TOWARDS SUSTAINABLE NUTRITION IMPROVEMENT IN RURAL MOZAMBIQUE: ADDRESSING MACRO- AND MICRO-NUTRIENT MALNUTRITION THROUGH NEW CULTIVARS AND NEW BEHAVIORS

TECHNICAL REPORT:

FIRST YEAR OF PROJECT ACTIVITIES

1 SEPTEMBER 2002 - 31 AUGUST 2003

By

Jan Low and David Tschirley

Project Partners:

Department of Agricultural Economics, Michigan State University (MSU)
Nutrition Division, Ministry of Health, Mozambique (Nutrition/MISAU)
World Vision, Mozambique (WV)
National Institute for Agronomic Research, Mozambique (INIA)
Southern African Root Crops Research Network, Mozambique (SARRNET)
Ministry of Agriculture and Rural Development, Mozambique (MADER)
Helen Keller International, Mozambique (HKI)

Financial Support Provided by:

Micronutrient Initiative (MI)
Rockefeller Foundation
USAID-Washington D.C.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Three districts within the most populous province of Zambézia, Mozambique, are the sites for the implementation of a 2.5 year action research project to determine whether a food-based intervention strategy can lead to sustainable, year-round intake of vitamin-A rich foods, reduced fluctuations in seasonal household calorie supply, and an overall improvement of diet diversity, nutritional status and diet quality in a cost-effective manner, particularly among children under five years of age. Emphasis is placed on addressing two major nutritional problems: vitamin A deficiency and inadequate caloric intake. To achieve this, the project introduced eight pro-vitamin A (beta-carotene) rich varieties of sweet potato (identified by their orange-flesh), utilizing these new cultivars as a low-cost, effective entry point for improving the kinds of weaning foods given to young children and increasing the frequency of intake of essential micro-nutrients and calories.

The key hypotheses to be tested are that adequate consumption of sweet potato-based weaning foods by young children and sweet potato roots and leaves by adults can contribute to a significant improvement in the diversification of both young child and adult diets, and that the cultivation and appropriate uses of this important pro-vitamin A rich food can become permanent and sustainable practices in rural Mozambican households. If such diversification occurs and there is a significant increase in overall consumption of vitamin A rich foods, this dietary improvement may be reflected in improved serum retinol status. Since serum retinol status is influenced by absorption and loss of vitamin A, particularly that caused by infection, information concerning health status must be taken into account.

The project, which began in September 2003, has three major components: extension, research, and capacity strengthening. The extension component emphasizes a coordinated approach among nutrition and agricultural extension activities to maximize the potential for improving diet quality at both the household and individual young child levels. The research component focuses on measuring the impact of the extension intervention, as well as providing insights to improve on-going extension activities. The capacity strengthening component reflects the need to train Mozambican nationals in skills essential for making effective extension interventions and conducting quality research.

The project draws on five principal partners to achieve its goals. Michigan State University is providing the leadership in the design of research and training components, and is overseeing overall project management and supervision of the nutrition extension activities. The National Agronomic Research Institute in collaboration with the Southern African Roots Crops Research Network provides new sweet potato varietal material, assists in training extension staff, and coordinates regional varietal trials. World Vision directs the agricultural extension program and provides infrastructural support. The Nutrition Division of the Ministry of Health developed nutrition education materials appropriate for community level interventions and assists in organizing stakeholder seminars and coordinating project activities with

provincial, district, and local health personnel. Helen Keller International is responsible for developing the social marketing strategy to increase demand for vitamin A rich foods and promote behavioral change regarding care giving practices within the project areas.

A critical component of this project is to determine the most cost-effective strategy for implementing an intervention focused on improving dietary quality through dietary diversification and improved feeding practices. Two approaches are being compared: 1) an intervention based on extension personnel holding regular meetings with farmer's groups, and 2) an intervention based on these group meetings plus home visits to individual women belonging to the group by nutrition extension personnel. In January-March 2003 of year one, all 53 farmers' groups received the sweet potato planting material (vines) which they subsequently multiplied for distribution to their own group members between April and July 2003). In total, four intervention sites were established, two in Mopeia District and two in Namacurra District. One project agricultural extension agent and one project nutrition extension agent live at each site.

In addition to the two intervention groups, a control group was selected in a district contiguous to the intervention districts (Nicoadala), with the goal of selecting areas with the same agro-ecological and socio-economic characteristics as the intervention households. The control group receives no group or individual visits from the extension personnel, although limited exposure to information concerning sweet potato and improved feeding practices may occur through listening to radio messages in year two of the project. Sweet potato vines will be distributed to participating control group families at the end of the project.

Baseline data collected from January through May 2003 on 826 study households clearly establish that the level of vitamin A deficiency is very high among reference children (71% prevalence rate), and rates of chronic and acute malnutrition are also high (54.4% and 8.2%, respectively). Child malnutrition has many determinants, of which intake and morbidity are among the most important. Intake of vitamin A rich foods, of which small fish and dark green leaves are the most common, is very limited. The number of times young children of different ages are fed per day for the majority of households falls below recommended values, particularly for children 6-18 months of age. Hence, the likelihood is high that caloric intake is insufficient. Moreover, the high incidence of diarrhea, fever, and other ailments contributes to poor absorption and loss of nutrients after ingestion.

The project follows three intervention pathways to achieve its goal of improved intake of calories and sources of vitamin A: 1) the production of more calories and beta-carotene per hectare through access to improved sweet potato cultivars, 2) effective feeding practices adopted by women and men empowered through knowledge of better practices, and 3) the purchase of more vitamin A rich foods and health services due to enhanced purchasing power. Each of these will be addressed briefly below.

First, participant households need to produce more calories and beta-carotene per hectare. At baseline, almost 70% of households were producing white-flesh sweet

potato, with an average production of 292 kgs per household in intervention areas. In these households, the goal will be to substitute a significant percentage of white-flesh sweet potato with beta-carotene rich varieties, characterized by their orange flesh.

Harvesting of sweet potato occurs throughout the year, but the period of greatest output is from August through November. The introduced beta-carotene rich sweet potatoes, if substituted for the existing white-fleshed varieties, should result in more beta-carotene production per hectare. If the new varieties prove to be higher yielding than existing varieties, then more calories can be produced per hectare without expanding total area under sweet potato production. However, to achieve year-round supply of beta-carotene rich sweet potato in the diet, two things need to be done. First, staggered planting of vines must be promoted when adequate rainfall exists for plant establishment. Second, extension messages must focus on changing the widespread practice of drying sliced white-flesh sweet potato in the direct sun, to drying orange-flesh sweet potato outside of direct sunlight (to protect the beta-carotene content).

The second pathway seeks to increase young child intake of calories and vitamin A through empowering caregivers to improve existing feeding practices through inter-active lessons and demonstrations conducted by extension agents based in intervention areas. Baseline results indicate that the level of nutritional knowledge and appropriate child feeding practices is extremely low among women and men in the study areas. Lack of understanding of the best time to introduce liquids other than breast milk and complementary foods means that infants are exposed to contaminated fluids at an early age, no doubt leading to increased illness, diarrhea in particular. Young childrens' digestive systems are exposed to inappropriate foods before they are mature, further exacerbating health problems. Moreover, once complementary foods are introduced, they are not given in sufficient quantity and quality to assure good growth.

Trials of improved practices (TIPs) constitute the core method used in this project to gain in-depth understanding of feeding practices, motivations and constraints to behavior change, and to identify effective and practical behavior changes which are acceptable and feasible for families. To apply the the method, several visits are made to caregivers in households selected to include a sufficient number of children in each age group of interest. Current nutritional practices are analyzed in the initial visits. During follow-up visits, the researcher negotiates specific changes in feeding practices that the caregiver follows for a set period of time. Researchers subsequently learn from mothers which practices work.

As part of the capacity strengthening component of the project, a Portuguese-speaking consultant was hired to train the project nutritionist and one provincial government nutritionist in the design and implementation of the TIPS methodology. This consultancy took place for three weeks in July 2003. As part of that work, 12 key recommendations for promoting feasible changes in dietary practices for study children were developed for extension agents to promote as their core set of interventions.

Nutrition extensionists visit each farmer group every 2-3 weeks introducing a different topic each visit and reviewing topics as needed. Men as well as women are encouraged to participate in nutrition education sessions. Home visits were initiated in August 2003, and a total of seven visits to women belonging to the second intervention group will be made by the end of the intervention period in September 2004.

The third pathway emphasizes the purchase of more Vitamin A rich foods and health services through the utilization of cash generated from the sales of sweet potatoes and products made from sweet potatoes. Given the low rates of initial commercialization of existing staple food crops at baseline (only 14% of households sold sweet potato in 2002, for example) and the limited market infrastructure within the intervention areas, this is likely to be the most difficult of the pathways to successfully develop within the short time frame of the project. However, improved knowledge of appropriate foods to feed young children could result in cash resources derived from non-sweet potato sources being used to purchase greater quantities of vitamin A rich foods and a more diversified diet. In this respect, a promotional campaign (signs, market booths, sales promotion) based in local markets to influence types of purchases made will be developed in year 2 of the intervention.

The project monitors serum retinol levels (vitamin A status in the blood) every six months to assess whether the increase in young child intake of foods rich in vitamin A leads to improved young child vitamin A status. If overall intake does increase, the translation of that intake into improved status will be heavily influenced by two factors. First, vitamin A absorption by the body can increase by up to 50% if a small amount of fat is ingested concurrently. The 20% of intervention households that possess coconut trees will be more able to regularly add fat to the young child diet than households which rely on seasonally limited supplies of groundnut or cashew nut or on purchased cooking oil.

Second, vitamin A status is influenced by morbidity. Parasitic infections can reduce vitamin A absorption, and depletion of vitamin A, particularly in the serum, is more rapid when children fall ill. Messages on improved caregiving practices will also address improved hygiene practices and appropriate home treatment of common ailments such as diarrhea (for example, over 60% of reference children suffered from a bout of diarrheia during the two weeks prior to the survey). Moreover, it is hypothesized that improved knowledge and increased cash income will result in greater and more timely use of health services, which in turn should reduce loss of ingested vitamin A due to morbidity. A key factor over which the project has no control, however, is the quality of existing health services. Greater use of a very poor service is unlikely to contribute significantly to improved vitamin A status.

Finally, baseline information gathered on both intervention and control areas will permit a comparison between these two areas of levels of nutritional knowledge and caregiving practices, young child diet diversity, cropping practices and expenditure patterns, serum retinol and nutritional status in reference children at the end of the study period. Baseline results indicate that reference children are well-matched between the two

areas in age structure, nutritional status, vitamin A and hemoglobin status. Moreover, the level of nutritional knowledge and feeding practices of men and women in control and intervention areas is quite similar at baseline. Given that extensive data on socio-economic conditions were also gathered, the plausibility of attributing any change in status to specific interventions is enhanced. Extensive data collection of other influential factors will permit any differences between households/individuals in the intervention and control groups to be taken into account at the end of the extension intervention in September 2004.

1. INTRODUCTION

The overriding goal of this project is to **determine whether a food-based intervention strategy can lead to sustainable, year-round intake of vitamin-A rich foods, reduced fluctuations in seasonal household calorie supply, and an overall improvement of diet diversity, nutritional status and diet quality in a cost-effective manner, particularly among children under five years of age.** Emphasis is placed on addressing two major nutritional problems: vitamin A deficiency and inadequate caloric intake. To achieve this, the project introduced eight pro-vitamin A (beta-carotene) rich varieties of sweet potato (identified by their orange-flesh), utilizing these new cultivars as a low-cost, effective entry point for improving the kinds of weaning foods given to young children and increasing the frequency of intake of essential micro-nutrients and calories.

Orange-fleshed sweet potatoes have been selected as the key intervention component as they are an excellent source of pro-vitamin A and calories, easy to cultivate, vegetatively propagated, fairly drought resistant, typically considered a woman's crop, and serve as an excellent food security crop. Sweet potato is less labor intensive than most other staple crops and can be planted over a considerable range of time without considerable yield loss. With adult labor availability highly likely to diminish as the AIDS epidemic continues its spread, sweet potato and cassava cultivation are important AIDS mitigation strategies for assuring adequate caloric availability at the household level. Moreover, as white-fleshed sweet potatoes are already grown in a large portion of Mozambique, families would only be making a *marginal* change in their dietary habits.

The key hypotheses are that adequate consumption of sweet potato-based weaning foods by young children and sweet potato roots and leaves by adults can contribute to a significant improvement in the diversification of both young child and adult diets and that the cultivation and appropriate uses of this important pro-vitamin A rich food can become permanent and sustainable practices in rural Mozambican households. If such diversification occurs and there is a significant increase in overall consumption of vitamin A rich foods, this dietary improvement may be reflected in improvement in serum retinol status. Since serum retinol status is influenced by absorption and loss of vitamin A, particularly that caused by infection, information concerning health status must be taken into account.

The project has three major components: extension, research, and capacity strengthening. The extension component emphasizes a coordinated approach among nutrition and agricultural extension activities to maximize the potential for improving diet quality at both the household and individual young child level. The research component focuses on measuring the impact of the extension intervention, as well as providing insights to improve on-going extension activities. The capacity strengthening component reflects the need to train Mozambican nationals in skills essential for making effective extension interventions and conducting quality research.

The introduction of any new cultivar is a complex process, which must take into account the time required to multiply and produce the crop, and an understanding of both farmer and consumer preferences. The modification of behaviors regarding child feeding practices and care is equally challenging. The only possible way to achieve the project's objectives within the limited 2.5 year time frame currently financed is through a partnership approach, drawing on the skills of diverse organizations already working within the country.

This project draws on five principal partners to achieve its goals. Prior to project initiation, SARRNET/INIA in collaboration with several non-governmental organization partners, had tested and released the 8 sweet potato varieties being distributed by the project. World Vision has been working in Zambézia province for over 7 years and it's current OVATA extension project, which began in late 2001, covers 10 of Zambézia's 16 districts. By linking to areas within two districts covered by World Vision's mandate, the project is able to benefit from the knowledge and existing community and local authority contacts World Vision had already established. The Nutrition Division of the Ministry of Health has already developed nutrition education materials appropriate for community level interventions in rural Mozambique and has conducted district level food security and dietary practice surveys throughout the country which facilitates site selection based on greatest need and accelerates the implementation of any nutrition intervention. Helen Keller International brings extensive experience from other countries in how to intervene to combat vitamin A deficiency, particularly in how to communicate through media and village-level interventions to achieve impact. Finally, Michigan State University has been collaborating with the Directorate of Economics in the Ministry of Agriculture and Rural Development for over 10 years, and through the project coordinator, is providing the leadership in the design of research and training components of the project as well as overseeing overall project management.

This document first reviews the methodology adopted to intervene in rural households and to measure the impact of the intervention and the process of site selection. Second, the document provides a description communities in intervention and control areas, followed by a summary of the major activities and achievements during the first year of the project. Subsequently, the final section presents key findings from the analysis to date of the baseline survey data. While attempts will be made to appropriately acknowledge specific partner contributions to various activities, the term "project" should be seen as encompassing the contribution of all partners.

2. METHODOLOGY

2.1. Design of the Intervention

As described in the project proposal, the proposed interventions build on the experience and understanding gained from a pilot project in Western Kenya (Low et al. 1995,Hagenimana et al. 1999b). The most important finding from that study was that increased frequency of consumption of vitamin A-rich foods by young children was higher in the intervention groups receiving extensive nutrition education in addition to the new orange-flesh sweet potato varieties, than in control groups, where the varieties were introduced without any nutrition education component. This finding is consistent with evaluations of other household food security initiatives, which have found that increases in the availability of certain foods typically do not result in improved child nutritional status when no additional effort has been made to specifically improve nutritional practices (Dickin et al. 1997).

A critical component of this project is to determine what is the most cost-effective strategy for improving dietary quality through dietary diversification and improved feeding practices. Two approaches are being compared: 1) An intervention based on extension personnel holding regular meetings with farmer's groups, and 2) An intervention based on group meetings supplemented by visits to individual women group members in their homes by nutrition extension personnel. In year one, all farmers' groups received the sweet potato planting material (vines) which they subsequently multiplied for distribution to their own group members. In total, 4 intervention sites were established, 2 in Mopeia District and 2 in Namacurra District (refer to Figure 2.1). One project agricultural extension agent and one project nutrition extension agent live at each site.

In addition to the two intervention groups, a control group was selected in district contiguous to the intervention districts, with the goal of selecting areas with the same agro-ecological and socio-economic characteristics as the intervention households. The control group in Nicoadala District receives no group or individual level visits from the extension personnel, although limited possibility of exposure to information concerning sweet potato and improved feeding practices may occur through exposure to radio messages in year two of the project. Sweet potato vines will be distributed to participating control group families at the end of the project period.

The principal biological indicator of vitamin A status used in this study is serum retinol status. To detect significant differences in serum retinol status between the intervention and control groups in an environment with many factors potentially influencing status, a final sample size of 250 children per group (750 in total) was determined to be adequate. Due to the high infant mortality rate in Mozambique and potential out-migration of families from research areas due to changes in employment or marital status, 875 families were initially recruited to participate in the study and signed declarations of consent. By July 2003, that number had reduced to 826 families, 24 lost

FIGURE 2.1 TOWARDS SUSTAINABLE NUTRITION IMPROVEMENT STUDY LOCALITIES AND VILLAGES: 2003-2004

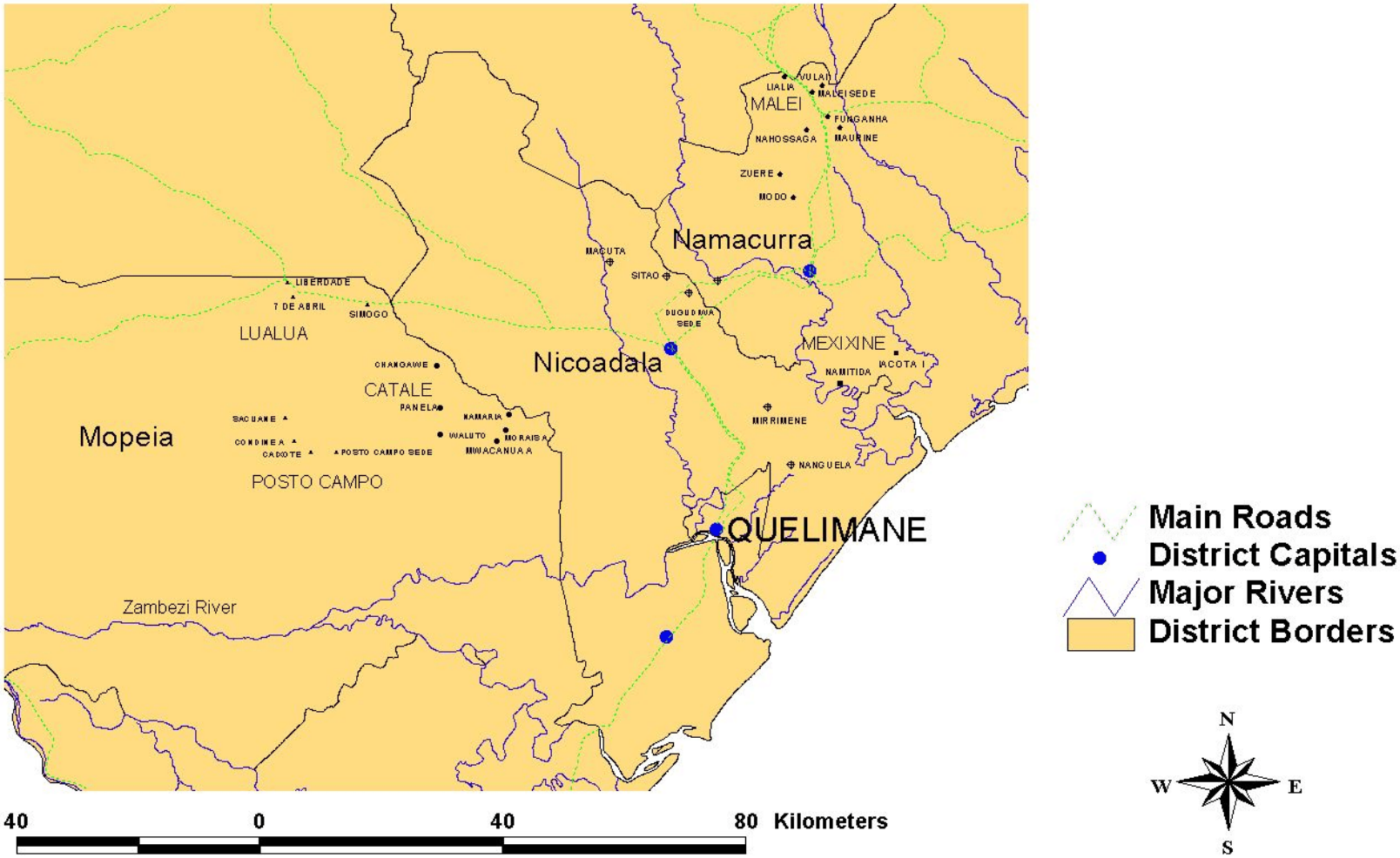
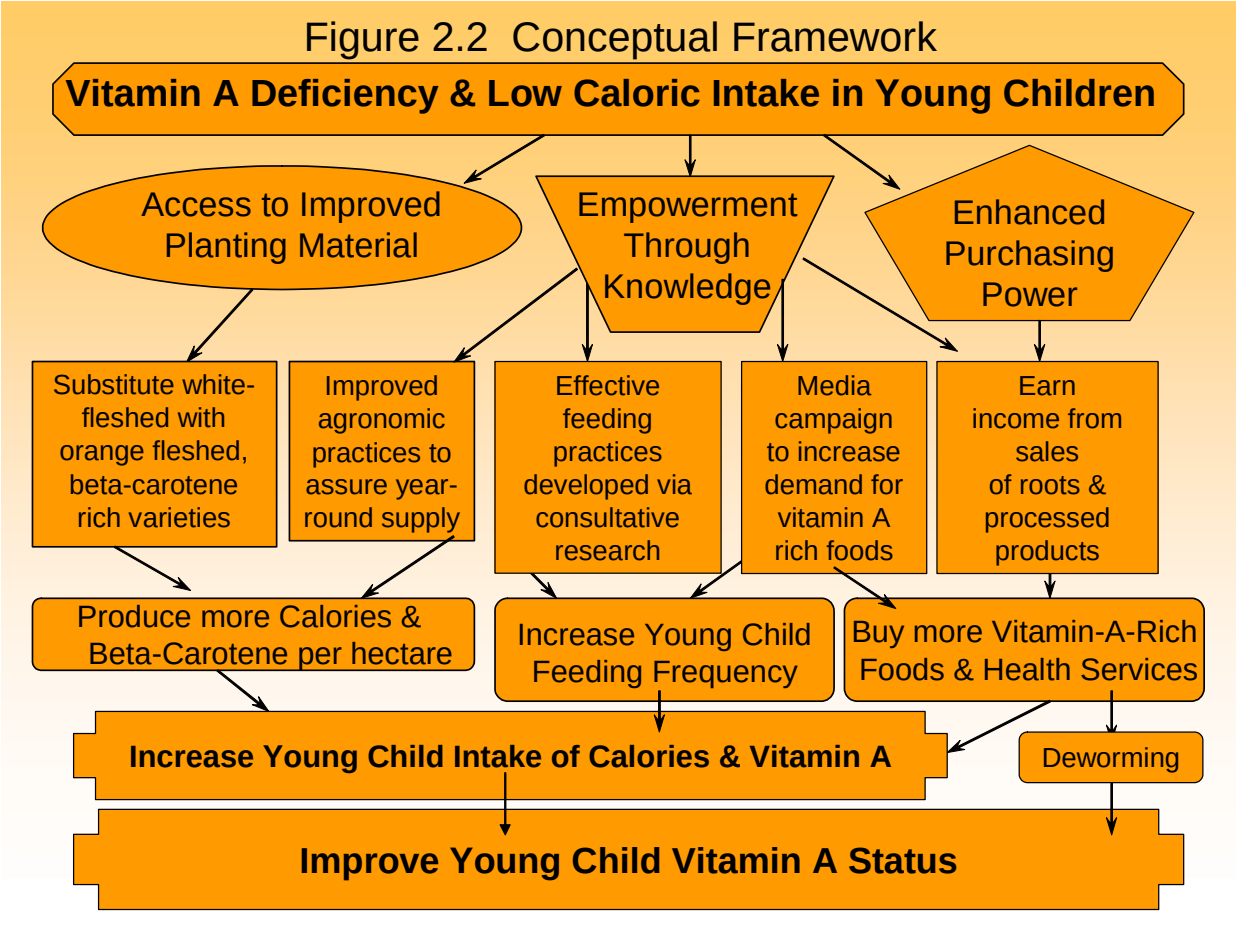


Figure 2.2 Conceptual Framework



due to the death of the reference child, 14 lost due to out-migration, and 11 lost due to refusal to continue participating in the study, in total 5.6% of the original recruits.

As shown in Figure 2.2, there are three major pathways through which the project will achieve its goal of increased production and intake of vitamin A rich foods. These are through:

1) *Access to Improved Planting Material:* Women farmers will receive (principally through groups) planting material of high-yielding beta-carotene rich varieties (HBCR) and be directly involved in varietal evaluation. Rapid multiplication, staggered planting, improved agronomic practices and out-of-ground storage techniques are being introduced to ensure year-round availability of orange-fleshed sweet potato in both the adult and young child diet.

2) *Empowerment through Knowledge:* Levels of formal education achievement among adult rural women in Zambézia province are abysmally low (61% of the mothers participating in the study have never attended school). Health and knowledge surveys in many other parts of Mozambique have noted several major areas where caregiver awareness of basic child feeding practices is severely lacking, including:

a. Duration of exclusive breast feeding
b. Preparation of appropriate complementary foods and correct timing of introduction of different foods into the young child diet
c. Frequency of feeding of young children in different age groups

3) *Enhanced Purchasing Power:* There are two principal mechanisms through which dietary diversification can be achieved at the household level. The first is the **direct production** of crops containing significant quantities of the desired nutrient. The second is through **market purchase**. Given the poor quality of the soil in the target districts, sweet potato is one of the few crops that can give acceptable yields without significant use of inorganic or organic fertilizers. Many of the other micronutrient rich foods will have to be purchased in the market. Enhancing the purchasing power of caregivers vastly improves their capacity to capitalize on whatever new knowledge they have obtained.

In this framework, orange-fleshed sweet potatoes are the **entry point** for improving caloric and vitamin A intake among young children. However, it is expected that consumption of other vitamin A rich foods and fats to enhance vitamin A absorption will also increase significantly due to the impact of greater knowledge regarding which foods to produce and feed to young children combined with greater capacity to buy vitamin A rich foods through the sale of fresh sweet potatoes and processed sweet potato based products.

2.2. Site Selection

Due to the nature of the study, selected sites had to meet the following criteria:

1. Have a substantial percentage of households producing white flesh sweet potato.
2. Fall within the boundaries of World Vision's extension mandate.
3. Demonstrate high levels of child malnutrition (to facilitate detecting nutritional status change)
4. Possess a common dominant local language (to minimize cost and complexity)
5. Be within reasonable distance of location with electricity (essential for data entry and communication)
6. Already have tested the production of orange-fleshed sweet potatoes within at least an equivalent agro-ecological setting.

The research and development intervention is component added onto the Ovata Project of World Vision, which has been operating in 10 districts in Zambézia Province since October 2001. Zambézia is the most populous province in Mozambique, with about 20% of the country's total population. Average annual household income in Zambézia in 2002 was only $213 USD, significantly lower than the national average of $291 (National Agriculture Survey, MADER, 2002).

Among all 10 provinces in Mozambique, Zambézia has the largest number of households in the country producing sweet potato (297,000) and is second after Tete in the total area of sweet potato produced -- over 17,000 hectares in 2001/2002 (Table 2.1). The size and composition of Zambezian households has been heavily impacted by the war and the AIDS epidemic, emphasizing the urgency of empowering women to improve the food security situation of their households. Average household size is only 3.95 in Zambézia, principally due to the dearth of males in the 15-49 age category (INE, 1999). This is reflected in 0.84 male-to-female ratio for the most economically active age group (15-49 years).

The Ovata Program has four main objects: 1) increase food security through agricultural production and marketing through developing marketing groups; 2) improve access to markets and improve infrastructure; 3) increase utilization of production through an integrated nutrition program, and 4) decrease the negative impact of HIV/AIDS on food security through an extensive awareness campaign.

Ten of the sixteen districts comprising Zambézia, approximately 955,000 people, are included in the Ovata design. The research part of sweet potato project focuses on a sub-sample of communities in three districts: Mopeia and Namacurra as Intervention Districts, and Nicoadala as the Control District, all sites being within a 200 km radius of Quelimane, the provincial capital (Figure 2.1). In all three areas, Chuabo is the dominant language and sweet potatoes are widely grown. While rice and manioc are the dominant staple food crops in all districts, there are distinct differences between more coastal villages with access to coconut trees (a major source of fat) and inland villages with limited access to coconut. Surveillance work conducted by the Ministry of Health repeatedly pinpoint Namacurra and Mopeia as two districts with high levels of child malnutrition.

The results from this work will be incorporated into the integrated OVATA nutrition-agriculture program which will be expanded to all ten districts during its five year life span. Thus, the scaling-up of the tested intervention component can readily occur.

2.3. Participant Selection

Participants in this study were not randomly selected from the general population. All participants in intervention areas were either already members of existing farmers groups working with World Vision, or were willing to join a group whose formation was being facilitated by project staff.

In both intervention and control sites, a two stage process was used to recruit project participants. First, a meeting was held with key community leaders (political, religious)

Table 2.1 Sweet Potato Production: Area, Percent of Population Growing, Total Number of Growers in 2001/2002 by Province

Province	Area under Sweet Potato (Hectares)	Percent of Households Growing Sweet Potato (%)	Percent Growing 1st Season (%)	Percent Growing 2nd Season (%)	Percent Purchasing Vines (%)	Total Number of Households Producing Sweet Potato	Mean Size of Plot (square meters) of those Producing	Mean Yield of Plot (tons /hectare) of those Producing
Niassa	9,382	51	47.0	1.5	1.4	88,763	1,182 (130)	4.7 (117)
Cabo Delgado	1,764	13	5.5	5.8	2.4	44,741	868 (31)	6.0 (25)
Nampula	1,744	6	4.7	0.5	7.3	42,527	649 (30)	12.6 (24)
Zambézia	**17,536**	**41**	**16.7**	**22.4**	**13.8**	**297,004**	**1,519 (114)**	**5.2 (78)**
Tete	28,081	57	52.0	3.8	18.5	156,076	2,204 (284)	5.2 (212)
Manica	9,460	49	47.2	0.6	7.3	104,841	1,125 (249)	5.6 (167)
Sofala	13,470	64	63.6	0.3	18.4	110,033	1,406 (246)	8.4 (70)
Inhambane	2,063	24	11.9	8.4	0	60,104	1,125 (55)	2.2 (26)
Gaza	8,020	60	29.1	36.6	5.2	133,595	1,867 (136)	3.9 (100)
Maputo	4,994	62	53.3	7.7	6.2	46,759	1,851 (163)	6.6 (97)

Source: National Agriculture Survey (TIA), 2002. Ministério de Agricultura e Desenvolvimento Rural. Number of observations for mean yields & plot size shown in parentheses. Twenty-five percent of interviewed households had their plots measured.

and professionals (teachers and health staff), to inform them about the objectives of the study and consult with them on the best ways to approach communities in their area. These leaders subsequently assisted in arranging village level meetings which all families in the community with children under five were encouraged to attend. The agricultural extension agent to be posted in that area attended the community meeting, obtaining names of all interested parties and, in cases where groups did not already exist, made arrangements to subsequently form groups among interested parties. Project staff performed a skit to introduce the project to the each community, which proved effective in informing a large number of persons about the objectives of the project.

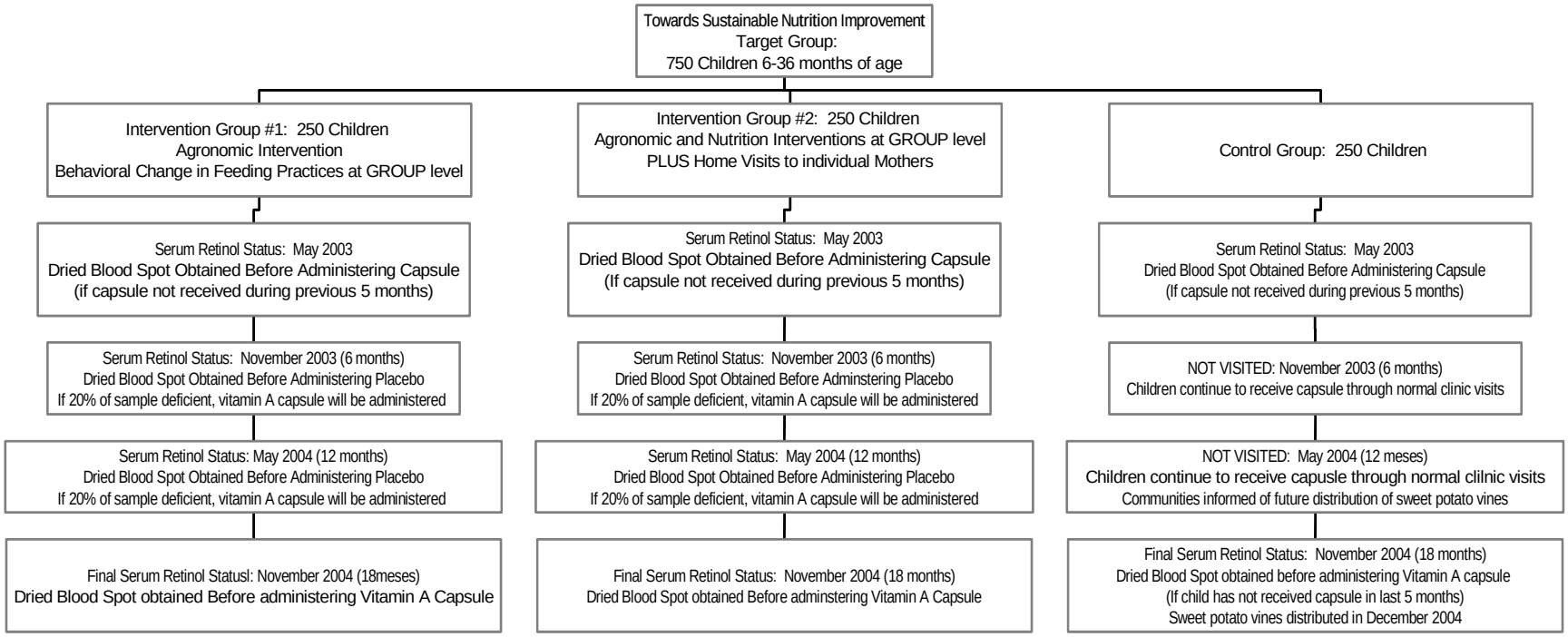
At the community meetings, the collection routine for blood samples was carefully explained to potential participants. In addition, during the first household visit, before initiated each interview, the enumerator read a statement printed on a declaration of consent form to principal men and women in the study and obtained their signatures on the form before commencing the first interview.

2.4. Monitoring of Nutritional Status

Biological and anthropometric indicators of nutritional status will be collected at four points in time during the study period. The periodicity of what, when, and from whom these indicators are to be obtained in summarized in Figure 2.3. Serum retinol (to reflect current vitamin A status in the blood), C-reactive Protein (to assess level of severity of current infections), temperature (to confirm reported current fever status) and anthropometric measure of weight, height, and arm circumference will be measured four times, every six months, in intervention children. In control areas, these measurements will be taken only at the beginning of the study, and 18 months later at the end of the study period. In addition, hemoglobin status will be determined in all study children and their mothers twice, at baseline and at the end of the study. The forms for recording biological indicators are shown in Sections G & H of Part II of the Baseline Questionnaire (Annex C).

Given that there are cultural constraints to taking large samples of blood and logistic constraints to maintaining a cold chain under rural Mozambican conditions, serum retinol status is being determined through the use of the dried blood spot method developed by Craft Technologies, Inc. of Wilson, North Carolina (USA). This method only requires a simple capillary puncture and the capacity to dry and store the spotted filter paper. This method was used by the National Institute of Health of Mozambique to conduct the National Survey on Vitamin A Deficiency, Anemia and Malaria Prevalence among Children 6-59 months of age and their Respective Mothers in 2001. According to Craft et al. (2000), levels of serum retinol are determined using High Performance Liquid Chromatography (HPLC) and original retinol readings are adjusted to account for the non-uniform serum concentrations in the sample used for analysis (refer to Annex A for a description of the adjustment procedure).

FIGURE 2.3 MONITORING OF SERUM RETINOL STATUS IN REFERENCE CHILDREN



Project nutritionists and one provincial government nutritionist were trained in collecting blood using the dried blood spot method for serum retinol and for utilizing hemacue machines to determine hemoglobin status by two staff members (one parasitologist, one lab technician) from the National Institute of Health of Mozambique, both of whom had participated in the National Vitamin A Deficiency Survey. Of the five trainees, three showed sufficient skill at the end of the five day training course to be selected for the blood sampling team. The trainers from the National Institute of Health supervised field work during the first week of data collection.

The challenge in designing the protocol for monitoring the effectiveness of the food-based intervention using serum retinol status, while recognizing that children under five years of age should be receiving a vitamin A capsule every 6 months through routine clinic visits, is considerable. The following protocol was based on consultation with experts in the area and approved by bioethics committees of Mozambique and Michigan State University:

When the first sweet potatoes were ready to be harvested (May-June 2003), a baseline serum retinol assessment was conducted using the blood spot filter paper technique. At that point, all children in the intervention and control groups were provided with vitamin A capsules to assure that they have adequate status (above severely deficient levels of less than 20 µg/dl) at the beginning of the intervention. (To avoid any risk of administering excess amounts of vitamin A, researchers verified through inspecting health cards and confirming with mothers that the child has not received a capsule in the proceeding 6 months under the new distribution system *before* administering the capsules).

Children in the intervention groups will not receive a capsule through the normal clinic distribution system during the course of the study. Every six months, the serum retinol status of all intervention group participants will be taken to determine if their vitamin A status has been adequately maintained by the food-based intervention. Subsequently, any deficient children (less than 20 µg/dl (or 0.70 µmol/L)) will be administered a vitamin A capsule. If more than 20% of the target group remains deficient, consideration will be given to adding a deworming component to the intervention (If parasitic infection is high, the presence of retinol in the blood can be suppressed even if the level of vitamin A stored in the liver is adequate).

At the end of the study period (18 months) serum retinol status will be taken on all children in the study. The food-based intervention approaches will be evaluated on their ability to maintain vitamin A status above levels considered to be deficient (20 µg/dl).

All other children under five in the study locations, including those in the control group, will continue to have access to the vitamin A capsules through the clinic distribution system.

With respect to hemoglobin status, children and mothers with low hemoglobin status were referred to local health services for treatment. In theory, local clinics should

determine whether low status is due to malaria infection, low iron intake or parasitic infections. However, during the baseline survey, the team encounter a major problem of lack of iron sulfate tablets at the local clinic and even district level. Consequently, the project purchased iron sulfate tablets to distribute to local clinics in the survey area and alerted local staff that they would be receiving clients referred by staff conducting village level assessments. In cases where young children had extremely low levels (less than 5 µg/dl) transport was provided to the provincial capital (100 to 200 kilometers away), where blood was available for transfusion at the central hospital.

Extensive training was given to staff conducting anthropometric measurements. Weight, height, length, and arm circumference was taken by a trained measurer and his/her assistant, with additional assistance requested from the child's mother or father during any length measurements. Shorr Height-Length Measuring boards were used for length measurements of children less than 2 years of age, and height for children 2 years of age and older. Height was also obtained from all mothers, and any principal m willing to be measured. The Seca Model 881 Scales for Research were used to obtain digital readings of weight for the selected study children, hence eliminating error associated with reading non-digital readout hanging scales. With these scales, the mother of the child is measured first, then the scale can be tarred to zero permitting the weight of the nude child to be accurately taken while being held in the mother's arms. Weight measures were obtained from all mothers and any principal males willing to be measured. Mid-Upper Arm Circumference was measured only in study children.

A major area of error in calculating accurate anthropometric indicators such as height and weight for age comes from inaccurate age data. This is particularly true in the rural Mozambique, where a high percentage of women have low levels of education, many births occur outside formal health facilities, and clinic cards of children over one year of age frequently are lost or severely damaged. To ensure the most accurate determination of age possible, each anthropometry team was provided with a age and sex specific table with the reference medians for weight, length and height, with accompanying columns showing ± 4 standard deviations. Any child whose height, length or weight was more than 4 standard deviations from the median was referred to the field supervisor who subsequently re-verified the age of the child. Age verification consisted of reviewing the health card, asking the mother and (if present) the father of the child to identify another member of the community who had a child born close to the same time as their child and reviewing that child's health card. In addition, the proposed birth datewas matched to the agricultural calendar and key events over the past 5 years. Fifty cases were identified where age had to be re-verified. This field verification technique no doubt substantially reduced the number of outliers due to age miscalculation.

2.5. Structured Interviews

During the first year of the project, three survey rounds have been conducted with the goal of obtaining detailed baseline information about the characteristics of the

household and three key individuals within the household: the selected child (up to 3 years of age at time of recruitment), the mother of the child, and the man most responsible for the well-being of the child, the so-called principal man. All survey instruments were developed in Portuguese and subsequently translated into Chuabo, the dominant local language in the study areas. Portuguese versions of the instruments are provided in the attached annexes:

Annex B. Baseline Survey, Part I, conducted from January through March, 2003;
Annex C. Baseline Survey, Part II, conducted from May through July, 2003;
Annex D. Consumption and Expenditure survey, conducted from August through mid-November 2003

A brief summary of the information collected in each module and the level at which it was obtained (household, individual mother, individual child, individual principal male) follows:

Table 2.2 Summary of Modules in Baseline Questionnaires Administered to Intervention and Control Households

Survey	**Module**	**Level**
Baseline Survey, Part I	A. Identification of Household and Quality Control, including Declaration of Consent to be signed by the Mother of the Reference Child, and the Father of the Reference Child, when resident.	Household
Jan-Mar 2003	B. Demographic Information, Formal Education, and Involvement in Different Work Activities for Household Members 60 months of Age or Greater	Individual Member
Annex B	C. Demographic Information, Birth date, Possession of Health Card and Number of Clinic Visits for Household Members less than 60 Months of Age	Individual Member
	C. Specific Village Residency, Birth Order, and Religious Information of Mother and Father/Principal Male of Selected Study Child	Individual Study Child
	D. Nutritional Knowledge, Dietary Practices and Habits of Mother and Principal Male	Individual mother and principal man
	E. Breast feeding Status, Feeding Frequency, Vitamin A Capsule Use, and Semi-Quantitative HKI Food Frequency Module for Vitamin A Rich Foods	Individual Study Child
	F. NUTRIPROX module: 24-hour Recall of Ingredients Consumed by Household Members	Household
	G. Agricultural Production Indicators in 2002: Number of Fields, Use of Hired Labor, Production and Commercialization of Food Crops and Recognized Cash Crops (Excluding Fruits and Vegetables)	Household
	H. Agricultural Production in 2002: Detailed Information on the Production and Sale of Sweet potato	Household
	I. Role and Diverse Uses of Sweet Potato within the Household	Household

Survey	Module	Level
	I. Participation in Farmer's Associations or Production Groups and Types of Activities Associations are involved in	Individuals Belonging to Groups
	J. Agricultural Production in 2002: Detailed Information on the Production and Sale of Manioc	Household
	K. Agricultural Production in 2002: Indicators of Production and Commercialization of Vegetables and Fruits	Household
	L. Indicators of Types of Food Expenditures Made in the Last 30 Days and Incoming and Outgoing Remittances	Household
	M. Number of Specific Assets Owned by the Household and Description of the Principal Sleeping Dwelling	Household
	N. Sources of Drinking Water and Distances to Sources in Rainy and Dry Season	Household
	O. Number of Specific Livestock Species Owned and Production and Selling of Different Types of Fish in 2002	Household
	P. Ranking of Most Important Economic Activities for Generating Income for the Household	Household
Baseline Survey, Part II	A. Identification of Household, Change in Residency Status and Level of Farmer Group Participation	Household & Individual Member
May-July 2003	B. New Household Members 60 months of Age or Greater since Part I: Demographic Information, Formal Education, and Involvement in Different Work Activities	Individual Member
Annex C	C. New Household Members Less than 60 months of Age since Part I: Demographic Information, Birth date, Possession of Health Card and Number of Clinic Visits	Individual Member
	D. Hospitalization and Vaccination History, Morbidity Status (diarrhea, respiratory infection, fever, and other diseases) during the Past Two Weeks	Individual Study child
	D. Morbidity Status of Other Household Members during the Past Two Weeks	Individual Member
	E. Breast feeding Status, Feeding Frequency, Observable Malnutrition Indicators, and Semi-Quantitative HKI Food Frequency Module for Vitamin A Rich Foods	Individual Study child
	F. Fertility History	Mother of Study Child
	G. Hemoglobin, Serum Retinol and Temperature	Individual Study Child & his/her Mother

Survey	Module	Level
	H. Anthropometry: Weight (adults, child), Height/Length (adults, child), Arm Circumference (reference children only)	Individual Study Child, Mother, & Principal Male
	H. Confirmation of Birth date, Health Card Possession, Number of Visits to Clinic, and Date Last Received Vitamin A Capsule	Individual Study Child
Consump-tion & Expen-ditures	A. Identification of Household and Change in Residency Status	Household & Individual Member
Aug-Nov 2003	B. New Household Members 60 months of Age or Greater since Part II: Demographic Information, Formal Education, and Involvement in Different Work Activities	Individual Member
Annex D	C. New Household Members Less than 60 months of Age since Part I: Demographic Information, Birth date, Possession of Health Card and Number of Clinic Visits	Individual Member
	D. Consumption Patterns: Major Meal, Separate Eating Groups, and Method of Feeding Child	Household & Individual Member
	E. Presence of Individual Household Members and Guests (by Age and Sex Group) at Meals during the Last 24 Hours. Estimated Consumption outside the Household during Last 24 Hours	Individual Household Member
	E. Consumption during Last 24 Hours with Quantities Estimated Using Volumetric Measures	Household & Study Child
	F. Infrequent Non-Food Expenditures during the Past Year	Household
	G. Frequent Non-Food Expenditures during the Past Month	Household
	H. Food Expenditures during Since the Beginning of the Rice Harvest 2003 (conducted in sub-sample of 25% of study households)	Household
	I. Patterns of Time Expenditure Outside the Household and Care giving Practices of the Young Child During Those Time (conducted in sub-sample of 25% of study households)	Individual Study Child & Mother

All five permanent survey staff are secondary school graduates. Part I of the Baseline Study and the Consumption and Expenditure Survey were conducted at the homes of the participants. Part II was conducted for 30-33 households per day in a central location within each major village where a covered building could be used by the blood collection team.

In April 2003, the survey staff were trained in numeric pad touch typing (essential for accurate but fast data entry) and in the use of the CSPRO version 2.3 data entry package developed by the U.S. Bureau of Census specifically for household surveys.

CSPRO data entry applications developed for all modules have extensive consistency checks between different sections of the questionnaire. The Project Coordinator trained the Administrator/Data Entry Manager for the project in programming techniques for CSPRO. All data for the Baseline Study Parts I and II have been entered and subsequently verified using this package. Double entry of data significantly reduces the number of errors in the database and subsequent time spent data cleaning. Description data analysis was done using the SPSS version 11.5 statistical package.

3. OVERVIEW OF DESIGN AND MAJOR ACHIEVEMENTS IN AGRICULTURAL AND NUTRITION COMPONENTS

A calendar summarizing major activities undertaken each month, including training activities, is provided in Figure 3.1. The first two months of project activities were dominated by staff recruitment, site selection, and conducting meetings, first to introduce the project to provincial, district, and local authorities, followed by community meetings in every selected village. Village level meetings focused on explaining the importance of vitamin A, the objectives of the project, and used a theater presentation to debate the pros and cons in participating in farmer groups promoting sweet potato production and improved dietary practices.

In this section, the agricultural and nutrition components of the project are presented separately. However, in practice, a substantial effort is made to coordinate the two activities. Nutrition and agricultural extension agents often hold joint meetings with project farmer groups and meet together monthly to share experiences and plan upcoming activities.

3.1. Agricultural Extension and Research

All four agricultural extension agents are graduates of one of the two institutes in the country that train agriculture technicians. Most completed 2 years of secondary school before joining the 3 year training program in agriculture. Specific training regarding sweetpotato was provided by staff of INIA/SARRNET, Eng. Sandramo (based in Zambézia), and Dr. Maria Andrade (based in Maputo). In addition, new topics are introduced and old topics reinforced at monthly staff meetings .

The agriculture extension program had to get underway extremely quickly to take advantage of the December-February planting season. Given that the project only began on 15th September, this was a challenging mandate – to recruit staff, identify participants,and have sweet potato vines multiplied and distributed to all groups. Farmer group size varies considerable. Farmers groups were formed if none existed, and existing groups expanded to include new members with children in the target age group. World Vision promotes groups of around 20 members as being the ideal size for effective transmission of messages. However, group sizes within the study vary from 6 members to 40. Much depends on the availability and skill level of persons willing to lead groups, population density, and existing levels of trust between neighbors. Since their formation, a few of the larger groups have split into smaller units, particularly to facilitate the nutrition extension work.

Sweet potato is vegetatively propagated, that is, the vine itself is cut and replanted to generate a new plant. Care must be taken to disinfect material to prevent the spread of disease from field to field. Sweet potato vines can be generated quickly (within 6 weeks) by using rapid multiplication techniques emphasizing vine over root growth.

Figure 3.1 Towards Sustainable Nutrition Improvement: Major Activities from September 2002 through September 2003 by Category and Month

Category	2002 September	October	November	December	2003 January	February	March	Abril	May	June	July	August	September
Administration	Staff Recruitment Bioethics Committee: MSU	Staff Recruitment Bioethics Committee: Mozambique	Staff Recruitment Equipment Purchase	Equipment Purchase	Equipment Purchase	Staff Recruitment	Staff Recruitment Arrival of Project Vehicles						Financial Accounts: First Year
Consultation & Dissemination		Seminar: Provincial level: Introduction of Project Meetings with Provincial & District Leaders	Meeting with Advisory Group: Maputo Meetings with Community Leaders & Individual Communities	Meetings with Control Communities		International Vitamin A Meetings Visit by Cheryl Jackson of USAID				Biofortication Challenge Program Meeting in Colombia	Meeting with Advisory Group: Maputo		
Agricultural Extension				Posting of Agricultural Extension Agents Establish of Multiplication Plots in Namacurra & Luala	Group Formation & Consolidation	Distribution of Sweet potato vines to Farmer's Groups	Distribution of Sweet potato vines to Farmer's Groups	Distribution of Sweet potato vines to Farmer's Groups Group Training: Sweetpotato Weevil	Distribution of Sweet potato Vines to Individual Families Group Training: Sweetpotato Weevil	Distribution of Sweet potato Vines to Individual Families	Distribution of Sweet potato Vines to Individual Families	Group Training: Sweet Potato Storage	Group Training: Sweet Potato Storage
Agricultural Research					Establishment of New Varietal Research Trials					Harvest of 1st Season New Varietal Trials	Planting of 2nd Season Extension Agent Managed Varietal Trials Planting of Farmer Managed Trials		Survey of Project Area under Sweet Potato Survey of Channels of Sweetpotato Commer-cialization
Nutrition Extension								Posting of Nutrition Extensionists Group Training: Malnutrition	Group Training: Vitamin A & Food Groups	Group Training: Vitamin A Rich Foods	Group Training: Vitamin A & Sweet Potato Weaning Foods	Group Training: Vitamin A & Sweet Potato Weaning Foods Trials for Improved Practices (TIPS)	Group Training: Complementary Foods
Survey Work	Site Selection	Site Selection	Site Selection	Household Listing in Study Areas Initiation of Monthly Price data Collection	Initiation of Baseline Survey: Part A	Baseline Survey: Part A	Baseline Survey: Part A	Digitation of Baseline Survey: Part A	Digitation of Baseline Survey: Part A Initiation of Baseline Survey: Part B	Baseline Survey: Part B	Baseline Survey: Part B Digitation of Baseline Survey: Part B Preliminary Analysis of Baseline Survey: Part A	Digitation of Baseline Survey: Part B Initiation of Consumption and Expenditure Survey	Consumption and Expenditure Survey
Capacity Strengthening		Financial Management Chuabo Training	Training in Household Listings Rapid Multiplication of Sweet Potato	Price data collection Training of Baseline Survey: Part A			Sweet potato Production Concepts; CSPRO Programing (Data Entry Program)	Digitation Technique CSPRO Programing (Data Entry Program)	Dried Blood Spot & Hemacue Sampling Anthropo-metry; Survey Instrument Baseline Part B		Nutrition Modules & Communi-cation Techniques Improved Practices; Digitation of Baseline Survey: Part B	Survey Instrument: Consumption and Expenditures Complementary Feeding & Conducting Household Visits	Nadia Osman begins Phd (4 months in England)

Alternatively, conventional multiplication generates vines which can be used to plant additional areas as part of the normal production process within 3-4 months.

Because of the limited amount of planting material for each of the 8 varieties available at the beginning of the project, the extension program carried out sweet potato multiplication in three phases:

1) Rapid multiplication of sweet potato material in 2 sub-stations (Namacurra, Luala) managed by project personnel and other OVATA technicians during the first months of the project while extension personnel and project participants were being recruited.
2) Rapid multiplication of sweet potato by one farmer's group in each of the four intervention locations to assure additional material being available nearer to intervention sites.
3) Distribution to the 53 farmers groups recruited for project participation between January and March 2003. These groups conventionally multiplied this material to obtain both roots and vines to distribute to individual group members.
4) Distribution to individual households having at least one member in the farmer's group. Priority was given to members who were also study participants.

All groups received and multiplied sweet potato during the first season (Dec-Feb) 2003. Due to drought in many locations in Malei in February 2003, over a third of the fields in that location had to be re-planted in March and April 2003.

By the end of August 2003, 76% of study participants (628 households) had received sweet potato material to produce within their own households. The average amount of sweet potato planted per household was 33 square meters. Almost all of those not receiving vines came from one location, Mexixine, where the extension agent had consistently lied that he had overseen distribution to households when he had not. Subsequent investigation led to the replacement of this extension agent in September 2003.

In addition to distributing planting material, agricultural extension agents have demonstrated improved cultural practices for growing sweet potato, particularly for controlling sweet potato weevil, the major pest of the crop in Zambézia. In the dry season, participatory discussions were held with each group to decide which of three storage techniques they would like to test for sweet potato: 1) in-ground storage based on a plan for regular staggered planting, 2) fresh root storage in pits, and 3) slicing and storage dried sweet potato chips.

The research component of the agricultural intervention focuses on project collaboration with INIA/SARRNET efforts to identify promising beta-carotene rich sweet potatoes with higher dry matter content than existing approved varieties. While all of the varieties currently being distributed have dry matter contents between 21-27% and are acceptable to consumers, those with higher dry matter content are likely to be popular among adults as they tend to prefer a more mealy sweet potato than children do (Mealiness is a property associated with high dry matter). In the first season, two

research protocols were used: one provided by SARRNET/INIA for 21 varieties that was established in Posto Campo, the other consistent with trials being conducted by World Vision elsewhere in the province with 10 SARRNET/INIA varieties being mounted in Mexixine. Following the first season harvests in June 2003, two SARRNET trials (Posto Campo and Mexixine) managed by extension agents were established as well as 11 trials managed by farmer's groups of 5 to 6 of the most promising varieties from the first round harvest results.

In addition to the distribution of sweet potato vines to study participant households, project partner World Vision is distributing sweet potato vines in 10 of the 16 districts of Zambézia through its OVATA project. In 2003, over 13,000 households participating in farmer's groups or health councils each received on average 4 kilograms of orange-flesh sweet potato vines (Annex E provides a district breakdown of distribution efforts).

3.2. Nutrition Extension and Research

The nutrition intervention component central to the research hypothesis has already been described in Section 2.1. The nutrition extension component began much later than the agriculture extension component due to: 1) greater difficulty in recruiting and training personnel to work as nutrition extension agents, and 2) prior to beginning their extension work, the nutritionists served as part of the anthropometry and blood sampling survey team to ensure their mastery of techniques and their introduction to all study participants.

Three of the four nutrition extensionists currently in the field are mid-level nurses with over 10 years of experience in government clinics. The remaining extensionist is a secondary school graduate, recruited after other nurses failed to pass the nutrition course. None of the extensionists had adequate prior training in nutrition and basic mathematics. Nadia Osman, the project nutritionist, conducted several rounds of training sessions to prepare the extensionists for the field. In addition, one of the two provincial level nutritionists participated in the Part II of the Baseline Survey and is currently assisting in supervising nutrition extensionists two weeks per month.

Reviews of successful nutrition education programs in developing countries have emphasized some common themes. Integration of interpersonal and media channels (including traditional or "folk" media) is a common characteristic of many successful programs. Different channels influence different stages of the behavior change process. (Cerqueira and Olson 1995, Zeitlin and Formacion 1981). In addition, development and testing of messages that respond to the needs of program participants ("receiver-oriented" messages) is another key feature of successful programs (Cerqueira and Olson 1995), (Favin and Griffiths 1999). Trials of improved practices (TIPs) are one method to achieve this (Dickin et al. 1997) and is the method adopted by this project. TIPs constitute the core method in a consultative research approach which offers the potential to gain in-depth understanding of feeding practices, motivations and constraints to behavior change. Typically, several visits are made in to caregivers in carefully selected households. Current nutritional practices are analyzed in the initial

visits. During follow-up visits, the researcher negotiates some specific changes in feeding practices that the caregiver follows for a set period of time. Researchers subsequently learn from mothers which practices work. This process identifies effective and practical behavior changes which are acceptable and feasible for families.

As part of the capacity strengthening component of the project, a Portuguese-speaking consultant who had applied the TIPS method in her own country, Brazil, was hired to train the project nutritionist and one provincial level nutritionist in the design and implementation of the TIPS methodology. This consultancy took place for 3 weeks in July 2003. As part of that work, 12 key recommendations for promoting feasible changes in dietary practices were developed specifically for study children (who had attained 6 months of age when the messages were developed), summarized as follows:

1. Give orange-flesh sweet potato to the child every day, preferably accompanied by a source of fat.
2. Provide one type of basic food such as rice, sweet potato, manioc, maize, rhizome, sorghum, or millet, in each of the three principal meals: breakfast, lunch, and dinner.
3. Give green leaves every day to your child.
4. Give fruit to your child at least once a day.
5. Put a tablespoon of fat in the meal of the child during the three principal meals.
6. Give at least one source of protein every day and if it is from plant source, complement that protein with a cereal.
7. Do not skip any of the three principal meals.
8. The child should eat from his/her own plate.
9. The mother should assist her child in eating.
10. The mother should stimulate the child to eat when he/she refuses.
11. The mother must pay lots of attention to her own personal hygiene and that of the child, especially when preparing food.
12. Give boiled water to the child. Take advantage of boiled water leftover after cooking certain foods like sweet potatoes and manioc.

While group sessions will include other topics as well, the adoption of these 12 recommendations will be closely monitored as an indicator of project impact. During the consultancy test sessions and protocols for conducting recipe trials involving sweet potato weaning foods were also developed.

Nutrition extensionists visit each farmer group every 2-3 weeks. Men as well as women are encouraged to participate in nutrition education sessions. The degree of male participation, however, varies widely by group. Nutritionists note who among the study participants are attending group sessions. Nutritionists attend monthly meetings at which the training material for the coming month is reviewed. Group session topics covered to date include:

1. What is malnutrition? (Identifying the different types and causes of malnutrition)
2. What are the kinds of different foods (food group identification) and what does each of them do for our health?
3. What is vitamin A and why is it good for you and young children?
4. What are key sources of vitamin A?

5. Demonstration of sweet potato based weaning foods, emphasizing the importance of adding a locally available source of fat and protein.
6. What is complementary feeding?
7. Frequency and composition of complementary feeding at different ages.

Households enrolled in the intervention group receiving home visits will be visited seven times by nutritionists during the study period. During the initial visit, an assessment of the quality of the young child's diet during the previous day is made, and the 12 recommendations are presented and discussed with the mother. Then each mother is asked whether she is willing to implement the recommendation, and if not, why not. During follow-up visits the extension will review with the mother how many of the recommendations she has been able to implement, noting any constraints to adoption and working with the mother to seek a solution. The composition of the diet, based on interviewing about what was fed during the previous day, in addition to observing on-going practices in the household is monitored at each visit (Refer to the detailed first visit questionnaire in Annex F).

The division of the intervention areas into two intervention groups was done based on matching key characteristics of the participant households among 2 different groupings of randomly selected villages for each category within each of the four study localities (Catale, Posto Campo, Malei, and Mexixine). The goal was to have each extension agent with approximately the number of household level visits. However, to avoid within village contamination, all households within a particular village had to be part of either intervention group #1 (group visits only) or intervention group #2 (home visits in addition to group visits).

At the time the selection of intervention groups was made, data from Part II had not yet been verified. Matching was done based on a series of key characteristics of the household based on the intervention sample size during Part I of 584 households. Based on these criteria, the intervention groups were closely matched, and almost equal numbers of households fell within each group. Home visits were initiated in August 2003. Each round of home visits is to be completed within a two-month period.

4. UNDERSTANDING THE STUDY HOUSEHOLDS: A DESCRIPTIVE ANALYSIS OF THE BASELINE DATA

Results from the baseline data analysis provide a basis for judging the eventual impact of the intervention. In addition, information emerging from the baseline study can aid in project design. For example, detailed findings on current nutritional knowledge of participants and their sources of guidance on health and nutrition help guide the prioritization of nutrition training activities, the content of training modules, and the need for incorporating other target groups (for example, husbands and mother-in-laws) into the communication/education strategy.

This section presents descriptive preliminary results comparing intervention and control households. Ideally, the characteristics of control and intervention households, both at the individual and household level, should be similar before the intervention begins, thus facilitating measurement of the impact of project interventions on these distinct groups at the end of the intervention period (September 2004).

After a general description of the distribution of the sample between intervention and control sites, the characteristics of the three principal individuals studied in each household will be presented: the reference child, the mother of the reference child, and the man in the household most responsible for the care of the child (the principal man). Then, findings regarding the nutritional knowledge of the mother and principal man will be summarized. Subsequently, results on frequency of consumption of vitamin A rich foods by the reference child will be presented, based on the Helen Keller International semi-quantitative food frequency index. A general description of the production systems of study households follows, with particular emphasis on the existing role of sweet potato in the farming system. We close with a general description of assets and other important socio-economic characteristics of households, with emphasis on the main sources of family income.

In general, the control and intervention children, mothers, and fathers are similar in terms of most of the biological indicators, age distribution, levels of education, and nutritional knowledge. Differences between control and intervention groups tend to be seen in the types of economic activities engaged in, and the relative importance of those activities. If control areas remain relatively uncontaminated during the study period, the likelihood of being able to statistically detect changes due to project intervention is high. Contamination would only be significant if a large number of control households obtained beta-carotene rich sweet potatoes or access to nutrition extension services, both highly unlikely to occur.

Distinct differences often exist between the two districts composing the intervention areas, particularly in terms of household characteristics. These differences are important to note when planning extension interventions, and district level information is included in key tables for that purpose. Localities were chosen in the control areas to proportionally match the agro-climatic conditions seen in the two distinct intervention districts. Therefore, this document emphasizes the more relevant contrast between

intervention and control areas, than that between specific districts. All tables cited in section 4 of this document are presented in Annex G.

4.1. Sample Size and Mean Household Size

The baseline sample consists of 826 families having a child less than three years of age at the time of recruitment (Table 4.1). Approximately 2/3 of the sample are in intervention areas (560 households), with the remaining third in control areas (266 households). Districts are sub-divided into Localities. In the intervention district of Mopeia (285 households), 51% of the households are in the locality of Catale, with the remainder in the localities of Posto Campo/Lualua (the latter served by one team of extension agents). In the intervention district of Namacurra, approximately 52% of households are in the locality of Mexixine, the rest in Malei. Control sites in Nicoadala District (266 households) were spread across villages in four localities (Dugudiwa, Namacata, Nhafuba, Nanguela) to assure the proportionate match to the agro-ecological conditions in the intervention localities.

Mean household size is 5.2 members, with little variation between intervention and control areas. This is larger than the average for Zambézia province reported in the 1997 census (3.95 members) as the study specifically selected households with young children (INE, 1999). Household size ranges from 2 to 10 members, with only 2% of study households consisting solely of the mother and child pair. The average dependency ratio[1] is 0.55, and 28% of households have ratios exceeding 0.65.

Eight-four percent of households are headed by a male. In contrast, almost 10% of households are headed by women receiving no help from a non-resident male (*de jure* female-headed households), while 6% of households are headed by women who do receive assistance from a non-resident male.

4.2. Characteristics of the Reference Child

The nutritional status of reference children in the study area is quite low (Table 4.2). This is reflected in high levels of chronic malnutrition (54.4% below -2 Z-scores of height-for-age) and significant levels of acute malnutrition (8.2% below -2 Z-scores of weight-for-height). Vitamin A deficiency, defined as serum retinol status below 0.70 µmol/L, is extremely high at 71.5% of reference children[2]. The overall mean for serum

[1]Dependency ratio in this study is defined as the total number of dependents (children less than 14 years of age plus adults greater than 59 years of age) divided total household size.

[2] The National Survey of Vitamin A Deficiency, Prevalence of Anemia and Malaria in Children 6-59 Months of Age and their Respective Mothers was conducted from December 2001 through February 2002. Results of the analysis of 705 children randomly selected from throughout the country (Repartição de Nutrição (MISAU), 2003) showed that 68.8% of children 6-59 months of age were vitamin A deficient (below 0.70 µmol/L) and 7.2% suffered from severe anemia. No sample means were published in the

retinol was 0.600 µmol/l (Table 4.3). Mean hemoglobin levels of children were 8.2 g/dl, with almost a quarter of the sample falling below 7 g/dl of hemoglobin (considered to be severe anemia), the level at which they are sent for further examination in Mozambique.

A quarter of the study children at baseline had at least one observable sign of malnutrition. The most common observable signs were swollen bellies, discoloration of the hair or skin, or an apathetic air (Table 4.4).

While there was no significant difference in mean age, hemoglobin levels or serum retinol status between intervention and control households, a slightly higher percentage of children in control areas fell below standard cut-off values for a number of biological indicators. However, these differences were statistically significant (t-test, ρ=0.05) only for acute malnutrition: 10.9% of control children were acutely malnourished compared to 7.0% of intervention children.

Reference children are well-distributed across age categories of interest. When serum retinol was obtained (3 to 5 months after being recruited into the study), 6% of the children were less than 6 months of age, a quarter fell between 6 and 12 months of age, another quarter between 12 and 18 months of age, 21% between 18 and 24 months of age, and 24% between 24 and 36 months of age (Table 4.5). As expected, anthropometric indicators varied significantly by age group (Table 4.6), with the highest levels of acute and chronic malnutrition appearing in the 12-24 month old children. This is a typical pattern throughout the developing world that is closely associated with the weaning period when children are at high risk of malnutrition. Note, however, that mean Z-Scores are already below -1.5 among children less than 6 months of age, indicating that inadequate nutritional status is a problem from birth in the study area (Table 4.7). No statistically significant differences were found in the biological indicators between reference children living with or without their own fathers at the time of recruitment.

The reference child sample consists of more girls (54.8%) than boys (45.2%). Boys in the 12-24 month age group were found to suffer more from chronic malnutrition than girls and boys in the 18-24 month group showed higher levels of acute malnutrition than girls (Table 4.7). No significant differences in hemoglobin or serum retinol were detected between the sexes for any age category.

Over 80% of the children possessed health cards during the baseline survey. A slightly higher percentage of control children (88.2%) than intervention children (80.2%) possessed cards at the first baseline interview. This indicates that children attended a health facility or were served by a mobile vaccination team at least once since being

---

report. The levels found in this study are quite similar to the national average in the case of vitamin A deficiency but more than three times as high for severe anemia.

Rates of vitamin A deficiency (below 0.7 µmol/L) vary considerably throughout Sub-Saharan Africa but few nationally representative studies have been conduced. Figures for Mozambique (68.8%) are much higher than those seen in Kenya and Ethiopia, for instance. A 1994 survey of 6-72 month old children in Kenya had a prevalence rate of 33% and in Ethiopia had a national prevalence rate of 38.9% in children 6-60 months of age in 1996 (ACC/SCN, 1997).

born. Regular attendance at health facilities drops off significantly after the first year of life (Table 4.8). For example, over 63% of study children 12-18 months of age only had 1-6 visits registered on their cards, and only 69% of this age group had been vaccinated against measles.

Levels of morbidity are high in all project areas. During the two weeks prior to the serum retinol measure, 41% of children reportedly suffered from diarrhea, 23% from a respiratory infection, and 64% reported fever, a symptom highly associated with malaria.

On a positive note, breast feeding is widely practiced during the first year of life, and 92.6% of children 12-18 months of age were still being breast-fed. The incidence of breast feeding dropped to approximately a third of reference children in the 18-24 month age group.

4.3. Characteristics of the Mother of the Reference Child

There are few differences in the characteristics of the mothers in the intervention and control areas. In general, a high percentage of the mothers can be classified as uneducated, married, and principally engaged in agricultural activities (Table 4.8). Sixty-one percent of mothers have never attended school, and only a fifth have had more than 2 years of formal education. Since only 31% speak Portuguese, it is clear that extension messages must be prepared in the local language and any prepared materials must be visual and verbal as opposed to written.

Significant differences do exist in the extent of involvement of control and intervention mothers in certain activities (Table 4.9). Control mothers were more involved in casual labor (42%) than intervention mothers (28%) in 2002. This is probably due to the greater proximity of the control district, Nicoadala, to the provincial capital Quelimane (Figure 2.1). Many urban dwellers have fields in Nicoadala for which the regularly engage casual agricultural labor (known as *ganho-ganho*). A slightly higher percentage of control mothers (46%) sold some agricultural or livestock product in 2002 than did intervention mothers (40%). In other realms, differences between areas were not significant. Few mothers in 2002 engaged in petty trade and only one had salaried employment paid monthly. Approximately 16% of mothers engaged in a non-agricultural off-farm business activity, such as brewing, selling firewood, etc.

Over 60% of mothers in the sample were born in the village in which they currently reside. A quarter are the oldest among their siblings, a potential indicator of additional experience in child rearing. Eighty-six percent of mothers actively participate in religious activities. Thirty-nine percent are Catholics, and only 8% are Muslims. Five percent of the mothers do not practice any religion. The remaining women belong to a large number of sects believing in Jesus Christ, of which the Baptist derivatives predominate (17%). Sects are particularly predominant in Mopeia District.

Mean hemoglobin status was 11.3 g/dl, with 17% of mothers suffering from levels below 10 g/dl. This prevalence of anemia is higher than the average country-wide rate of 12.3% obtained by the national sample survey in 2002. Eighteen percent of women had inadequate weights for their height, reflected by a body mass index falling below 18.5 kilograms per meters of height squared. Only 4% of study mothers suffered from low hemoglobin status and low body mass index concurrently.

The mean age of mothers in the sample is 28 years, but 39% of them are under 25 years of age with an overall average of four live births per mother. Fertility history data reveal that half of the mothers have already lost at least one child who was less than five years old at death. Almost a quarter of mothers have lost at least two children. On average, these women had their first birth at 18 years of age, and the mean number of live births per woman increases in a linear fashion from an average of one for women less than 20 years of age to nine for women 45-57 years of age (Table 4.10). Almost a quarter of the mothers expressed a desire to have no more children, with rates varying dramatically by age group, from a low of 4% of women less than 20 years of age to over half of women 35 years of age and above. The most common reason given by older women is that they already had sufficient numbers of children. Younger women cited reasons of poor health, often associated with pregnancy or childbirth, or difficulties maintaining marital relations. A few mentioned the problems of their children always dying or the lack of conditions to sustain the children as the principal reason.

The impression which emerges is that poorly educated women, living in an environment plagued by high levels of infection and illness, are learning to be mothers through the costly experience of losing a child. Most mothers, however, do correctly recognize when their children are not growing well. 70% of the children whose mothers felt they were not growing well had at least one observable sign of malnutrition and significantly lower weight-for-height Z-scores (-1.25 on average) than children whose mothers thought they were growing well (average weight-for-height Z-score: -0.67).

4.4. Characteristics of the Principal Man

Eighty-six percent of study households have a man living in the household who contributes to the care and well-being of the reference child, the so-called *principal man*. Of these, 80% (663 individuals) are the biological fathers of the reference child. On average these men are older, more educated, and have greater levels of involvement in off-farm or non-agricultural activities than do the mothers of the reference children. The mean age of the principal men is 34 years, with 18% of the men being less than 25 years of age. A quarter have had no formal schooling, but over a half studied formally for more than two years. Consequently, almost 80% of the principal men speak Portuguese. The vast majority are married, with 14% practicing polygamy (Table 4.11).

Three-quarters of the men were born in the village in which the reside, and almost a third are the oldest among their siblings. Religious belief and practice are very similar to thos of the mothers.

Agriculture is the dominant activity of principal men. However, higher numbers of principal men than women engaged in a diverse set of strictly non-agricultural activities, reflecting the difficult agro-ecological conditions of the study area. Participation rates of men in various activities vary between control and intervention zones (Table 4.11). Almost 18% of men in control areas have regular salaried employment compared to just 7% in intervention areas. Control areas also had a higher percentage of men in 2002 working as *ganho-ganho* laborers. In contrast, intervention men were more likely to have sold an agricultural or livestock product in 2002 or to have engaged in petty trade than men in control areas. Both areas had similar levels of participation in self-employed non-agricultural activities – 72% of men in the study areas engaged in at least one such activity (fishing, brewing, carpentry, etc.) in 2002.

4.5. Nutritional Knowledge and Awareness of Vitamin A

One of the key intervention pathways to improving child nutritional status is increased knowledge on appropriate use of foods. Given the dominant role of principal men in the decision making processes in the households, it is important to assess knowledge of men as well as that of women, and subsequently assure that key messages reach all those who may influence a woman's care giving decisions and resource base.

Both principal men and mothers of the reference child were posed a series of questions to assess: 1) their awareness of vitamin A, 2) the depth of their knowledge concerning vitamin A rich foods, 3) their beliefs concerning certain aspects of breast feeding, 4) their ability to identify the causes of marasmus and kwashiorkhor, and 5) their thoughts on the age of introduction and frequency of complimentary feeding. Women were posed additional questions on the content of weaning foods currently being fed to young children. In addition, information was sought from the principal men and women concerning who they turned to for advice on nutrition and health matters. Each of these areas are addressed below. In the remaining parts of this section, when the term men is used, it is referring to the principal men (fathers or key providers) in the life of the reference child. The term women refers to the mothers of the reference child.

4.5.1. Awareness of Vitamin A and Knowledge Concerning Vitamin A-rich Foods

There was extremely high awareness of the term *Vitamin A* among men and women in the study area, with 88% of mothers and 91% of men reporting the had heard of the term. The major sources of information concerning vitamin A were health facilities and radio. No doubt this awareness is linked to the massive national campaign promoting vitamin A capsules. Radio was a more important source of information for men (65% reporting they had heard of vitamin A on the radio) than for women (38%). For women, the most frequently cited source of information was the local health facility (71%), whereas for men the health facility second to radio, at 53%. Few individuals cited extension agents, or local political or religious leaders.

While awareness was high, accurate knowledge concerning where vitamin A is found, its role in nutrition, and the identification of foods rich in vitamin A proved to be limited. Only 5% of women and 4% of men were able to provide a completely correct response to the question of where vitamin A is found. A third of women and 17% of men admitted that they just didn't know.

In general, there was an awareness that vitamin A is good for your health (*dá saúde*), but little knowledge of vitamin A's protective role against illness or poor eyesight. For example, only 11% of women and 16% of men mentioned that vitamin A helps protect the body against disease.

To assess knowledge of vitamin A rich foods, individuals who responded that they had heard of vitamin A were read a list of foods and asked if each food was a good source of vitamin A. The responses suggest a tendency to respond yes when in fact the person was unsure. As such, the percent of respondents "correctly" identifying vitamin A rich foods appeared to be fairly high – over 60% of respondents for all foods except sweet potato leaves. In contrast, the percentage of individuals responding correctly that a non-Vitamin A rich food was not a good source of vitamin A was much lower, ranging from only 4% of women identifying cooking oil as a poor source to a high of 30% in the case of rice and white-flesh sweet potato. Approximately 15% of both men and women responded that all listed products were good sources of vitamin A. This means that the method for assessing knowledge of vitamin A rich foods at the end of the study may have to be altered to an open question format (for example, please name good sources of vitamin A rich foods).

4.5.2. Beliefs Concerning Breast milk and the Timing of Introduction of Other Liquids

Breast milk is a free source of retinol along with many other essential nutrients. Given the poor sanitation conditions of the environment and lack of access to clean water, exclusive breast feeding is promoted by the Mozambican government up to four months of age. Moreover, while the use of powdered milk is very rare in poor rural environments, children under two years of age are sometimes abruptly weaned due to several widespread beliefs concerning the quality of breast milk.

The baseline survey documented the extent of key beliefs concerning breast milk with the perspective of changing inaccurate beliefs during the course of the project intervention. With one exception (concerning the percentage of men believing that colostrum is good for the baby), there were no significant differences between the intervention and control mothers, and the intervention and control fathers. Unless specifically indicated, cited results in this section refer to the entire project sample.

Mothers and principal men were interviewed separately. Each was asked five questions concerning breast milk, and their reasons underlying their response. A summary of responses to each of these questions follows.

a) Is it good to breast-feed your baby with the first milk (colostrum)? Forty-one percent of mothers and 37% of men correctly believed it was good to give colostrum to the baby[3]. Only 1 percent of women and 8% of men responded that they didn't know. That means that more than half of target men and women in the project hold the incorrect belief that colostrum is bad for the newborn. The most common reasons cited by both men and women who felt it is bad is that it provokes illness (general) or provokes diarrhea. About 10% of both men and women felt that colostrum is dirty. Those recognizing that colostrum is good for the infant were equally divided among three top reasons: it has vitamins, it gives health or strength, or because it is the first food of the child.

b) Is it good to give water or other liquids besides breast milk during the first four months of a young child's life? Almost all of the mothers (90%) and principal men (88%) believe incorrectly that it is good to give water or other liquids during the first four months of a young child's life. The provision of water, often with some type of traditional herb added, is common during the first days of life. Slightly over half of the women, and 47% of the men belief that this is necessary to "kill" the thirst of the child, implying that breast milk is not an adequate source of liquid in their hot environment. Other less frequently cited reasons included that these liquids give health, provide vitamins, assist blood circulation, and assist in cooling the breast milk. The majority of those who correctly believed that the practice of giving liquids other than breast milk was bad explained that the child was not old enough yet to drink water, or these liquids would provoke diarrhea or other illnesses.

Mothers were asked what was the age at which other liquids are introduced. Over 50% responded that this occurs during the first three days of life. Only 8.4% of mothers felt that the introduction should occur at 4 months or later.

c) When a breast feeding mother is ill, is her breast milk good or bad for the child? The vast majority of women (78%) and men (83%) incorrectly believe that breast milk is *not* good to give to young children when the mother is ill, principally because it will contaminate the child, causing the child to fall ill as well. This belief can result in the early cessation of breast feeding if the mother falls ill for a significant period of time. A small percentage (2.4% of women, 3.5% of men) felt that the quality of breast milk depends on how ill the mother is, and how contagious the illness she suffers from is. Those that believe breast milk is still good when the mother is ill know that it doesn't transmit illness, with some stressing that the child needs to breast-feed, particularly when he/she is not eating complementary foods.

d) Is a mother's milk good or bad for the child when she becomes pregnant and is still breast feeding? It is common in many parts of Africa for people to believe that the mother must stop breast feeding when she falls pregnant. Central Mozambique

[3] More principal men in the intervention areas (42%) felt it was good to breast-feed colostrum to the baby, compared to only 27% of men in control areas. There was no significant difference in belief on this issue between the mothers in the control and intervention areas.

appears to be no exception. Almost all of the mothers (98%) and principal men (96%) felt that continued breast feeding was bad for the child when a woman becomes pregnant. Again, the reasons focus on the perceived poor quality of the breast milk– it will provoke diarrhea and illness (vomiting, stomach cramps, fevers, anemia, and major weight loss were mentioned by various women). Some mentioned that the breast milk becomes watery, as the milk is going for the new child. Again, this belief contributes substantially to percentage of women abruptly weaning the child before two years of age.

e) Is a breast feeding mother's milk good or bad for the child when it has stayed in the breast for a long time? Over 90% of both women and men surveyed incorrectly believe that it is not good to give children breast milk that has stayed in the breast for a long time (i.e. several days). The three major responses given to why this breast milk is bad are: 1) the milk is spoiled, 2) it would provoke diarrhea, and 3) the milk has become watery. The small percentage responding yes know that the milk has not spoiled.

While all reference children have not been exclusively breast-fed through four months of age, the project will attempt to reduce the incidence of weaning before two years of age, and increase the knowledge concerning appropriate breast feeding practices to help improve the chances the subsequent children born in the intervention areas will be able to receive the maximum benefit from their mother's breast milk.

4.5.3. Identification of Causes of Marasmus and Kwashiorkhor

To determine whether women and men recognized the causes of marasmus and kwashiorkhor, interviewees were shown pictures of affected children. In the case of marasmus, the mothers and principal men were separately asked: *why is this child so thin?* The picture of the child with kwashiorkhor was accompanied with the question: *Why does the child have a swollen belly and swollen feet?*

Concerning marasmus, a quarter of the women and 16% of the men responded that they didn't know. Twenty-four percent of women and 34% of the men believed that it was due to poor nutrition (the child is poorly fed, eats little, etc.). Most of the remaining respondents attributed the condition to the presence of illness, particularly diarrhea and to a less extent anemia. Of note is the response of 21 women and 12 men that the child in the picture was suffering from AIDS. Two women mentioned the poor condition of the child was due to the mother breast feeding the child while pregnant.

In the case of kwashiorkhor, 65% of both men and women responded that the child suffered from anemia. The second most common response was lack of blood (6% of women, 12% of men), the third, lack of vitamins. A small percent of both women and men responded that the child was eating many foods of inadequate quality.

In a few cases for each disease, respondents mentioned that the condition was caused by one of the parents committing adultery, a traditional belief regarding the cause of malnutrition.

4.5.4. Thoughts Concerning Appropriate Child Feeding Practices

Modification of child feeding practices is a key goal of the project. Baseline information was obtained regarding beliefs on when foods should be introduced, the frequency of feeding any food by age group, the use of different ingredients in weaning foods, and the frequency of consumption of vitamin A rich foods. The latter was assessed using the Helen Keller semi-quantitative food frequency index.

a) Age of Introduction of Foods. A significant proportion of women and men believe that other foods should be introduced earlier than typically recommended by the Ministry of Health. Twenty-six percent of mothers and 32% of principal males responded that other foods should be introduced to infants earlier than 4 months of age (a time when exclusive breast feeding is the recommended norm). The majority (58% of women, 48% of men) felt that the introduction of other foods should occur from 4-5 months of age. Nearly a quarter of the women and 19% of the men believe that foods should be introduced only at 6 months of age or more.

Most nutritionists promote the heavy use of enriched mashed foods (*papas*) from 6 to 24 months of age. Even when children should begin to be served as part of the family meals at two years of age, they need to receive 2 additional snacks per day to achieve adequate growth and development. Interviewees were asked to respond to the question at what age should children begin eating the food of the family? A small proportion of men (11%) and women (4%) felt that this should occur at 12 months of age or above. Approximately a quarter of men and women believed that family foods could start to be consumed at 4-5 months of age, over half stipulated 6-11 months of age. In retrospect the question is somewhat ambiguous, and some respondents may not have interpreted as the time when children join in family meals. Many mothers take a portion of the family meal rice, for instance, and mash it before giving it to the young child.

However, what is clear is that a significant number of mothers at the time of the baseline survey were not specifically preparing weaning foods for their children under two years of age. As shown in Table 4.12, only three quarters of mothers with children 6-11 months old were regularly preparing *papas* for them. This percentage drops to 44% for mothers of children 12-17 months of age and to 37% for children 18-23 months of age. Children not receiving specific weaning foods are relying on sharing part of the normal family diet.

b) Frequency of Feeding. To assess general knowledge of how often young children should be fed, both women and men were asked how many times a day a breast feeding child that is beginning to crawl should be fed and how many times a day a 2 year old, who is no longer breast feeding, should be fed. In general, the responses clearly indicate that inadequate feeding frequency of all foods is likely to be a major problem and consequently, a major focus of the nutrition intervention.

A crawling, breast feeding child should be receiving 3 meals a day. However, 44% of mothers and 29% men felt once a day was appropriate. Thirty-nine percent of mothers and 47% of men responded twice a day. Only 15% of women and 21% of men said crawling children should be fed three or more times a day.

A typical recommendation for a non-breast feeding two-year old is to assure that he/she participates in three family meals each day, and in addition receives two supplementary snacks. Sixty percent of women and 66% of men felt two-year olds need to eat three times a day. Only 10% of women and 11% of men recommended 4-6 times per day. Of greater concern is that a quarter of the mothers and a fifth of the men felt two times a day was required. A few men and women responded once a day.

Clearly, the level of nutritional knowledge and appropriate child feeding practices is extremely low among women and men in the study areas. Lack of understanding of timing of introduction of liquids other than breast milk and complementary foods means that infants are exposed to contaminated fluids at an early age, no doubt leading to increased illness, diarrheia in particular. Digestive systems are exposed to inappropriate foods before they are mature, further exacerbating health problems. Once complementary foods are introduced, however, they are not given in sufficient quantity and quality to assure good growth. On the positive side, the vast majority of children are breast fed during their first year of life on demand. Unfortunately breast feeding can be abruptly terminated when the mother falls ill or becomes pregnant due to incorrect beliefs concerning the quality of breast milk.

4.6. Diet Diversity: Frequency of Consumption of Vitamin A Rich Foods, Major Carbohydrates, and Fats by Reference Children

The semi-quantitative food frequency index developed by Helen Keller International (HKI, 1994) was chosen to track seasonal patterns of consumption of vitamin A rich foods by the reference children throughout the study period. Thus, the HKI food frequency survey, adopted to local conditions, was administered in the field during the hungry period in January-March, and again in May through July during the second part of the baseline survey.

The instrument is based on recall information from the caregiver on the number of days the reference child consumed a variety of animal and plant sources of vitamin A during the seven days prior to the interview. In calculating the index[4], heavier weight is given to animal sources, as plant sources must be converted into retinol within the body.

Total weighted index = sum of days of consumption of all animal sources +
(sum of days of consumption of all plant sources)/6.

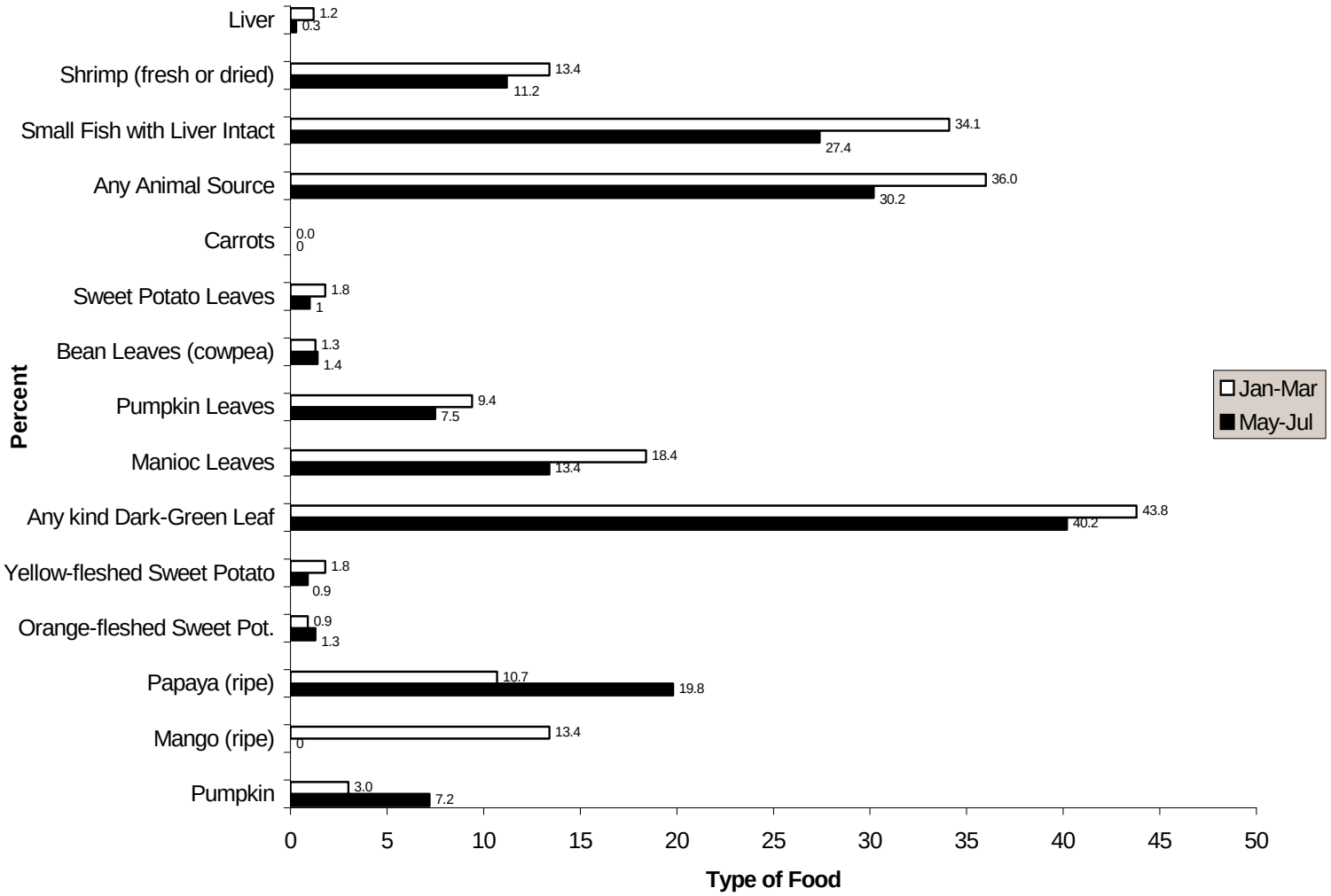
Based on previous work correlating the index with level of serum retinol, a cut-off point of 6.0 was determined as representing the level below which, on a community level basis, there is high probability of vitamin A deficiency.

Excluding all children less than 6 months of age during the second round (Part B) of the Baseline survey (May-July 2003) provides a sample of 776 reference children to whom the food frequency instrument was administered. The total weighted score averaged 3.80 during the hunger season, falling to 3.36 during the harvest season (Table 4.13). Both scores are substantially below the cut-off level of 6, indicating a high probability of vitamin A deficiency due to low levels of intake of vitamin A rich foods.

Figure 4.1 shows the percentage of children consuming different sources of vitamin A at least three times during the last seven days. No source was fed by at least 50% of the households, explaining the overall low mean. Two sources were consumed at least three times a week by at least a quarter of the households: any kind of dark green leaf,

[4] This index was developed at the time when the common conversion ratio used to convert beta-carotene from plant sources to retinol was 6:1. Since then, further work on bioavailability has found that orange fruits and vegetables, orange-flesh sweet potato should have conversion ratios closer to 12:1, whereas dark green leaves are much less bioavailble with conversion ratios of 24:1. However, since the HKI index in 1994 was validated against serum retinol levels in a study population in Tanzania, the conversion ratio on which that validation was based is retained here.

Figure 4.1 Percent of Reference children Consuming a Source of Vitamin A at Least Three Days in the Past Seven Days: January-March versus May-July 2003



and small fish with liver intact[5]. Small fish with liver intact and shrimp (both dried and fresh) were the predominant animal sources of vitamin A and are the reason why animal sources comprise 75% of the total weighted index. Over half of study households consumed small fish at least once during the seven previous days in both seasons (Figure 4.2). Shrimp was also consumed by over a quarter of study children in both seasons at least once during the seven day period. Liver consumption is low, and egg consumption non-existent at baseline due to taboos against feeding eggs to young children and pregnant women.

Considerable seasonal variation is seen in the consumption of fruit and vegetable sources of vitamin A. Papaya is the most regularly consumed of the fruits, at least 40% of children consuming at least once a week in both seasons (Figure 4.2). Over 30% of children consumed mangos at least once a week in January-March, but mango consumption virtually disappears by harvest season. Pumpkins begin to be harvested in March, with consumption rising considerably by the harvest period; 42% of children consume pumpkin at least once a week in May-July.

Consumption of dark green leaves shows significantly less seasonal variation than the fruits, with manioc and pumpkin leaves being preferred over bean and sweet potato leaves in the young child diet. Given their overall availability, considerable potential exists for young children in all areas to be consuming a dark green leaf on daily basis. Over half of the reference children did not consume a dark green leaf during the week prior to the interview.

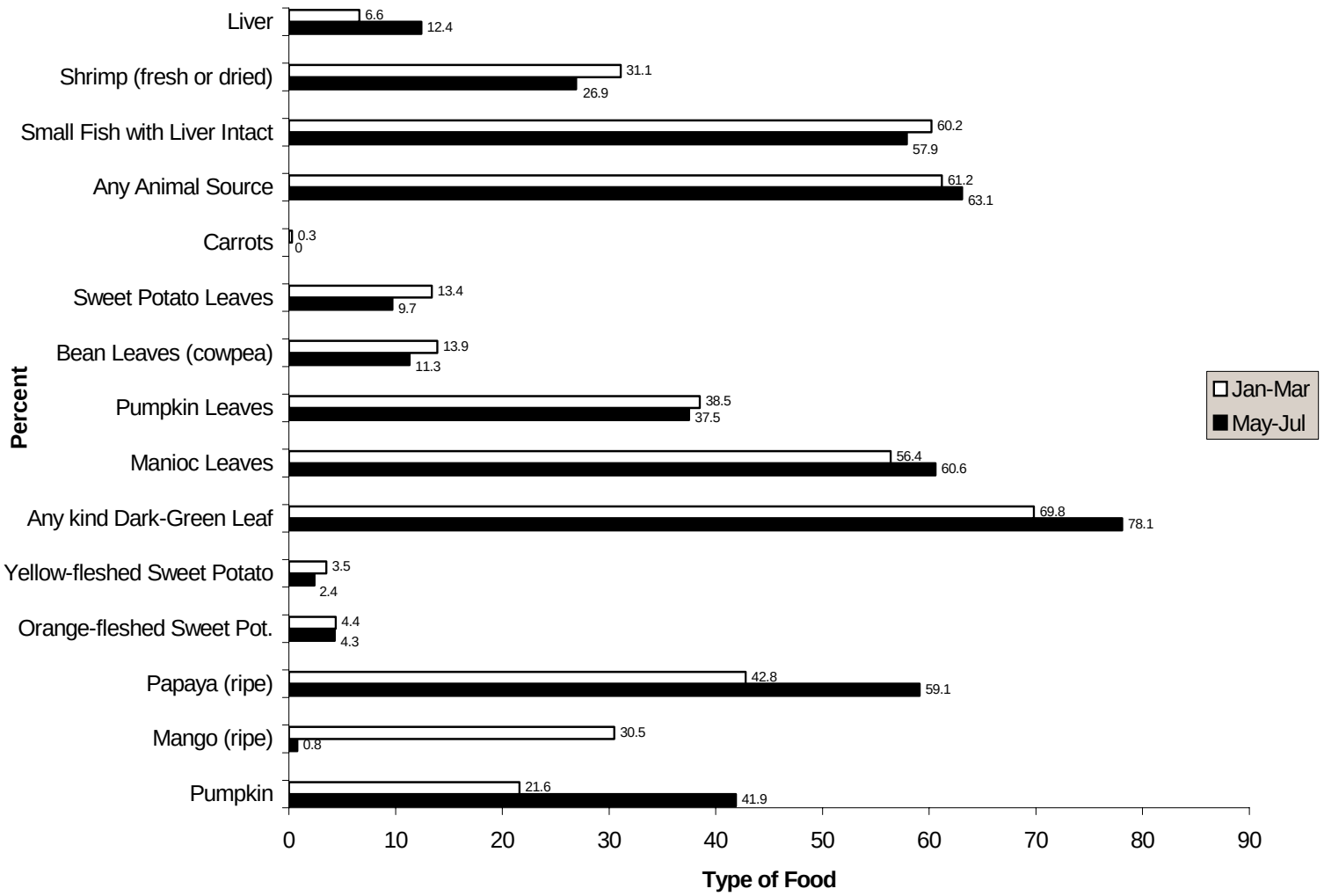
Due to it's recent introduction, orange and yellow-flesh sweet potato are consumed at very low levels. However, over a third of study children (Fig 4.3) consume white fleshed sweet potato at least once a week in both seasons, usually as a boiled or steamed root. The fact that sweet potato already exists in the young child diet enhances the potential for orange-fleshed sweet potato to be permanently incorporated into existing feeding practices.

The half point drop in total weighted HKI score between the "hunger" and the "harvest" season can be explained by the drop in mean consumption of small fish and the disappearance of mango from the diet. Although pumpkin and papaya consumption increased, these increases did not compensate for the drop in a higher weighted animal source. The reason for the drop in small fish consumption needs to be investigated further.

A small amount of fat in the diet greatly enhances the absorption of vitamin A. The dominant source of fat in the research area, particularly in the coastal zone, is coconut

[5] Vitamin A is concentrated in the liver of small fish. Small fish are consumed fresh and dried, but the survey instrument did not distinguish between the two. The amount of loss of vitamin A in the liver when the fish are sun-dried is not clear. Most food composition tables lack information on small dried fish of the type consumed in Mozambique. Thus, it is possible that the overall HKI index should be even lower than reported here.

Figure 4.2 Percent of Reference children Consuming a Source of Vitamin A at Least Once in the Past Seven Days: January-March versus May-July 2003



milk. Over 70% of study children consumed coconut milk at least once during the past week in both seasons. In contrast, vegetable oils are typically purchased in small quantities, if at all, due to their high cost. Only 22% of children in the hunger season, and 25% of children in the harvest season consumed foods prepared with oil at least once during the previous seven days. Butter and margarine are beyond the reach of all but a few individuals in the study area. The other major source of fat in the area, groundnuts, is subject to seasonal availability. Fifteen percent of children consumed groundnuts at least once in the past seven days during the hunger season, compared to 37% in the harvest season (Figure 4.3).

Significant changes were seen in the consumption of other foods between the hunger and the harvest season. There was a dramatic increase in the consumption of rice, with over 90% of families feeding it to the young child at least once a week during the harvest season. This expansion was accompanied by a decrease in consumption of foods made with manioc, maize/sorghum, and wheat (small rolls and biscuits). The frequency of bean and chicken consumption also increased during the harvest season. However, fish is always a much more important source of protein in the reference child diet than beans, groundnuts, or meat.

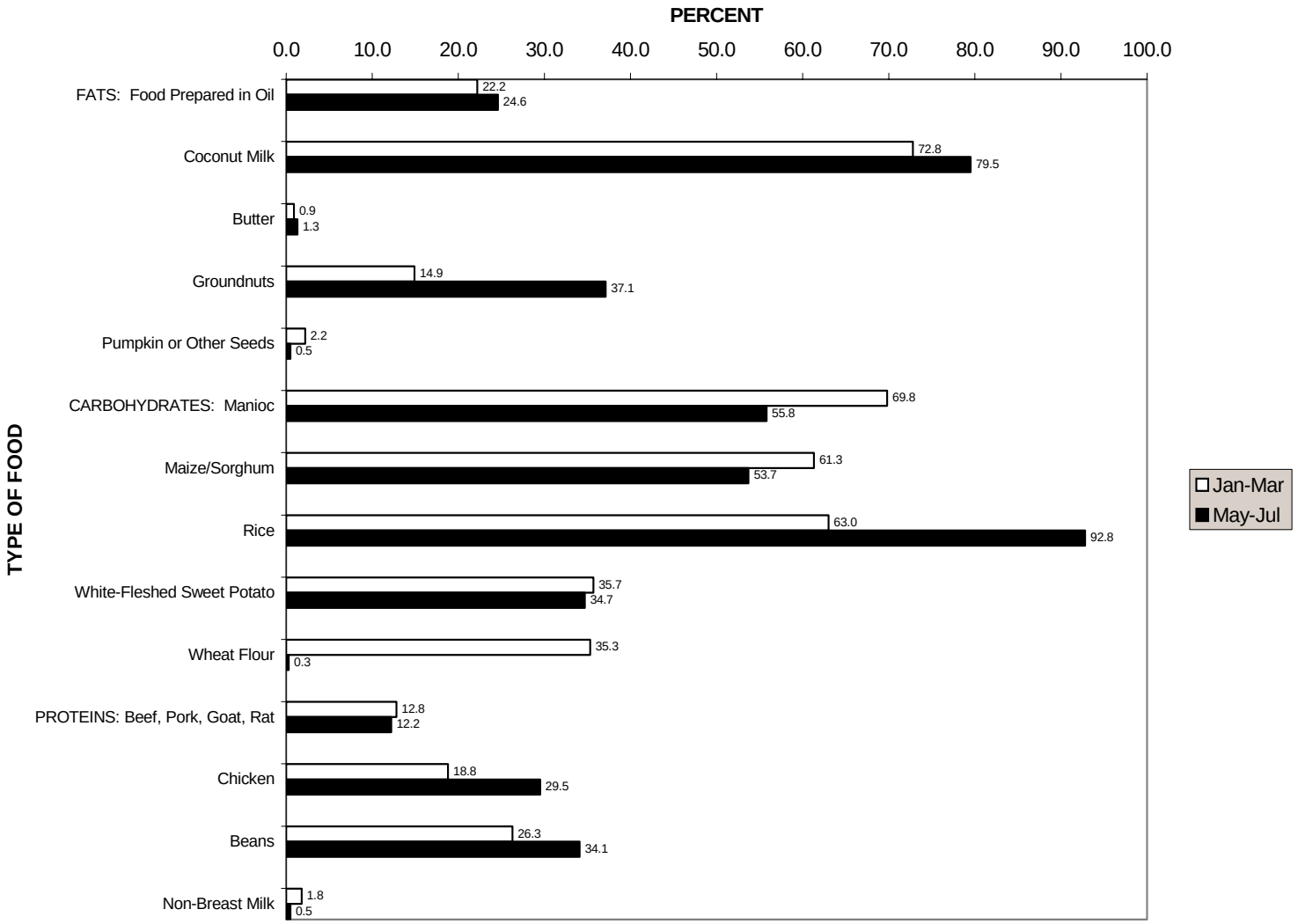
Scores did not differ significantly between control and intervention areas in January-March, but both the animal score and the total weighted HKI score were significantly higher by almost half a point in control areas than in intervention areas in the May-July period (Table 4.14). This difference was principally due to higher small fish (with liver intact) and papaya consumption in control areas than in the intervention areas.

Within the intervention areas, significant differences exist between the frequency of consumption of vitamin A rich foods by children in Mopeia and Namacurra districts (Table 4.15). The higher animal and total weighted scores in Namacurra district compared to the other two sites are principally driven by the greater frequency of consumption of shrimp and manioc leaves.

The HKI food frequency index is normally applied only to children 12 months or older, as the role of breast milk in the diet is reduced in children who are at least one year old. In this sample children at least 6 month of age during the harvest period were included to have a basis to monitor change over the life of the project. As expected, the mean HKI total weighted score was significantly less for children less than 12 months of age, than for children 12 months or older (Table 4.16). No significant differences existed between the other age categories.

Alternatively, one can compare the HKI scores of breast-feeding and non-breast-feeding children. Seventy-nine percent of study children were still breast-feeding between January and March 2003, and the mean score of breast-feeding children, 3.47, is significantly lower than that of non-breast-feeding children, 5.04 (Table 4.17). The total gap between breast-feeding and non-breast-feeding children was 1.57. However, breast milk contains retinol which compensates in part for lower dietary intake of sources of vitamin A. By the harvest season, only 61% of the study children were

Figure 4.3 Percentage of Reference Children Consuming Other Types of Food at Least Once During the Past Seven Days: January-March 2003



still breast-feeding. The HKI total weight score was still significantly lower, but the gap between the two scores was only 0.75. Analysis of change in HKI scores overtime will need to control for initial breast-feeding status and age.

In conclusion, young children suffer from inadequate consumption year-round of vitamin A-rich foods. At baseline, the most available sources of vitamin A in the diet are small fish, manioc leaves, and papaya. Other sources vary considerably in their seasonal availability. The introduction of beta-carotene rich sweet potato provides another source of vitamin A that is more bio-available than dark green leaves and is subject to less seasonal fluctuation in supply than mango, for instance. An effort also needs to be made to combat the taboo against feeding eggs to young children and pregnant women.

The availability of fat in the young child diet is quite limited in households not possessing coconut trees. This is due to the low purchasing power of these households, as cooking oil is available year-round in local markets. Groundnut availability increases in the harvest season, but declines significantly by September. Cashew nut is expected to appear in the diet in some areas during its harvest season between November and January.

4.7. The Production System

All areas in the study fall within the same agro-ecological classification specified by the National Institute of Agronomic Investigation. The Low Altitude Region of Sofala and Zambézia consists of a strip of land under 200 meters in altitude bordered by the sea on the east and running inland between 50-150 kms. Depending on the topography, soils vary from sandy in the higher zones to heavy vertisols preferred for rice production in the lower areas (*zonas baixas*). Precipitation ranges from 1000-1400 mm per year, with the heaviest precipitation occurring between the months of November and March.

The most important staple foods in this area (in terms of total quantities produced) are manioc, rice, sweet potato, and maize (Table 4.18). Few study households produced sorghum, and none grew millet. Within the study areas, distinction must be made between those areas with and without coconut trees, due to the dominant role coconut has in the household and young child diet when the family has access to its own coconut trees. Sugar cane was the most important cash crop for a third of study households as it is the dominant ingredient in locally produced alcohol. For slightly over 30% of households, cashew nut was the dominant cash crop. Coconut was the third most important cash crop, being the most significant source of cash in almost a quarter of study households (Table 4.18).

Household production in general can be described as semi-subsistence, with the majority of households cultivating 2-3 fields mostly with family labor. Approximately 10% of households hired casual labor in 2002, with less than 1% utilizing permanent hired laborers (Table 4.19). Most families possess 2-3 hoes and have a slasher (*catana*), but less than half possess a bucket or an axe and only a few individuals have watering cans, sprayers, or shovels. Livestock holdings are extremely limited. Only 1 family owns a cow, 5% possess at least one goat, 4% possess at least one pig, and only one raises sheep. Sixty-eight percent of households have at least one chicken, but only a fifth own more than five chickens.

The section reviews the production and commercialization of major foods, fruits and vegetables in the year just prior to the start of the project (2002), and then focuses in more detail on the production and use of sweet potato in the household at the time of the baseline survey. Again, emphasis in the text is on similarities and differences between control and intervention areas. However, often very significant differences exist between the two intervention districts as shown in the relevant tables.

4.7.1. Production and Sale of Staple Foods and other Potential Cash Crops

The percent of study households growing and selling the six dominant staple foods in 2002 is shown in Table 4.20. Most households grow these crops for home consumption. Although few households sell these crops, sales are more likely to occur in intervention than in control households, with the exception of sweet potato.

Almost 90% of households produce rice, but only 14.5% sell it. Manioc is grown by 94% of intervention households, but only three quarters of control households. Twenty percent of intervention households sold some manioc in 2002, compared to only 8% of control households.

Sweet potato is produced by over two-thirds of all households. Nineteen percent of control households reported selling some sweet potato in 2002, compared to only 12% of intervention households. Maize is produced by slightly under half of the study households.

The two major plant sources of protein in the area are various types of beans and groundnuts. Unfortunately, only a third of households cultivated beans in 2002 and a mere fifth produced groundnuts. This is due to a combination of poor soils for these crops combined with lack of affordable seed. Less than 5% of households sold either one of these crops in 2002.

Table 4.21 shows the percentage of families producing and selling other crops that are often classified as cash crops in Zambézia province. As previously mentioned, the three most important of these are sugar cane, cashew nut, and coconut. Slightly over half of intervention households and almost a third of control households produce sugar cane. Only 14% reported selling sugar cane, but this may understate the crop's commercial importance because many households use it to produce traditional alcoholic drinks for sale.

Slightly over a third of intervention families produce cashew nut compared to a fifth of control families. Again, the vast majority is used for home consumption with only 13% of study families both growing and selling cashew nuts.

The coconut growing areas for the study are concentrated in Mexixine Locality in Namacurra District (51% of households), and in Namacata and Nanguela Localities in Nicoadala District (23% of households). A fifth of Mopeia households possess coconut trees. Consequently, 35% of intervention households possess coconut trees compared to 23% of control households. Even though Zambézia is renowned for commercial copra production, less than 10% of households reported selling coconut in 2002.

Slightly over 15% of households are producing hot pepper (*pili-pili*) and pineapples, again mostly for home consumption. A few households are trying crops more recently introduced into the province: paprika, tobacco, sunflower, and sesame.

4.7.2. Production and Sale of Horticultural Crops and Fruits

Production of vegetables is limited in the study area, due to lack of suitable soils, lack of seed, and lack of exposure to producing and/or consuming a diversity of horticultural crops. As shown in Table 4.22, no vegetable is grown by at least half of the study households. Pumpkin, the most widely grown vegetable in 2002 and a good source of beta-carotene, is produced by 45% of households. Okra and tomatoes are the next

most widely grown vegetables, produced by approximately a third of study households. Cucumbers are produced by a fifth of households, and melons grown by 16%. A few households produce onions, cabbage, lettuce, or carrots.

Few horticultural crops are sold. The most widely commercialized horticultural crop is tomatoes, being sold by 12.5% of study households in 2002.

Fruit production is much more widespread (Table 4.23). Over 90% of households produced guava in 2002, almost entirely for home consumption. Lemons are produced by 81% of study households, but sold by only 10%. Oranges are the third most widely produced fruit, and the most commercialized in intervention areas. Three-quarters of study households produced oranges in 2002, and 28% of intervention households grew and sold them, compared to only 9% of control households.

Over half of study households grow bananas, and it is also a source of cash in both control and intervention areas, with 30% of control households selling bananas compared to a fifth of intervention households.

Two important sources of vitamin A, mango and papaya, are produced by approximately a half of intervention households and 40% of control households. Neither of these two fruits were widely commercialized by study households in 2002.

Very few households produced maracuja, tangerines, or avocados in 2002, even though these trees could be cultivated in this agro-ecological zone.

4.7.3. The Role of Sweet Potato in the Production System

White-fleshed sweet potato is widely grown in the study area. An understanding of how the sweet potato is currently utilized provides a basis for planning how to expand and diversify its use within the household. Table 4.24 summarizes responses to a series of questions regarding sweet potato utilization prior to the project intervention.

First, sweet potato has a dual role in the diet as both roots and leaves are commonly consumed. Around 67% of households have consumed sweet potato leaves. Roots are typically boiled and steamed. Almost half of households responded that sweet potato roots are principally used as a breakfast food. For most other households, the meal in which sweet potato is consumed varies.

Young children tend to be given boiled roots. Only 5% of households reported having ever prepared mashed sweet potatoes as a weaning food. Only 6% had ever processed sweet potato into flour. However, slicing and drying sweet potato and storing it is common. Forty-nine percent of intervention households and 35% of control households had previous experience cutting sweet potato in slices and sun-drying for storage. On average, families stored dried sweet potato roots for 8.5 weeks, with a maximum reported storage period of 36 weeks (9 months). Dried sweet potato storage could be an important technique for guaranteeing year-round supply of vitamin A.

However, care must be taken to *not* dry orange-flesh sweet potato in direct sunlight as this would destroy the beta-carotene content.

Only a fifth of households had tried to store fresh sweet potato after harvest. The mean storage period reported for fresh roots was 3.6 weeks.

Sweet potato leaves and roots can also be exploited as an animal feed. Roots are typically fed to pigs and leaves to goats and cattle. Given the low level of livestock ownership there is limited scope for expanding sweet potato use as an animal feed. Even so, 38% of households have given sweet potato roots to animals at some point in time, and 19% have fed sweet potato leaves.

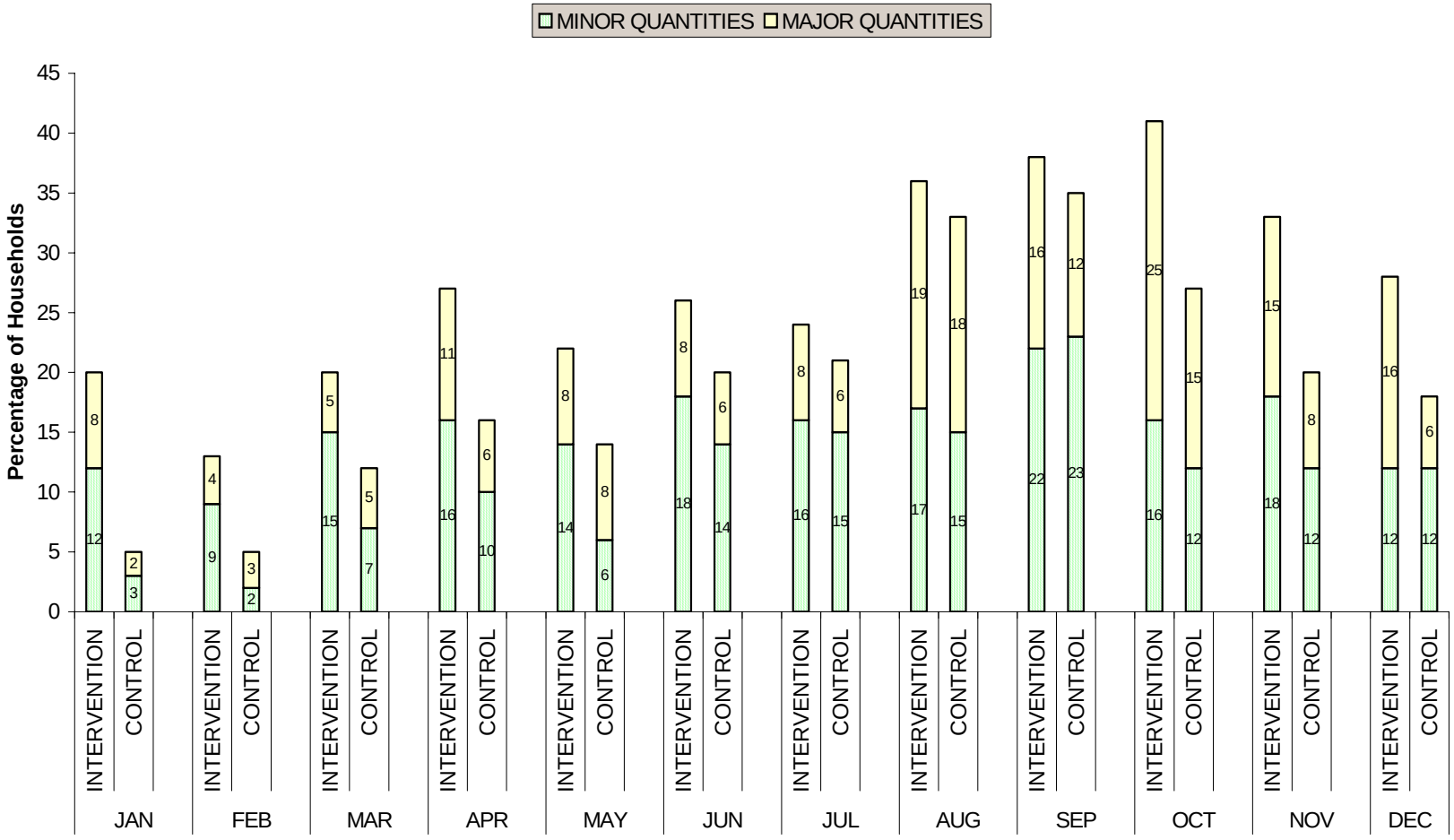
Reported mean sweet potato production in 2002 was significantly higher in intervention households (292 kgs) producing sweet potato than in control households (173 kgs). In households producing sweet potato, production ranged from a low of 6 kgs to a high of 5,784 kgs (Table 4.25). Commercialization of sweet potato is limited. Of the 122 study households who sold some sweet potato in 2002, the average amount earned was 106 Contos (106,000 Meticais), approximately $4.40 USD. Amount earned ranged from 2 to 1,200 Contos, with a median value of 60 Contos. Most growers sold directly to clients in local markets (59% of those selling). Others sold to neighbors (19%), or local traders known as *ambulantes* who purchase at the farm gate (20%).

Sweet potato production is spread throughout the year. In a “normal” year, the main rainy season begins in late November/early December. Households prioritize the planting of rice in the lowland areas, and small amounts of sweet potato are planted in higher zones as sweet potato cannot withstand long periods submerged under water. Once the rice harvest begins in April through June, sweet potato is planted in beds prepared in the former lowland rice fields, thriving on the residual moisture from the rains which begin to decline significantly in force and duration beginning in April. The months of greatest sweet potato production are August through November (Figure 4.4). Production is lowest in January and February due to the difficulty of establishing vines in new plots in August and September, the height of the dry season. Production is possible throughout the year in households with access to lowland areas with sufficient residual moisture or having the capacity to hand water small plots at the height of the dry season.

4.8. Assets, Housing Conditions, Sources of Income and Other Indicators of Well-Being

The capacity of a household to change behaviors and adopt new technologies depends to some extent on their resource base – both human (level of knowledge and education and labor, for example) and the non-human assets (goods, land, and financial) they have to draw on. Moreover, one needs to monitor how the resource base is altered

Figure 4.4 Distribution of Sweet Potato Production: Percentage of Intervention and Control Group Households Harvesting Minor or Major Quantities of Sweet Potato Roots by Month in 2002



during the course of the project intervention. This section summarizes the non-human resource base available for these households to draw upon at the time of the baseline assessment.

4.8.1. Asset Ownership

The number of assets a family has in their possession is an indicator of accumulated wealth over time. Each households was asked if they possessed certain assets in functioning condition, and if they did the number of those assets was recorded. Results are shown in Table 4.26.

The majority of families in the study area possess few assets of moderate value, whether in intervention or control areas. Among the list of goods queried, the most commonly possessed item was small petrol lamps, with half of households owning one, and slightly over a quarter owning more than one. Close to a third of households have functioning radios, and a little over a third possess bicycles. Control households were slightly more likely to possess radios and bicycles than intervention households. Bicycles are highly prized forms of transport in this mostly flat terrain of coastal Zambézia, where public transport is sparse off the principal paved roads. Radio Quelimane covers all study areas and broadcasts in the local language, Chuabo. Therefore, radios are also highly desired possessions.

Other asset ownership is limited. Only 15% of households have someone with a watch, 9% possess a cassette player, 18% a bed made of wood (most families sleep on mats), 20% a table of wood or metal, and 11% a storage container of wood. Few families have mattresses either of sponge foam or straw, flashlights, or a sewing machine. Only one family possessed a motorcycle and none had cars.

4.8.2. Housing Conditions, Sanitation, and Source of Drinking Water

Housing and sanitation conditions are poor in both intervention and control areas (Table 4.27). Only 3% of households have latrines. Eighty-nine percent of the main sleeping dwellings have walls consisting of sticks plastered with mud. Eighty-two percent of houses have roofs of grass thatch; an additional 16% of leaves from palm trees. Eighty-three percent of dwellings have no windows, and only 5% have at least one window filled with glass or with a wood shutter. Only 1% of dwellings have cement floors, the rest are packed earth. Based on the enumerators subjective assessment, a half of the main sleeping dwellings were found to be in poor condition, and only 3% in good condition.

The dominant source of drinking water (75%) is unimproved wells in both rainy and dry seasons. Approximately a fifth depend on improved wells (Table 4.28). Control areas have slightly better access to improved wells than intervention areas. Less than 1% of households have access to piped water or water from a public fountain.

The time spent traveling to the drinking water source does increase somewhat in the dry season. While 4.6% of families walked more than 3 kms to fetch water during the rains, that percentage rose to 17.7% in the dry season. Twenty-nine percent of households had sources of water very close to the house during the rainy season, with this percentage dropping to 18% in the dry season.

4.8.3. Sources of Income and Other Indicators of Well-Being

Households in the study area, and in particular the principal man of the family, engage in a diverse range of activities to ensure survival. In this section, we will examine the relative importance of the different sources of income in control and intervention areas.

The southern part of Zambézia is dominated by several major rivers (refer to Figure 2.1), of which the Zambeze is dominant. However, there are a myriad of smaller streams and tributaries, often seasonal in nature, that provide the most important source of regular protein in the diet for study households — fish. Fishing is engaged in by significantly more intervention households (46%) than control households (32%), and fishing is a particularly important activity in the intervention district of Mopeia (Table 4.29). Moreover, 26% of intervention households and 10% of control households dried fish in 2002. In areas of Namacurra and Nicoadala closer to the sea, it is possible to capture prawns and other crustaceans such as crab. Eight per cent of households fished for prawns in 2002.

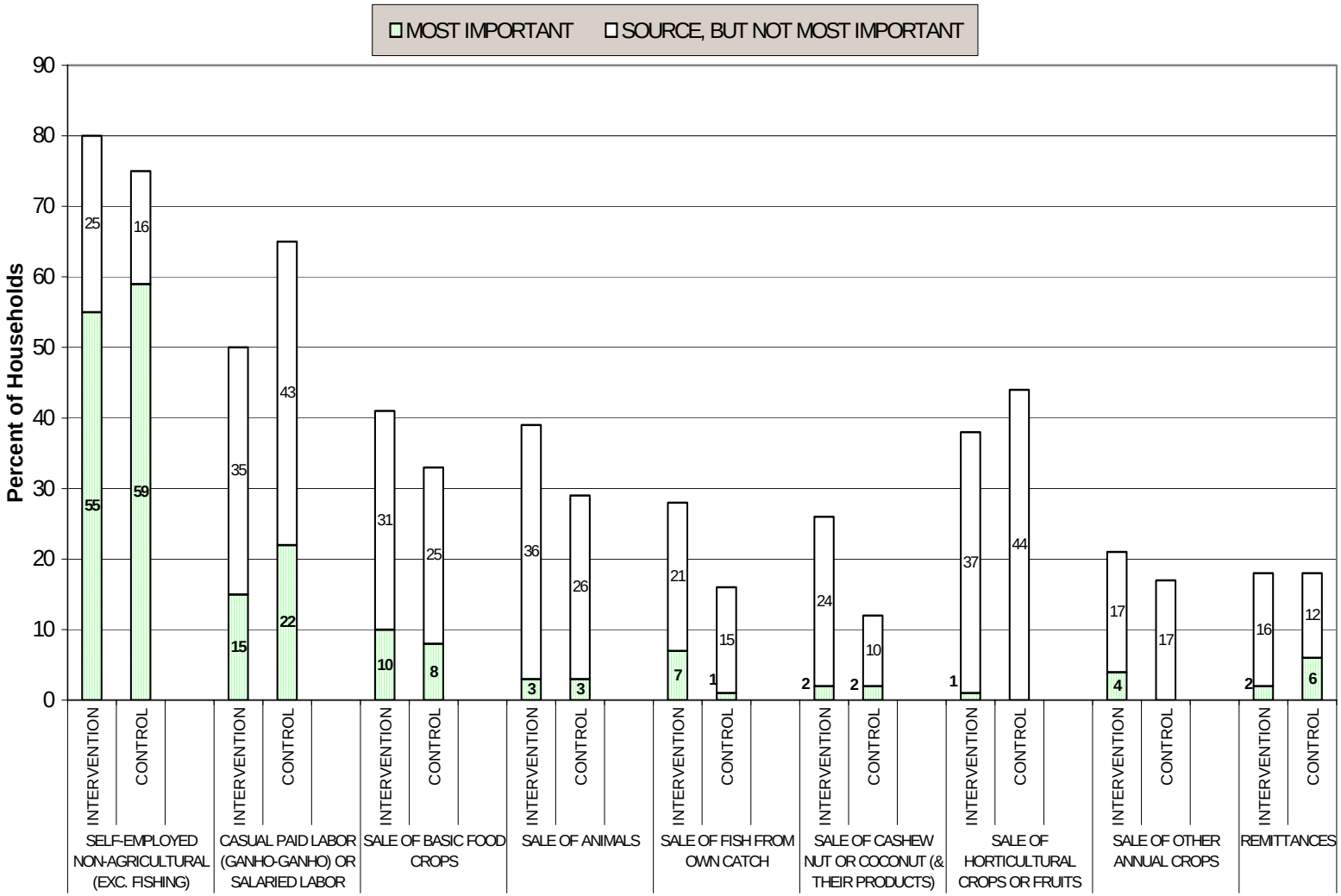
Half of the households who do capture fresh fish also sell it. However, only 7% of intervention households and 1% of control households reported that the sale of fresh or dried fish was their most important source of household income.

Figure 4.5 summarizes major categories of sources of income for study households, indicating the percentage of households reporting a particular category as the most important source of cash income for the household as opposed to not being the principal source of cash income.

Clearly, self-employed non-agricultural activities are the most important sources of income in both intervention and control areas. Fifty-five percent of intervention households and 59% of control households cite these activities, which include charcoal manufacture and sale, brewing, petty trading, self-employed construction activities, etc., as their most important source of household income. Second in importance is paid labor, with 15% of intervention households and 22% of control households mentioning this as the most important source of household income. Most of these labor activities are informal, as formal sector jobs are scarce in the study area. Sale of basic food crops was cited as the most important source of household income in 10% of intervention households, and 8% of control households.

The remaining activities shown in Figure 4.5 are more important as secondary or tertiary sources of cash income. These include the sale of animals, fish from one's own

Figure 4.5. Most Important and Other Sources of Income for Intervention and Control Households in 2002 (Percentage of Households Engaging in the Activity)



catch, cashew nut and coconut sales, sales of horticultural crops, fruits, and other annual crops, and remittances from outside the household. Only 2% of intervention households and 6% of control households cite remittances as their most significant source of household income, but 18% in both areas received some form of remittance in 2002.

Since household food security depends not only on the food one grows, but also on the food one purchases, households were asked whether they purchased a series of products during the month prior to the baseline survey. This survey was conducted during the hungry season of 2003, when food stocks from own production are low. Market purchases can be an essential way to diversify the diet in areas where growing a range of different foods is limited by agro-climatic conditions, as is the case in the study area. Clearly, the capacity to purchase food depends on cash income available within the household. Responses (Table 4.30) indicate that a higher percentage of control households purchased basic starchy staples and cooking oil in the month prior to the survey than did intervention households. Percentage of households purchasing meat, fish, eggs, soap, sugar, and carbonated beverages were similar in both areas.

Almost all households purchased soap in the previous month. The second most common purchase was fish (dried or fresh), bought by 92% of study households. This somewhat unexpected result is probably due to the difficulty of fishing during January-March due to heavy rainfall. The third most common purchase was sugar, bought by approximately two-thirds of households. The fourth most purchased commodity was maize, bought by 76% of control households and 60% of intervention households. The fifth most purchased item is cooking oil, obtained by 64% of control households versus 57% of intervention households. Over a third of households purchased rice and manioc, and at least a quarter bought some kind of meat, groundnuts, and sweet potatoes. Fifteen percent of households bought eggs and a similar percentage purchased carbonated beverages.

Households in this area are typically cash short. Only 5% of households reported having sent or given cash to someone outside the household during 2002. In contrast, 24% of intervention households and 15% of control households sent food or some other item to a non-household member in 2002 (Table 4.30).

4.9. Conclusion

Results from the baseline survey need to be examined with regards to the project's conceptual framework (Figure 2) to enable the development of an intervention strategy based on knowledge of existing resource bases, production constraints, and current family knowledge and behaviors regarding child feeding.

Baseline results clearly establish that the level of vitamin A deficiency is very high among reference children (71% prevalence rate), and rates of chronic and acute malnutrition are also high (54.4% and 8.2%, respectively). Child malnutrition has many determinants, of which intake and morbidity are among the most important. Intake of

vitamin A rich foods, of which small fish and dark green leaves are the most common, is very limited. While caloric intake was not quantified at baseline[6], the number of times young children of different ages are fed per day for the majority of households falls below recommended values, particularly for children 6-18 months of age. Hence, the likelihood is high that caloric intake is insufficient. Moreover, the high incidence of reported diarrhea, fever, and other ailments contributes to poor absorption and loss of nutrients after ingestion.

The framework for this project proposed three intervention pathways to achieve improved intake of calories and sources of vitamin A. First, participant households need to produce more calories and beta-carotene per hectare. At baseline, almost 70% of households were producing white-flesh sweet potato, with an average production of 292 kgs per household in intervention areas. Harvesting of sweet potato occurs throughout the year, but the period of greatest output is from August through November. The introduced beta-carotene rich sweet potatoes, if substituted for the existing white-fleshed varieties, should result in more beta-carotene production per hectare. If the new varieties prove to be higher yielding than existing varieties, then more calories can be produced per hectare without expanding total area under sweet potato production. However, to achieve year-round supply of beta-carotene rich sweet potato in the diet, two things need to be done. First, staggered planting of vines must be promoted when adequate rainfall exists for plant establishment. Second, extension messages must focus on changing the widespread practice of drying sliced white-flesh sweet potato in the direct sun, to drying orange-flesh sweet potato outside of direct sunlight (to protect the beta-carotene content).

The second pathway seeks to increase young child intake of calories and vitamin A by empowering caregivers to improve existing feeding practices through inter-active lessons and demonstrations conducted by extension agents based in intervention areas. Baseline results indicate that the level of nutritional knowledge and appropriate child feeding practices are extremely low among women and men in the study areas. Lack of understanding of the best time to introduce liquids other than breast milk and complementary foods means that infants are exposed to contaminated fluids at an early age, no doubt leading to increased illness, diarrhea in particular. Young childrens' digestive systems are exposed to inappropriate foods before they are mature, further exacerbating health problems. Moreover, once complementary foods are introduced, they are not given in sufficient quantity and quality to assure good growth.

As the majority of women have never been to school, messages will have to be simple, repeated, and emphasis placed on use of non-written means of communication. Since men have considerable influence in the care of children and the purchase of food and non-food items, special consideration will have to be given to how to reach principal

[6] Quantitative data on actual amounts of consumed during 24 hours prior to the survey will be obtained for overall household consumption and for the specific reference child during the consumption-expenditure survey conducted from August through November 2003 and repeated one year later to record changes in the quantity and quality of foodstuffs consumed.

males as well. A potential approach is to enlist them to help ensure that all members of the household improve their caregiving practices. Given that only 30% of intervention households possess radios, the potential for exploiting this medium of communication to promote awareness and behavioral change among study households is reduced unless further investigation reveals that radio listening occurs in groups. Radio and community theater campaigns can also be used to augment demand for vitamin A rich foods. Increased demand would encourage expansion of area planted to beta-carotene rich sweet potatoes, which could lead to more staggered planting, and hence greater year-round availability of sweet potato for home consumption and sale.

The third pathway emphasizes the purchase of more Vitamin A rich foods and health services through the utilization of cash generated from the sales of sweet potatoes and products made from sweet potatoes. Given the low rates of commercialization of existing staple food crops at baseline (only 14% of households sold sweet potato in 2002, for example) and the limited market infrastructure within the intervention areas, this is likely to be the most difficult of the pathways to successfully develop within the short time frame of the project. However, improved knowledge of appropriate foods to feed young children could result in cash resources derived from non-sweet potato sources being used to purchase greater quantities of vitamin A rich foods and a more diversified diet. In this respect, a promotional campaign (signs, market booths, sales promotion) based in local markets to influence types of purchases made needs to be considered.

The last step in the conceptual framework is whether the increase in young child intake of calories and vitamin A leads to improved vitamin A status. Two factors will influence this relationship. First, vitamin A absorption by the body can increase by up to 50% if a small amount of fat is ingested concurrently. The 20% of intervention households that possess coconut trees will be more able to regularly add fat to the young child diet than households needing to rely on seasonally limited supplies of groundnut or cashew nut or on purchased cooking oil. Children without access to fat will have to consume greater quantities of vitamin A rich foods than children with sufficient access to achieve the same impact on vitamin A status.

Second, vitamin A status is influenced by morbidity. Parasitic infections can reduce vitamin A absorption, and depletion of vitamin A, particularly in the serum, is more rapid when children fall ill. Messages on improved caregiving practices will need to address improved hygiene practices and appropriate home treatment of common ailments such as diarrhea (for example, over 60% of reference children suffered from a bout of diarrhea during the two weeks prior to the survey). Moreover, it is hypothesized that improved knowledge and increased cash income will result in greater and more timely use of health services, which in turn should reduce loss of ingested vitamin A due to morbidity. A key factor over which the project has no control, however, is the quality of existing health services. Greater use of a very poor service is unlikely to contribute significantly to improved vitamin A status.

Finally, extensive baseline information on both intervention and control areas will permit a comparison to be made between these two areas of levels of nutritional knowledge

and caregiving practices, young child diet diversity, cropping practices and expenditure patterns, serum retinol and nutritional status in reference children at the end of the study period. Baseline results indicate that reference children are well-matched between the two areas in age structure, nutritional status, vitamin A and hemoglobin status. Moreover, the level of nutritional knowledge and feeding practices of men and women in control and intervention areas was quite similar at baseline. Given that extensive data on socio-economic conditions were also gathered, the plausibility of attributing any change in status to specific interventions is enhanced. Extensive data collection on other influential factors will permit any differences between households/individuals in the intervention and control groups to be taken into account during analysis.

5. OVERVIEW OF WORK PROGRAM THROUGH DECEMBER 2004

A calendar listing scheduled extension and social marketing activities is shown in Figure 5.1, and the schedule of data collection for 2003 and 2004 is provided in Figure 5.2. Given the several month delay in initiating the project, it will be necessary to seek a six-month extension of the project end date to assure that all collected data are analyzed and final reports produced.

Extension activities begun in 2003 are scheduled to continue through September 2004. At that time, the introduced sweet potatoes will have been grown for 2 rainy seasons and be in the middle of their 2nd dry season. From October through mid-December 2004, extension agents will assist the survey team in completing the final survey round. The emphasis in the second year of the agricultural extension program will be on increasing production of sweet potato, drying surplus amounts to assure greater household supply during the hunger season and increasing commercial sales. A complementary marketing campaign is intended to increase demand for the product.

SARRNET/INIA has contributed three pedal pumps to be tested in the study area. These pumps will be sold at a highly subsidized price to interested farmer groups possessing appropriate sites for rapid production of sweet potato planting material and an interest in commercially producing sweet potato.

Group level nutrition visits continue on a monthly basis in year 2, with extensionists using a variety of materials and techniques, including community theater. Mothers and children belonging to Intervention Group #2 received 2 home visits in 2003 and will receive an additional 5 visits in 2004, one visit every 2 months.

HKI will collaborate with the coordinator and the nutritionist of TSNI to finalize the behavioral change communication strategy in late 2003. HKI staff will lead the implementation of the radio programs and market campaigns promoting the consumption of sweet potato and other vitamin A rich foods.

As shown in Figure 5.2, data collection will continue on a regular basis, with serum retinol samples being obtained every six months from intervention households. The final dates of the end of project survey may need to be altered slightly to avoid conflict with nation-wide presidential elections due to be held in October 2004. Beginning in July 2004, two additional staff will be hired to assist with data entry to help ensure that all data are entered and verified by the end of January 2005.

Figure 5.1 Calendar for Extension and Social Marketing Activities for the Towards Sustainable Nutrition Project: January 2003-December 2004

	2003												2004											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1. Agriculture																								
1.1 Multiplication of Planting Material	X	X										X	X											
1.2 Planting of Sweet Potato		X	X	X	X	X								X	X	X	X	X						
1.3 Control of Sweet Potato Weevil						X	X	X										X						
1.4 Introduction of Storage Techniques								X	X															
1.5 Survey of Sweet Potato Yields in Farmer's Fields											X	X						X	X				X	
1.6 Establishment of New Varietal Research Trials	X											X	X											
1.7 Harvest of Research Trials						X	X											X	X					
1.8 Testing of Pedal Pumps											X	X	X											
1.9 Expansion of Use of Storage Techniques																			X	X	X			
2. Nutrition																								
2.1 Group Level Visits by Extension Agent				X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			
2.2 7 Home Visits (once ever 2 months): Intervention Group #2									X	X	X	X	X	X	X	X	X	X	X	X	X			
2.3 Special Sessions Targeting Men, Older Women, and Community Leaders															X		X		X					
2.4 Testing of Processed Products															X	X	X							
3. Marketing Campaign																								
3.1 Finalization of Behavioral Change Communication Strategy with HKI											X													
3.2 Development of Materials												X	X	X										
3.3 Promotion through Radio Programs														X	X	X	X	X	X					
3.4 Market Promotion Campaign: Booths and Signs															X	X	X	X	X	X	X			

Figure 5.2 Calendar for Data Collection for the Towards Sustainable Nutrition Project: January 2003-December 2004

	2003												2004											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1. Nutritional Knowledge	X	X	X											x	x							X	X	X
Sweetpotato & Manioc Production & Comercialization & other Ag Production Indicators	X	X	X											x	x							X	X	X
Income Indicators	X	X	X											x	x							X	X	X
Demographic Composition of Household	X	X	X		X	X	X	X	X	X	X	X		x	x		X	X	X	X	X	X	X	X
Nutriprox	X	X	X											x	x									
Labor Use in Sweetpotato Cultivation (Indicators)														x	x							X	X	X
2. Serum Retinol & Morbidity & Anthropometry					X	X	X				X	X					x	x				X	X	X
3. HKI Food Frequency (concurrently with #1 & #2)	X	X	X		X	X	X				X	X		x	x		x	x				X	X	X
4. 24-Hour Recall & Non-Food Expenditures								X	X	X									X	X	X			
5. Food Expenditures & Time Use outside the Home (concurrent with #4)								s	s	s									s	s	s			
6. Marketing Channels										C	C	C						C						C
7. Sweetpotato Yields on Farmers Fields (Introduced vs Local) & Consumer Acceptability trials											E							E	E					
8. Sweetpotato Yields on New Varietal Trials & Consumer Acceptability trials						E					E	E												
9. Community Facilities																E								
10. Market Prices	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
11. Fresh Root Acceptability to Urban Consumers											E							E	E					
12. Processed Product Feasibility & Acceptability																		E	E					
13. Dissemination of Material through Informal Mechanisms														x	x							x	x	x

LEGEND:

- X collected in intervention & control households by survey team
- x collected in intervention households by survey team
- s collected in sub-sample (25%) of intervention & control households by survey team
- C collected by Felipe Zano, project agronomist
- E collected by extension agents

REFERENCES

Cerqueira, M.T. and C.M. Olson. 1995. Nutrition Education in Developing Countries: An Examination of Recent Successful Projects. In *Child Growth and Nutrition in Developing Countries: Priorities for Action*, ed. Per Pinstrup-Andersen, David Pelletier, and Harold Alderman, Chapter 4:53-77. Ithaca: Cornell University Press.

Craft, N.E., T. Haitema, L.K. Brindle, S. Yamini, J.H. Humphrey, and K.P. West Jr. 2000. Retinol Analysis in Dried Blood Spots by HPLC. *Journal of Nutrition* 130, no. 4: 882-885.

Dickin, Kate, Marcia Griffiths, The Manoff group, Ellen Piwoz, and SARA/AED. 1997. *Designing by Dialogue: A Program Planners' Guide to Consultative Research for Improving Young Child Feeding*. Washington, D.C.: Academy for Educational Development.

Favin, M. and M. Griffiths. 1999. *Communication for Behavior Change in Nutrition Projects: A Guide for World Bank Task Managers.* Nutrition Toolkit Publication of the Human Development Network. Washington, D.C.: The World Bank.

Hagenimana, Vital, Mary Anyango Oyunga, Jan Low, S.M. Njoroge, Simon Gichuki, and Jackson Kabira. 1999b. The Effects of Women Farmers' Adoption of Orange-Fleshed Sweet Potatoes: Raising Vitamin A Intake in Kenya: International Center for Research on Women.

Helen Keller International Vitamin A Technical Assistance Program; Rosen, D.S., N. J. Haselow, and N.L. Sloan. 1994. *How to Use the HKI Food Frequency Method to Assess Community Risk of Vitamin A Deficiency.* Helen Keller International, New York.

Low, Jan, Peter Kinyae, Simon Gichuki, Mary Anyango Oyunga, Vital Hagenimana, and Jackson Kabira. 1995. *Combating Vitamin A Deficiency through the Use of Sweetpotato: Results from Phase 1 of an Action Research Project in South Nyanza, Kenya*. Lima, Peru: International Potato Center.

(INE), Instituto Nacional de Estatística. 1999. *Segundo Recenseamento Geral da População e Habitação 1997: Resultados Definitivos, Província de Nampula*. Maputo: INE.

Ministério de Agricultura e Desenvolvimento Rural (MADER), Preliminary Results from the National Agricultural Survey (TIA 2002) for 2001/2002, personal communication, December 2003.

Repartição de Nutrição e Instituto Nacional de Saúde, Ministério de Saúde, The National Survey of Vitamin A Deficiency, Prevalence of Anemia and Malaria in Children 6-59 Months of Age and their Respective Mothers, Report, Maputo, October 2003.

United Nations, Administrative Committee on Coordination Sub-Committee on Nutrition A. C. C. S. C. N. 1997. *Third Report on the World Nutrition Situation*. Geneva: World Health Organization.

Zeitlin, M.F. and C.S. Formacion. 1981. Nutrition Education. In *Nutrition Intervention in Developing Countries, An Overview*. Cambridge, Massachusetts: Oelgeschlager, Gunn and Hain Publishers.

Annex A.

DESCRIPTION FROM CRAFT LABORATORIES OF PROCEDURE FOR ADJUSTING RETINOL CONCENTRATION USING SODIUM MEASUREMENT

The Centers for Disease Control has determined that the median volume of serum contained in a typical ¼ inch punch from a dried blood spot on Scheicher and Scheull #903 paper is 6.6 ml. However, DBS from the field are not uniform, therefore the actual serum volume in a ¼ inch punch varies both across a single sample as well as between different samples. To circumvent this potential bias, the sodium concentration can be used to estimate the amount of serum that has been extracted from each dried blood spot.

Sodium concentration in the serum component of the blood is tightly regulated at about 140 mmol/L. Therefore, by making up a solution that contains 140 mmol sodium per liter and diluting it to simulate the first step of the extraction, calibration solutions representing 0-10 l. of serum can be obtained and used to calibrate a sodium meter.

For DBS samples, after elution but before adding the denaturant, 100 l. of the extraction solution is removed from the tube and placed into a microcentrifuge tube. Only 80 l. is needed to test for sodium. The remaining 20 l. can be used to test for CRP, RBP, TFR, or AGP.

The Horiba sodium meter is used to measure the sodium content of the eluted DBS. If the response from the meter has proved to be linear, the 10 l. calibrant can be set equal to 100. Then the reading from the Horiba meter for each sample is equal to ten times the serum volume for each sample. (If the reagent blank is set equal to zero.)

The DBS retinol concentration determined by HPLC is adjusted by multiplying the measured DBS retinol by 6.6 then dividing by the measured serum volume:

$$\frac{\text{DBS [retinol]} * 6.6}{\text{measured volume}}$$

Please note that in order to use this approach, the Triton X-100 and the ascorbic acid must be left out of the extraction solution as they interfere with the sodium measurement and the ELISA assays. Also, only 80% of the original extract remains to be analyzed for retinol. (This is accounted for in the calibration if the DBS calibrants are treated exactly as samples.)

To account for any degradation that may occur as a result of the collection and drying process or by the removal of the ascorbic acid from the extraction solution, the HPLC is calibrated using a QC dried blood spot that has a known retinol concentration. Further, a QC plasma is also extracted in the same manner to verify the method.

Annex B.

BASELINE QUESTIONNAIRE
JANUARY-MARCH 2003

Annex C.

BASELINE QUESTIONNAIRE
MAY-JULY 2003

Annex D.

CONSUMPTION & EXPENDITURE QUESTIONNAIRE
AUGUST-NOVEMBER 2003

Annex E.
DISTRIBUTION OF VINES OF BETA-CAROTENE-RICH SWEET POTATO BY WORLD VISION IN 10 DISTRICTS OF ZAMBÉZIA PROVINCE 2003.

Annex F.

QUESTIONNAIRE TO ACCOMPANY HOUSEHOLD VISITS MADE BY NUTRITION EXTENSIONISTS

Annex G.

TABLES FOR SECTION 4: UNDERSTANDING THE STUDY HOUSEHOLDS