs, meat and green vegetables. Most children are weaned on starchy foods, which are low in their supply of vitamin A. This can be seen in the summary sheet for key informant interviews with community health workers (Table 4.3).

Table 4.3: Dietary practices of Makindu households

Practices	Households upholding the practices	Implications
Food taboos Eggs Kale Meat Pigeon pea	 60% 10% 10% 40%	Food taboos around pregnancy and weaning in Makindu revolve around four main foods most of which are rich in protein, iron and vitamin A. This implies that there is likely to be deficiencies of the nutrients at this stage.
Colostrum use	Over 90%	Almost all mothers feed colostrum to their infants ensuring sufficient nutrient and antibody supply to their young.
% breast feeding women	Most	It was reported that most of the mothers breast feed their infants except those who are HIV positive. Indicating AIDS and HIV awareness in the area and hence the avoidance of mixed feeding.
Average length of breast feeding	3 years (unemployed mothers), 3 to 4 months employed	The length of the breast feeding stage is highly dependant on the occupation of the mother
Weaning from breast	Gradual	Weaning is gradual but a month earlier than recommended.
Age at introduction of weaning foods	1 to 6 months with most mothers weaning at 3 months	
Types of weaning foods	Cereal porridge (millet, maize and blends of the above) 100%, Milk 80%, Bananas 10%, Potatoes 10%, Avocados 20%, Rice10%,Beans 20%	All children are weaned on porridge hence if the intervention food product takes this form it can cater for children of all ages.
# of meals that children eat	3 to 5 with a mode of 4	Product should be designed to fit within one of these feeding times
Mode of feeding	Separately	Portion fed to children must be assessed
Feeding practices for sick children	Less often	More nutritious foods should be introduced to counter reduction in nutrient intake
Preferred dish for sick children	Porridge	The final intervention food product should take the form of a porridge as this is the accepted food for the sick children in the area.

The survey showed that most (75%) of the households had 3 meals a day. The rest of the households had 2 to 4 meals a day Of these, 20% had two meals and 5% had four meals a day. The major food source consumed was cereals and legumes. Despite the fact that Makindu is a semi-arid area, maize is the major cereal consumed It is consumed in all the households as: whole grain in *muthokoi* and *githeri*; off the cob roasted or boiled; and as maize meal in *ugali* and porridge. Other cereals consumed include sorghum (in 3.3% of the households surveyed), millet (in 1.7 %); and wheat (in 5%) Sorghum and millet are utilised in porridge as a breakfast cereal while wheat is utilised in *chapati* and *mandazi* production.

A comparison of actual nutrient intake with the recommended dietary allowance in terms of energy, protein and vitamin A shows that the household diets are deficient in their supply of the three nutrients These diets are most deficient in terms of their supply of vitamin A followed by energy, then protein.

The results also showed that the food consumption pattern is dependent on the day of the week. There was a significant difference ($p<0.05$) in the nutrient supply of the diets depending on the day of the week in question. Intakes varied from day to day e.g. Monday was different from Thursday according to intakes of food/ micronutrient. On Mondays 35.2% of the households did not meet their dietary requirements. Sixteen percent met less than 70% of their recommended dietary requirements. Of these 34.8 % met less than half of their requirements More households (48.6%) did not meet their energy requirements on an ordinary weekday. The fraction that met less than 70% of their requirements and that which does not even meet 50% is significantly different

($p>0.01$) i.e 17.1% and 41.3 of this respectively. Twenty percent of the households do not meet their protein requirements. On Mondays, 9.2 % did not meet 70% of their protein requirements about half of these did not meet half of the protein requirements. The situation was different on Thursday were the fewer households have a protein deficit in their diets (14.1 %). Six percent met less that 70% while 44.4 % of these households meet less than half the requirements

Almost all the households did not meet their vitamin A requirements (87.9%) on Mondays. The percentage increased significantly ($p<0.05$) on Thursdays where 94.3 % (6.4 percent more) of the households do not meet their vitamin A requirements. Seventy three percent met less that 70% of their vitamin A requirements with 86 percent of these not meeting 50 % on Mondays. A higher percent of the households did not meet 70 % of the vitamin A requirements on Thursdays with 95 percent of these no meeting 50%. This may be due to the fact that most sources are perishable and are most affordable and available on the market day hence they are consumed before Thursday. In addition most sources of vitamin A available in Makindu were not in season and hence were expensive or unavailable. It is important to introduce an affordable source of vitamin A that can be efficiently stored to even out the season and day of the week effect.

As is the case everywhere, the most affordable vitamin A rich foods are of plant origin and are hence highly perishable and dependent on rainfall for constant supply. Makindu is a semiarid area and is bound to have fluctuations in supply of foods available, leading to fluctuating prices and reduced consumption. A food frequency based on foods rich in vitamin A available in Makindu was also carried out. The results show that the households consume more of the plant sources than the animal source of vitamin A. ver

80% of the vitamin is obtained from plant sources. In addition, most of the rich plant sources of vitamin A are seasonal and were not in season during the survey. These include mangoes, pumpkin and cow pea leaves. These were hence expensive and limited in supply. Tomatoes are the most commonly used source of vitamin A. Milk and papaya are next in importance. Although milk is a rich source of vitamin A it is used only in Tea. The ratio of milk to water stands at about 1:4 hence quantity of vitamin A supplied is not sufficient. A summary of the sources of vitamin A available within Makindu and their availability throughout the year is shown on Table 4 4.

Table 4.4: Summary of sources of vitamin A and their availability in Makindu

Source	Availability through out the year					
	January	March	May	July	September	November
Milk	———	———	———	———	———	———
Kale		———			———	———
Cow pea leaves	———	———				
Papaya	———	———				
Mangoes	———					

4.2.2 Nutritional status

The nutritional status of children is shown on Table 4 5. The percentage of stunting was higher than that of wasting meaning that malnutrition in the area was more due to the cumulative effect of chronic malnutrition than acute or recent nutritional deficit. The KDHS (1998), estimate of the prevalence of chronic malnutrition or stunting is 33 percent. The results depict this to be at 37.4 percent, which is not significantly different ($p>0.05$). The weight for height index (wasting), is a condition reflecting acute or recent nutritional deficit, was 7 % this is not significantly different ($p>0.05$) from the Kenyan situation where 6 percent of the children are estimated to be wasted. It is reported (KDHS, 1998) that 22 percent of children under five are underweight the survey results

show that in Makindu the figure stands at 21 percent, which is not significantly different ($p>0.05$). Since all the nutritional indices of these children concur with those at the national level, it can be inferred that their nutritional needs are similar and hence they too suffer from the nutritional deficiencies such as iron and vitamin A common to other Kenyan children

Established malnutrition level in Makindu is similar to National data hence, whatever intervention is made for Makindu will apply well nationally.

Table 4.5: Nutritional status of children by background characteristics

Percentage of Makindu children under five years of age who are classified as *malnourished according to three anthropometric indices of nutritional status*: height-for-age, weight-for-height, and weight for age by age and sex

Background characteristic	Height- for -age		Weight –for- height		Weight- for -age		Number of children
	Percent below –3 SD	Percent below –2 SD[1]	Percent below –3 SD	Percent below –2 SD[1]	Percent below –3 SD	Percent below –2 SD[1]	
Child's age in months							
24-35	14.5	43.6	1.7	5.1	2.6	23.9	117
36-47	11.4	34.1	1.1	4.5		14.8	88
48-59	8 9	29.9	1.5	7.7	1.5	20.9	67
Child's sex							
male	13	39.1	2.2	8	1.4	23.2	138
Female	11.2	35.1	0.7	5.2	1.5	17.2	134
Total	**12.1**	**37.1**	**1.5**	**6.6**	**1.5**	**20.2**	**272**

Note: Figures for Makindu children born in the period 24-59 months preceding the survey. Each index is expressed in terms of the number of standard deviation (SD) units from the median of the NCHS/CDC/WHO international reference population. Children are classified as malnourished if their z-scores are below minus two or minus three standard deviations (-2 SD or –3 SD) from the median of the reference population.
[1] Includes children who are below –3 SD

4.2.3 Health priorities

Information collected from the two hospitals in the area, one of which is the district's referral hospital, through Key Informant Interviews with clinical care providers show that the five most important health problems in the area are malaria, skin infections, upper respiratory tract infections, PEM and Anaemia. Very few cases of xerophthalmia were recorded mainly because of effective measles prevention through vaccination and prolonged breast-feeding. This in no way implies that there are very few cases of vitamin A deficiency. It was estimated that 30 % of the sick children suffer from upper respiratory infection. In addition high (20 %) diarrhoea cases are reported. According to the data collected through Key Informant Interviews with clinical caretakers, this value rises up to 30 % during the rainy season. As alluded to earlier, most of the water in the area is obtained from a river. If this is not treated, then it can transmit water borne diseases such as cholera, typhoid and dysentery, all of which have diarrhoea as a symptom, to the households and especially to the children. This could precipitate malnutrition. It is important that the community is educated on the need for good sanitary practices and that good manufacturing practices are emphasised in the production process of the intervention product. Given that the children are fed on less food when ill and that vitamin A demand increases in cases of disease especially diarrhoea and respiratory tract infection, it is evident that the children in this area suffer from moderate deficiency at the least.

Although Kenya is not one of the countries mentioned in the HKI first tier question, prior assessments indicate that VAD is a problem in the country. The 1999 national survey states that " The prevalence of vitamin A deficiency remains a significant public

health problem in Kenya." The results of the survey showed that "The inferred prevalence of vitamin A deficiency based on serum-retinol deficiency among pre-schoolers (14.7% for acute and 61.2% for moderate grades) was nearly twice that reported in the 1994 survey." In addition a study carried out in Baringo, an area similar to Makindu in terms of geography, rainfall distribution and food availability, indicates that VAD is prevalent.

The study carried out established the local phrase *"kwona kivindu"* for night blindness in use in Makindu. Many factors contribute to VAD. According to the VAD conceptual framework (ACC/SCN, 1997), the immediate causes are inadequate intake of vitamin A or vitamin A precursors and diseases including measles. The underlying causes are consumption of foods low in vitamin A/ vitamin A precursors or poor in bioavailability of the vitamin; inadequate body fat, infrequent feeding and inappropriate food preparation: inadequate sanitation, safe water, measles vaccination or lack of supplementation. It is evident from the study carried out that consumption of food low in vitamin A/ vitamin A precursors and inappropriate food consumption especially in terms of lack of fat incorporation in diet are major factors contributing to low vitamin A intake in Makindu.

The intervention product must be designed for August, which was voted as the month with the most food scarcity, for greatest impact if it is to solve the problems of the area. It was hence necessary to develop a product using cheap plentiful raw materials in season which, could be stored so as to provide nutrients in months of scarcity.

4.3 Intervention product development

4.3.1 Production of raw materials

The household survey had already established that the raw materials to be used in the formulation of the intervention product were locally grown in the area. These raw materials include maize, pigeon peas and sweetpotato. As pointed out earlier the sources of vitamin A in Makindu are limited and very seasonal. It was then necessary to introduce another source of vitamin A in Makindu similar to the crops grown in the area. It was on this basis that three varieties of orange fleshed sweetpotato were introduced. The varieties included SPK 004 (Kakamega 4), Salyboro and Jewel.

Of the three varieties, Salyboro adapted best. It produced the highest yield within the shortest time of four months. It was even nicknamed the Makindu Carrot by some women groups. The varieties were introduced as cuttings in a nursery at Makindu Children's Centre and later transplanted to a demonstration farm. Extension work was necessary if orange fleshed sweetpotato was to be adopted in the area. An awareness campaign was carried out in which the benefits of the crop especially as an ingredient in the intervention product was done. This resulted in over 50 farmers adopting the crop. It was agreed that they should buy the vines as a commitment that they would take care of the crop.

4.3.2 Optimisation

Four formulations (Table 4.6), were computed using the linear programming technique. Rations were obtained within the constraints of cost, nutrient and basic raw materials as outlined in Section 3.3.1. The proximate composition for the raw materials was obtained from food composition tables. The recipes met the RDA criteria for protein, energy and vitamin A. All the four recipes contained pigeon pea, sugar, orange fleshed sweetpotato and maize. The differences lie in their ratios, inclusion of fat and hence the prices. The rations obtained met the cost criteria of Kenya shillings 50 and below. Recipe III did not contain fat as an ingredient. The recipe did not obtain further attention as the bioavailability of vitamin A from the ration was limiting. It should be noted that since the bioavailablity of the vitamin A in the orange fleshed sweetpotato is not known, an assumption that the retinal equivalent value holds had to be made for product formulation. This assumption holds for this section. Recipe IV was selected as the recipe of choice for this project as it meets RDA requirements of the children in terms of energy, protein and vitamin A in 100 grams of the dry product. In addition to meeting RDA requirements it also contains fat. This criterion of choice was necessitated by the average food consumption of Makindu children which, is about 450 grams per meal, as estimated in the survey.

Although Recipe IV had 25% sugar in terms of sucrose, it was passed on to the next stage of product development. This is because for the Makindu community sweetness was a key attribute for acceptability of the product and this project used a participatory approach in the product development. There is need to consider reducing the amount of

sugar added by increasing sweetness through conversion of the starch through enzymes This will also reduce bulk density meaning more of maize can be used to replace sucrose and still produce a product providing the same energy level.

All the ingredients are added in their dry form. The 56g of orange fleshed sweetpotato added to produce a kilo of the product translates to about 300g of raw orange fleshed sweetpotato making dry orange fleshed sweetpotato an expensive ingredient. Due to cost the cost limitation dry orange fleshed sweet potato should mainly be used to provide β-carotene. The ratio of maize to pigeon pea stands at 33:20. There is still room for more maize since maize can be added until the ratio stands at 70:30.

The retail price of Recipe IV is estimated at Kenya shillings 50 per kilogram. A child is expected to consume 100 g per day. Hence the actual price per serving is 5 Kenya shillings. This price is equal to or less than even the price of a fruit at the market. For example a banana or orange goes for between 5 and 7 Kenya shillings. The product later branded Makindu Sweet Flour is hence affordable.

Recipe	Maize (g/kg)	Pigeon pea (g/kg)	Orange fleshed sweetpotato (g/kg)	Fat (g/kg)	Sugar (g/kg)	Vit A (µg re /100g dwb)	Protein (per 100g dwb)	Energy (kcal/100g dwb)	Cost in Ksh (per Kg)
I	420	259	6	53	262	105 ± 6.6	39 ± 2.4	596 ± 14 9	34.70
II	441	221	7	110	221	124 ± 7.76	26 ± 1.62	693 ± 17.3	38.45
III	498	246	7	None	249	135 ± 8.42	44 ± 2.74	625 ± 15.6	30.70
IV	400	244	56	50	250	546 ± 34	37 ± 2.3	565 ± 14.1	46.55

Table 4.6: Summary of the ingredients, nutrients and cost of the possible recipes

4.3.3 Production of Makindu Sweet Flour

The final product was branded Makindu Sweet flour (MSF) by a group of locals who had assisted in the development of the product. MSF is a roasted flour that provides fifty percent of the child's (2 to 3 years) RDA in terms of energy, protein and vitamin A in 350 ml of the final product. Although the product was roasted boiling of the water is necessitated by the poor water quality of the area. As alluded to earlier, most of the water in the area is obtained from a river. This product may be taken in one or two of three meals breakfast, ten o'clock snack or four o'clock snack. It may be used in school feeding programmes, for the refugees, expectant mothers and the household in general.

Table 4.7: A comparison of the expected quality for Cereal based foods for infants and young children versus the actual quality of MSF

Food component	Kenya bureau of standards Requirements per 100 g	Makindu sweet flour (MSF) Per 100g
Moisture	4.0	3.0
Total Protein	14.0*	9.40
Fat	8.5 (Maximum)	7.9
Fibre	1.0 (Maximum)	1.0
Ash	5.0 (Maximum)	1.0
Carbohydrates	60.0	77.03
Vitamin A	500 IU/100g (Minimum)	750 IU/ 100g

* At least 70 percent of the protein must be casein.
No milk product is used in the production of Makindu Sweet Flour due to cost implications. However If milk is used instead of water in the preparation of MSF then the requirement is met.

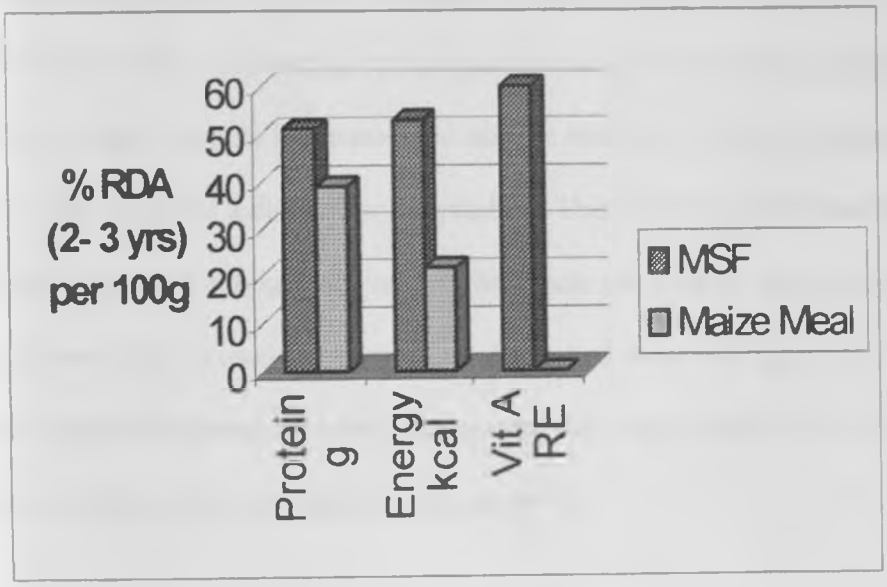


Figure 4.3: Comparison based on percent RDA supply by MSF and Maize meal a product commonly used in Makindu

Makindu Sweet flour is more superior, in terms of its nutrient content, to the product commonly used in the area to serve the same purpose, maize meal. In fact, the results show that Makindu Sweet flour provides more energy and protein than the recommended dietary allowance.

4.3.4 Product evaluation

Acceptability

Two sensory attributes namely, appearance and taste were used. These sensory attributes were used because of their importance in the sale of a food product in the market place. The appearance of the product is a very important aspect when Makindu mothers buy flour from the market. The results in Figure 4.4 show that Makindu Sweet flour was more acceptable

to the community than the traditionally accepted product, maize meal, in terms of its appearance and the taste. There was no correlation between the age of the mothers and their preference but there was a very strong correlation ($p < 0.01$) between the appearance and the taste of the product. It would be incorrect to assume that a low value for the maize meal on the 15-cm scale indicates a dislike for the product. This is based on the fact that maize meal is a widely accepted product not only in Makindu but also all over Kenya. In my view, the scale can only be used for comparison basis and hence the high score for MSF only indicates a higher preference for the product over the Maize Meal by the mothers. The results indicate that the product is better than maize meal.

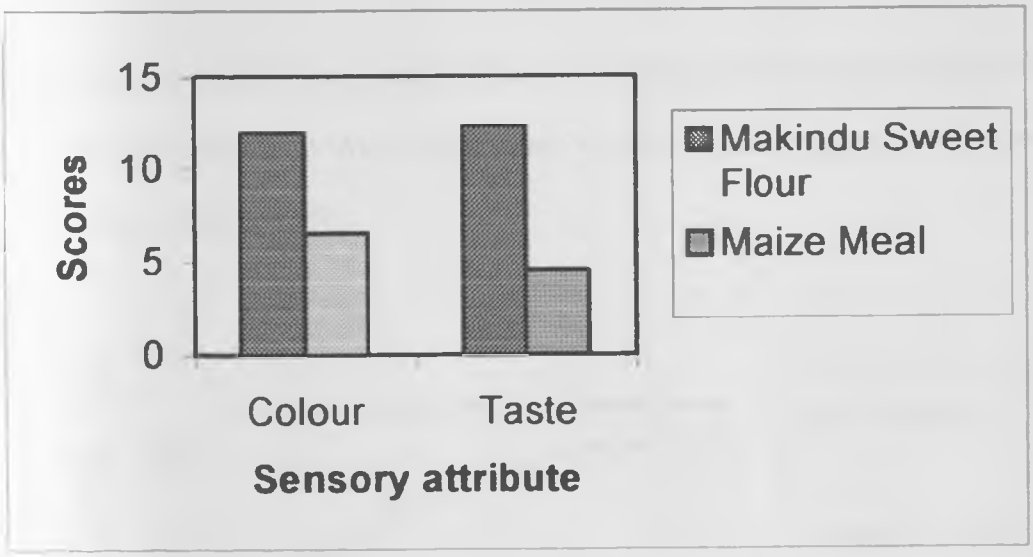


Figure 4.4: Acceptability of Makindu Sweet Flour

Safety of Makindu Sweet Flour

The KBS states that a product is safe if its aflatoxin level is less than 20 parts per billion. No aflatoxin was detected and, therefore, the product was rendered as safe for consumption with respect to aflatoxins. Roasting, a unit operation used in the production of MSF is known to destroy antinutrients especially those of protein nature by denaturation. In any case, the raw materials used in the production of MSF are those that are commonly in use in Africa and the area in particular.

Shelf life

The accelerated shelf life study results (Figure 4.5) showed that the product has a shelf life of more than one year. How ever it is important to carry out more rigorous studies so as to determine its actual shelf life.

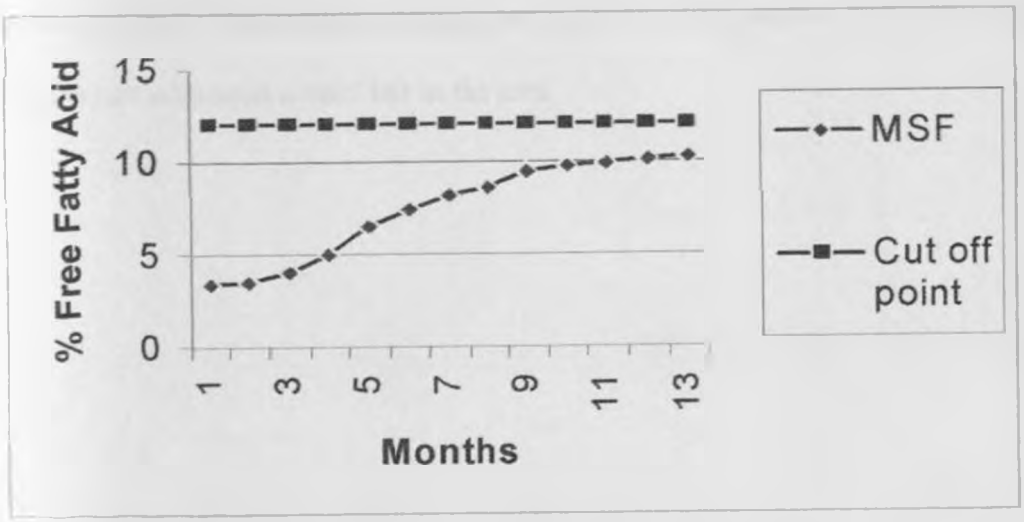


Figure 4.5: Shelf life of Makindu Sweet Flour

4.3.5 Product development training for women

The intervention product addresses the specific needs of the Makindu community. It was hence found necessary to involve the community in production if the impact is to be sustainable Towards this end, a product development centre was set up to facilitate training. The centre was named Makindu Product Development Centre. It provided a neutral point for women's meetings during training without one group dominating another, as was the problem in previous community product development strategies in the area. A total of 175 women were trained on the production of MSF. This included seven women groups in the area. The training was aimed at creating awareness on the existence of the new product, problems it addresses, its production and possible commercialisation. This was done in three phases. The first was an introduction, which emphasised inadequate food intake as an immediate cause of malnutrition. The second emphasised on the function of energy, protein and vitamin A giving foods in the body. The last phase dealt with the production of MSF. The women reported that the production process was convenient and that the product addressed a need felt in the area.

CHAPTER 5

CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

5.1.1 Situation Analysis

The mean household size of Makindu of 5.2 was the same as that of the country (CBS, 1998). Poverty is rampant in Makindu, with 58 percent living below the poverty line. This is significantly ($p<0.05$) higher than the country's (52.6%). There is a high level of illiteracy (about 25%). Poverty when combined with the low education level in the area explains why food security especially in terms of food access and food utilisation is a problem in Makindu. Malnutrition is bound to be evident in most households.

Over thirty percent of the population in Makindu was below 5 years of age. There was a high prevalence of malnutrition in the area with 37.3 % being chronically malnourished and 7 % wasted. However, these percentages were not significantly different ($p>0.05$) from national statistics (33% and 6% respectively). It may then be inferred that any nutritional intervention that succeeds in this area will also be successful in other areas of the country with little or no modification.

5.1.2 Product Development

Vitamin A sources were limiting in Makindu, as was the vitamin A supply of the household diets. The orange fleshed sweetpotato was introduced to increase the availability of vitamin A sources and thus add variety to the household diets. The crop was well adopted by farmers. In fact, fifty farmers bought vines for planting.

The cross sectional survey established the need for a product that meets the RDA of children in terms of energy, protein and vitamin A. In a bid to address the felt need, MSF came to existence. Makindu Sweet Flour is a roasted sweetened flour that provides more than 50% of the child's (2 to 3 year old) RDA in terms of vitamin A, protein and energy. This product consists of locally grown raw materials namely maize, pigeon pea and orange fleshed sweetpotato. Makindu Sweet Flour was developed using technology that is very easy to adapt to rural setting. The product was found to be more acceptable than maize meal, a product used to serve the same purpose in the area but provides less energy, protein and vitamin A for the same quantity. It was estimated to cost 50 Kenya shillings at retail.

Makindu Sweet Flour provides a practical, culturally acceptable, affordable product for solving child malnutrition in Makindu. It hence, meets the overall objective of the project and nullifies the null hypothesis of this project.

5.2 *Benefits of the project*

The project has linked technology to community development. It hence aids solve problems of community within its environment. This ensures that the end result is sustainable. There will be improved nutrition of not only the children but also the households in Makindu. The sale of the product will result to financial empowerment especially of women and will also enhance market channels for the maize and pigeon pea locally grown in Makindu and other places in Kenya.

Makindu Sweet Flour is suitable for feeding programmes. It could be used as famine relief food and for refugees.

5.3 *Recommendations*

It is necessary to determine the bioavailability of the vitamin A from the orange fleshed sweetpotato so as to adjust the content of the raw material in the product. This is important in the view of the fact that this product is one of the very few sources of vitamin A to the Makindu child. The results of the bioavailability study can the be used in determining the actual amount of orange fleshed sweetpotato to be added in a ration so as to provide a predetermined amount of vitamin A.

Although sweetness of the product was found to be a major factor in the acceptability of MSF, the product has 25% sugar in its dry form. There is need to reduce this percentage through various technologies e.g. use of enzymes to convert starch into reducing sugars. This will increase the inherent sweetness of the product and at the same time reduce its bulk density. This will hence allow for more maize inclusion in the product so as to approach the maximum maize to legume ratio of 70:30.

It is a well-known fact that processing of food materials affects the bioavailability of the nutrients the food material provides either positively or negatively. In the manufacture of MSF, various processing techniques were used namely slicing, drying, grinding and roasting. The extent to which each of the operation is carried out greatly affects the availability of the nutrients to the consumer. It is hence important to obtain the optimal extent of each operation for optimal nutrient availability.

In addition, comprehensive nutritional analysis of MSF should be carried out so that the product may be adjusted to effectively meet the nutritional need of the child in Makindu. Comprehensive studies on the keeping quality of MSF especially as far as the bioavailability of vitamin A supply with storage is concerned. The effect of cooking on the availability of nutrients in MSF should be studied in depth so as to come up with optimal cooking methods and time for the product.

There is need to have an impact assessment of the project so as to qualify and quantify the effect the project has had in alleviating child malnutrition in Makindu. For example, it is important to repeat HKI at the household level to compare the impact of the project by

determining the difference between the baseline survey and the situation on the ground two years later for impact of study to be assessed.

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APPENDICES

Appendix 1: Key informant interview with clinical care providers

Person Interviewed _____
Date _____
Title _____
Hospital / Clinic name _____

Average daily case load (patients under 6 years of age) _____
What are the most important health problems in the area that you serve?

Are you familiar with the condition known as xerophthalmia? _____

Can you describe how it develops?

What is the cause of xerophthalmia?

Have you seen cases of xerophthalmia?

Who is at risk of xerophthalmia?

Have you noted any cases of post-measles blindness or other signs related to xerophthalmia?

When?

What is the treatment for xerophthalmia?

Have you ever received any training in xerophthalmia case detection?

When?

Who conducted the training?

Appendix 2: Key informant interview with community health workers

Person Interviewed _____

Date _____

Title _____

Average number of mothers/ children seen each day _____

Area of responsibility _____

What foods are considered "taboo", that is, inappropriate to feed to young children, and/or pregnant or lactating mothers in this area?

Vitamin A rich foods include dark green leafy vegetables and yellow or deep orange fruits and vegetables. What vitamin A rich foods are considered "taboo" in this area?

Do women generally feed colostrums to their newborn children?

Do most women breastfeed their children?

What proportion?

Until what age are children breastfed?

Are most children gradually weaned from the breast or is weaning abrupt?

What foods are considered appropriate as weaning foods?

Are special foods prepared for the weaning child?

How are they prepared?

On average, how many meals a day do young children eat?

Does this change depending on the time of the year?

Are children fed separately or do they eat from a common pot?

Do mothers feed their children differently when sick?

Are sick children fed more or less often?

What is night blindness?

Are you familiar with a local word for night blindness?

Is night blindness common in the area?

Among whom?

Have you seen blindness in babies or young children?

When?

Appendix 3: Focus Group Discussion

(Four focus group discussions each with eight to twelve members)

Date of Interview _____

Umbrella under which most members fall _____

Name of moderator _____ Name of recorder _____

General introduction for focus group discussion facilitators

Topic	**Discussions/ Transitions**
Introduction	Facilitators', note-taker's and observers' names
Topic of interview	This discussion is aimed at obtaining information on your feeding practices for children.
No right or wrong answers- Your opinions	There are no wrong or right answers to any of the questions. This is not a test. We would just like to know about your community's feeding practices and preferences.
Length of time of discussion	The discussion will take one hour
Talking to one another	As we will be discussing many things about ourselves, it will be important that we do not all talk at once because we will want to hear one another's point of view.
Explain note taking and tape-recording. Confidentiality	*** (note-taker's name) will be writing down some of the things that we talk about so we can remember them later. We would also like to use a tape recorder. Is that OK with you or does any one object? We are the only ones who will know your name.
Check understanding clarification if needed	Now, let's see if we have all understood what we are going to do, can anyone repeat for us? If anyone needs clarification, this is the time to ask your questions before we go on.

TOPIC	DISCUSSION/TRANSITIONS	PROBES
Introduction (warm up)	Please introduce yourselves and as you do, tell us something about yourself, your family, etc,	
Food security	How do you obtain food for use in households within this community?	▪ Self production ▪ Purchases ▪ Food aid/gifts
	Does the community experience any food shortages?	▪ Seasonality
	What causes food shortages in this community? Is this common?	▪ Rainfall/droughts ▪ Famine ▪ Insecurity ▪ Accessibility to farming inputs ▪ Pests/storage problems
	What time of the year do you have the most food? What time of the year do you have the least food? What are the usual planting seasons (months)? What are the usual harvesting months?	
	How do families in this community deal with food shortages? (Coping strategies)	▪ Purchases ▪ Food aid/gifts-from who? ▪ Labour/migration ▪ Unusual foods ▪ Sale of assets
	Who is the most vulnerable/affected segment of the community members? Why do you think so? Are there any organisations in this community involved in food relief distribution? Name them.	▪ Displaced/destitute ▪ Peasant farmers ▪ Nomads/pastoralists ▪ Rural/urban poor ▪ Women-headed hh ▪ Orphaned children ▪ Elderly ▪ Chronically ill ▪ Landless

Health and nutrition	What are some of the common diseases in this community? Why do you think these diseases are common? What are some of the common diseases in children in this community? Why do you think this is so? What is night blindness? (Explain if not understood) Is there a term/phrase for night blindness in this community? Is it common? Who suffers from night blindness? What do you think causes it? What do you think is healthy or good food for your child? What are some of the foods prepared for children aged 2 to 5 years? What is the mode of preparation? What are some of the raw materials used to prepare flour in this community? What are the methods used to prepare flours in your community?	
Vitamins (Vitamin A)	Do you know about vitamins? What foods contain vitamins?	

Are there any questions related to the issues we have discussed that you feel need to be addressed? Thank you for your time.

Appendix 4: Household food consumption questionnaire

Instructions (for enumerator)

Start the interview by introducing yourselves to the potential respondent Give him/her the following information.

"We are collecting data on household food consumption in Makindu so as to design a suitable food ration for malnourished children in this area. Your participation in this study is voluntary and will be of great value to the community as a whole including your own household. We appreciate your co-operation and assure you that individual responses will be kept confidential."

Section A: Demographic and socio-economic characteristics

Name of Interviewer _____

Date of interview ___/___/2001 Questionnaire No. _____

OBESERVATION

Main house roofing_____ 1=grass/thatch 2=iron sheets 3=Tiles

Main wall material _____ 1=mud/dung 2=wood/iron 3=Bricks/cement/stone

Main floor material _____ 1=mud/dung 2=cement 3=other (state which)

Mother's name _____

Sex of household head male=1 female=2

Household demographic profile

Name	Relation to head of hh	Occupation	Education	Marital status	Religion	Sex	age

1. What is your major source of income in this household? (Circle only one) 1=crop farming 2= livestock farming 3= mixed farming 4= employment 5= business 6=casual labor.
2. Approximately how much was the total household income in the past month?
3. What proportion of household income was spent on food? 1=< ¼ 2=1/4-1/2 3=1/2-3/4 4=3/4-1
4. What is your source of water? 1=private tap 2=public tap 3=well with pump 4=well without pump 5=surface water.
5. Who makes the decisions in your home?

Section B. Food security.

- How much land was cultivated last season? _____
- Is your house on the land? Yes _____ No _____
- Do you own the land?
- During what time of the year do you have the most food?
- During what time of the year do you have the least food?
- What are the harvest months?
- What crops do you grow?
- What is the major crop?
- How much was the yield?
- Do you get enough to meet all your needs?
- If not.
    i. Why not?

    ii. How do you cope?

Section C. Nutritional status.

Part 1.

1. Name of child (2-5 years) _____
2. Sex of child _____ 1=female 2=male
3. Birthday _____
4. Age: _____years _____months
5. Height R_1 _____, R_2 _____
6. Weight R_1 _____, R_2 _____
7. Did the child have diarrhoea in the last two weeks? _____1=Yes 2=No
8. Edema present? _____ 1=Yes 2=No

Part 2.

1. Mother's name _____
2. Birthday _____
3. Age _____years _____ months
4. Height R_1 _____, R_2 _____
5. Weight R_1 _____, R_2 _____
6. Expectant? _____ 1=Yes 2=No

Section D.

i) 24-hour recall

Please provide information on all meals consumed by the household

(Market day (Monday))

Amount of food served to child between 2 to 5 years.

Volume on plate

Volume on cup

1. The previous day from morning until they went to sleep.

Time (Meal)	Name of Dish	Ingredients	Amount of ingredients	Total volume of dish	Amount of food served	Amount of food left

ii) 24-hour recall

Please provide information on all meals consumed by the household

(To capture a weekday (Thursday))

Amount of food served to child between 2 to 5 years

Volume on plate

Volume on cup

1: The previous day from morning until they went to sleep

Time (Meal)	Name of Dish	Ingredients	Amount of ingredients	Total volume of dish	Amount of food served	Amount of food left

Section E: Food frequency

Below is a list of foods, please indicate how often your household feeds on them by checking the appropriate box

Food item	Never	Times a week	Fortnightly	Monthly	Other
Tomatoes					
Milk					
Fish					
Liver					
Mangoes					
Sukumawiki					
Paw paws					
Margarine					
Pumpkin					
Cowpea leaves					
Okra					
Cabbage					
Avocados					
Carrots					
Spinach					
Sweetpotatoes					
Carrots					

Appendix 5: ***Sensory evaluation form***

A: Appearance Test

Name:_____ **Date:**_____ **Place:**_____ **Age:**_____ **Sex:**_____

Instructions: Please, look at the two samples identified by the numbers on the lines below. Make a mark on the line between the liking image on the right side and the dislike image on the left side that corresponds to the way you feel about the appearance of each product

738

Dislike extremely
(Sipendelei hata Kidogo)

Like extremely
(Napendelea zaidi)

394

Dislike extremely
(Sipendelei hata Kidogo)

Like extremely
(Napendelea zaidi)

B: Taste

Name: _____ **Date:**_____ **Place:**_____ **Age:**_____ **Sex:**_____

Instructions: Please, look at the two samples identified by the numbers on the lines below. Make a mark on the line between the liking image on the right side and the dislike image on the left side that corresponds to the way you feel about the appearance of each product

_____

Dislike extremely
(Sipendelei hata Kidogo)

Like extremely
(Napendelea zaidi)

_____

Dislike extremely
(Sipendelei hata Kidogo)

Like extremely
(Napendelea zaidi)