Everything You Ever Wanted to Know about Sweetpotato

Reaching Agents of Change ToT training manual

VOLUME 2

Topic 4: Orange-fleshed Sweetpotato and Nutrition

RAC Reaching Agents of Change Support Vitamin A Sweetpotato

CENTRO INTERNACIONAL DE LA PAPA CIP A member of the CGIAR Consortium

UNIVERSITY of GREENWICH Natural Resources Institute

Helen Keller INTERNATIONAL

Orange-Fleshed SWEETPOTATO Rich in Energy & Natural Vitamin A

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Everything You Ever Wanted to Know about Sweetpotato
Reaching Agents of Change ToT Training Manual

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Foreword

During the past decade, interest in sweetpotato in Sub-Saharan Africa (SSA) has been expanding, the number of projects utilizing sweetpotato increasing, and the demand for training development practitioners and farmers subsequently rising as well. Sweetpotato scientists at the International Potato Center and national research centres often receive these requests and frequently hold 1-3 day training sessions, drawing on whatever training materials they have or can quickly pull together. The inadequacy of this approach has been quite apparent, but resources to address the problem were not available until now.

The funding of the Reaching Agents of Change (RAC) project in 2011 has changed the situation. Jointly implemented by the International Potato Center (CIP) and Helen Keller International (HKI), RAC seeks to empower advocates for orange-fleshed sweetpotato (OFSP) to successfully raise awareness about OFSP and mobilize resources for OFSP projects. RAC also seeks to build the capacity of public sector extension and non-governmental organizational personnel to effectively implement those projects funded to promote the dissemination and appropriate use of vitamin A rich, orange-fleshed sweetpotato. The goal is to see *sustained* capacity for training senior extension personnel about the latest developments in sweetpotato production and utilization in each of the major sub-regions of SSA: Eastern and Central Africa, Southern Africa, and West Africa. Hence, CIP has identified a local institution to work with in Mozambique, Tanzania, and Nigeria to host an annual course entitled: *Everything You Ever Wanted to Know about Sweetpotato.* During the first cycle of this course, CIP scientists worked closely with national scientists in implementing the course. During the second cycle, the national scientists will lead the training activities and course management with backstopping from CIP personnel. During the third cycle, national scientists will organise and conduct the course with just financial support from the project. In subsequent years, we hope that the course will have become fully self-sufficient on a cost recovery basis.

In developing the course content, a long-time collaborator of CIP, Dr. Tanya Stathers of the Natural Resources Institute (NRI), University of Greenwich, has led the review of existing training material, added in new knowledge from sweetpotato scientists and practitioners, and designed the course with a heavy emphasis on learning-by-doing. Dr. Stathers previously collaborated with CIP, Ugandan sweetpotato scientists from the National Agriculture Research Organization (NARO), and FAO Global IPM Facility in Kenya on a field project which developed a comprehensive Sweetpotato IPPM Farmers Field School manual for Sub-Saharan Africa in 2005. In developing the course, Dr. Stathers has consulted CIP personnel (Robert Mwanga, Ted Carey, Jan Low, Maria Andrade, Margaret McEwan, Jude Njoku, Sam Namanda, Sammy Agili, Jonathan Mkumbira, Joyce Malinga, Godfrey Mulongo) and HKI nutritionists (Margaret Benjamin, Heather Katcher, Jessica Blankenship) and an HKI gender specialist (Sonii David) as well as her fellow NRI colleagues (Richard Gibson, Aurelie Bechoff, Keith Tomlins). She adapted training material from the DONATA project, the Reaching End Users project and many others. After running the course and using the manual in 2012, a review was held and the manual and course were subsequently updated to meet facilitators and participants demands, and a standard set of accompanying Power Point presentations were created. Dr. Stathers has done a tremendous job and we deeply appreciate her commitment to producing this high quality manual.

The level of this course is aimed at senior extension personnel or leaders of farmer organizations who will in turn train others. We envision the course to be improved on an annual basis as new knowledge comes in and based on feedback received from the course participants. In this way, we expect the vibrant and knowledgeable sweetpotato community of practice to continue to grow in the coming years. The *Everything You Ever Wanted to Know about Sweetpotato* course will help us to achieve the major objectives of the Sweetpotato Profit and Health Initiative (SPHI). Launched in October 2009, the SPHI seeks to improve the lives of 10 million sub-Saharan African families in 16 countries by 2020 through the diversified use of improved sweetpotato varieties.

Jan W. Low, Leader of the Sweetpotato for Profit and Health Initiative, International Potato Center
June 2013

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This team has brought together and shared their many years of experience of working with sweetpotato systems and farmer learning processes across Sub-Saharan Africa to compile this *Everything You Ever Wanted to Know about Sweetpotato* resource. None of this experience would have been gained without the partnership of many sweetpotato farmers and other stakeholders (extensionists, national researchers, traders, transporters, NGO staff, nutritionists, media and donors) across the region. We thank you, and hope that this resource can in return offer you support in your sweetpotato activities.

The photographs used throughout this manual come from a wide range of places and we thank Margaret McEwan, Jan Low, Richard Gibson, Erna Abidin, Aurelie Bechoff, Keith Tomlins, Sam Namanda, J. O'Sullivan, Gabriela Burgos, Tanya Stathers, Olasanmi Bunmi, Benson Ijeoma, Grant Lee Neurenberg, Sammy Agili, the late Constance Owori, Ted Carey, Robert Mwanga, Ana Panta, Kirimi Sindi, Frank Ojwang, CIP digital archive, G. Holmes, B. Edmunds, and Nicole Smit for kindly sharing them. Most of the cartoons used in this manual were drawn by Movin Were.

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Acronyms and abbreviations

ACIAR	Australian Centre for International Agricultural Research
AIs	Adequate Intakes
ARMTI	Agricultural and Rural Management Training Institute
ASCII	American Standard Code for Information Interchange
AVRDC	The World Vegetable Centre
BMGF	Bill and Melinda Gates Foundation
CBO	Community Based Organisation
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Center
DAP	Days After Planting
DFE	Dietary Folate Equivalents
DONATA	Dissemination of New Agricultural Technologies in Africa
DVM	Decentralised Vine Multipliers
EMU	Eduardo Mondlane University
dwb	Dry weight basis
FAEF	Faculty of Agronomy and Forestry Engineering
FAO	Food and Agriculture Organisation of the United Nations
FC	Food Consumption
FW	Fresh Weight
GI	Glycemic Index
HH	Household
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
HKI	Helen Keller International
IBPGR	Bioversity International
IFPRI	International Food Policy Research Institute
IIAM	Institute of Agricultural Research Mozambique
IIED	International Institute for Environment and Development
IIRR	International Institute of Rural Reconstruction
IITA	International Institute of Tropical Agriculture
IMMPACT	International Micronutrient Malnutrition Prevention and Control Program
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IPPM	Integrated Pest&Production Management
IRETA	Institute for Research Extension and Training in Agriculture
K	Potassium
LGA	Local Government Areas
LGB	Larger Grain Borer
LZARDI	Lake Zone Agricultural Research and Development Institute (Tanzania)
M&E	Monitoring and Evaluation
MAP	Months After Planting
m.a.s.l.	metres above sea level
MM	Mass Multiplication
MRC	Medical Research Council, South Africa
MSC	Most Significant Change
N	Nitrogen
NARO	National Agricultural Research Organisation
NAS	National Academy of Sciences
NBS	National Bureau of Statistics
NGO	Non Government Organisations
NHV	Negative Horizontal Ventilation
NPC	National Population Commission
NPCK	National Potato Council of Kenya
NPK	Nitrogen, Phosphorus, and Potassium
NRI	Natural Resources Institute
OFSP	Orange-fleshed sweetpotato
P	Phosphorous
PMCA	Participatory Market Chain Approach
PMS	Primary Multiplication Site
PPP	Public Private Partnership
PVC	Polyvinyl chloride
QDPM	Quality Declared Planting Material
QDS	Quality Declared Seed
RAC	Reaching Agents of Change
RAE	Retinol Activity Equivalents
RCT	Randomised Control Trial
RDA	Recommended Daily Allowances
RE	Retinol Equivalents
REU	Reaching End Users
RH	Relative Humidity
SASHA	Sweetpotato Action for Security and Health in Africa
SDC	Swiss Agency for Development and Cooperation
SMS	Secondary Multiplication Site
SP	Sweetpotato
SPCSV	Sweetpotato chlorotic stunt virus
SPFMV	Sweet potato feathery mottle virus

SPHI Sweetpotato for Profit and Health Initiative
SPKP Sweetpotato Knowledge Portal
SPVD Sweetpotato Virus Disease
SSA Sub-Saharan Africa
SUA Sokoine University of Agriculture
TFNC Tanzania Food and Nutrition Centre
ToT Training of Trainers
TMS Tertiary Multiplication Site
Tshs. Tanzanian Shillings
TSNI Towards Sustainable Nutrition Improvement
UN HABITAT United Nations Human settlement Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
UNICEF United Nations Children's Fund
UNU United Nations University
USA United States of America
USAID United States Agency for International Development
USD United States Dollar
USDA United States Department of Agriculture
Ushs. Ugandan Shillings
USIM United States Institute of Medicine
VAD Vitamin A Deficiency
WAP Weeks After Planting
WFP World Food Program
WHO World Health Organisation
WTP Willingness To Pay

Contents

How to use this manual

This manual contains '*Everything you ever wanted to know about sweetpotato*'. We hope that it will be useful for those involved in training extensionists and NGO staff at different levels, and that they in turn will train farmers in practical ways that help them to build their problem solving and decision-making skills so they can continue to learn, question, test and address different opportunities and challenges relevant to their livelihoods.

The manual consists of fourteen topics which, after the initial two topics on training and the origin and importance of sweetpotato, follow the sweetpotato crop cycle. Each topic discusses the key need to know aspects highlighting the relevant gender issues and then presents suggestions for how this topic might be incorporated in a 10 day ToT course, with step by step guidelines for several hands-on learning-by-doing activities. The last two topics focus on the ToT training course programme and preparations. The fourteen topics are:

Topic 1: Helping Adults to Learn discusses the characteristics of good facilitators, and provides suggestions to help improve one's facilitation skills. It covers how to plan a training course from the needs assessment, through the development of learning outcomes, awareness raising, participant selection, development of the programme, use of discovery-based/ experiential learning approaches, follow-up and long-term monitoring and scaling up and out. The learning-by-doing activities involve the participants practicing their facilitation skills while delivering different sweetpotato topics and understanding the importance of evaluating their training.

Topic 2: Origin and Importance of Sweetpotato describes the historical origins and spread of sweetpotato and presents an overview of the current uses of and production figures for sweetpotato across the world.

Topic 3: Sweetpotato Varietal Selection and Characteristics. Sweetpotato roots range in colour from purple to orange to yellow or white. A wide diversity of leaf shapes, root sizes and shapes, tastes, textures, maturity periods and flesh colours also exist. Farmers use such characteristics to select which varieties to grow. A method for comparing the different characteristics of different varieties on-farm is described.

Topic 4: Orange-fleshed Sweetpotato and Nutrition. An overview of food groups and good nutrition is given, followed by discussion of the consequences of poor nutrition including vitamin A deficiency and the use of conventional breeding to biofortify crops. The benefits of eating orange-fleshed sweetpotato are discussed along with the complexities of trying to create demand for foods that help address frequently unrecognised nutritional problems such as vitamin A deficiency.

Topic 5: Sweetpotato Seed Systems are reviewed including the different seed multiplication levels, the roles of the different stakeholders within the system. The factors influencing decisions on whether to use a single shot or an ongoing planting material dissemination approach, and the level of subsidisation required are discussed. Examples are given for planning different types of planting material multiplication and dissemination strategies. Methods for selecting clean planting materials and then conserving and multiplying them are presented.

Topic 6: Sweetpotato Production and Management covers the importance of advanced planning to ensure sufficient planting materials are available at the start of the rains, land preparation, planting methods, intercropping, nutrients needs, the main growth stages and their associated management tasks.

Topic 7: Sweetpotato Pest and Disease Management explains how recognising the lifecycles of the damaging insect pests and diseases such as the sweetpotato weevil (*Cylas* spp.) and viruses can help farmers learn how to manage them more successfully. The signs and management strategies for mole rats and erinose are also discussed.

Topic 8: Harvesting and Postharvest Management. The physical damage caused during harvest and transport can reduce the shelf-life and value of sweetpotato roots. Over-drying and prolonged storage can reduce the beta-carotene content of dried orange-fleshed sweetpotato products. Good postharvest handling and storage practices for dried products are discussed, and methods for curing and storing fresh roots to increase their quality, value and availability are presented.

Topic 9: Processing and Utilisation. Many delicious, nutritious and potentially profitable food products can be prepared from orange-fleshed sweetpotato. The use of sweetpotato as animal feed is also discussed.

Topic 10: Marketing and Entrepreneurship. The concepts of marketing, market orientation, entrepreneurship, and the 5 pillars of marketing (product, price, price, promotion and people) are discussed in relation to fresh sweetpotato roots and sweetpotato products.

Topic 11: Gender and Diversity Aspects. The importance of recognising gender and diversity issues in agriculture and sweetpotato systems is discussed. Situations where sweetpotato is grown as a female crop, and others where it is grown as a male crop, or grown by both men and women are presented along with the different constraints, needs and priorities of female and male farmers. Best practice suggestions are made for how gender can be incorporated into sweetpotato programmes.

Topic 12: Monitoring of OFSP Dissemination and Uptake. An explanation of the reasons for monitoring and the differences between monitoring and evaluation is provided. This is followed by a range of tools which can be used for monitoring the dissemination, performance and use of sweetpotato planting materials. In order to understand the long-term impacts and reach of sweetpotato training it is important that records are kept on who has been trained. These records can be used for follow up activities.

Topic 13: Using the 'Everything you Ever Wanted to Know about Sweetpotato' ToT course. Detailed programs for a 10 day and a 5 day learning-by-doing ToT course are presented. They describe: the topics to be covered each day; the intended learning outcomes; the sequential activities and their timing; and the materials and advanced preparations required. These programs are not intended to be prescriptive and we hope that facilitators will creatively adjust them to their participants needs.

Topic 14: Reflections. We hope that after field testing this manual trainers and participants will reflect on it and share their ideas for how it could be improved. Please send any suggestions you have to Jan Low j.low@cgiar.org and where possible we will incorporate them into new editions.

TOPIC 4: ORANGE-FLESHED SWEETPOTATO (OFSP) AND NUTRITION

IN

EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

Contents

Topic 4: Orange-fleshed Sweetpotato and Nutrition

4.1 What is good nutrition?

Good nutrition means eating balanced meals that contain a variety of foods and nutrients. People select the foods they eat for many reasons such as taste, level of hunger, food availability, convenience, affordability and socio-economic status. However, we need to eat a mixture of foods of appropriate quantity, quality and combination to have a healthy body. Our bodies need foods that give us energy, promote growth, repair tissues, store energy and protect us from diseases.

The foods we eat are typically categorised into four main groups based on nutrient type and function.

- **carbohydrates** (energy giving)
- **proteins** (body building)
- **fats** (energy storage, insulation)
- **vitamins and minerals** (body protective)

In addition to foods in these four categories, we also need to eat **fibre,** which helps to move food through the digestive track, and to drink **water,** which is a key component in many bodily functions.

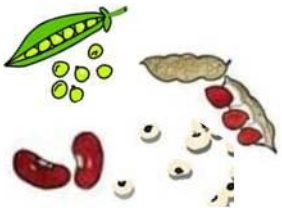
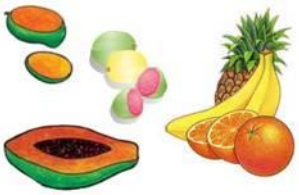
The first three groups, carbohydrates, proteins and fats are called *macronutrients* because they are needed in large amounts. Vitamins and minerals are called *micronutrients* because they are needed in small amounts. Even though micronutrients are only needed in small amounts they play important functions in the body and are essential for normal metabolism, growth and physical well-being. An individual's nutrient requirements vary depending on their age, gender, activity level, health status, and whether they are pregnant or lactating. To achieve a balanced diet and stay healthy, people must eat a variety of foods from each of these four food groups every day as illustrated in the following box.

carbohydrates (*energy giving food*)
+
proteins (*body building food*)
+
fats (*energy storage and insulation food*)
+
vitamins + minerals (*body protective food*)
=
Balanced and Healthy Diet

A balanced diet is one that provides an adequate amount and variety of foods to cover the energy and nutrient needs of the person eating it.

Nearly all foods contain a mixture of multiple nutrients. However, generalized classifications are commonly used to help people understand which types of foods typically provide which nutrients. Table 4.1 shows examples of which foods are good sources of which nutrient types. The recommended daily intakes of energy and key nutrients for individuals of different ages, sexes and conditions are shown later in Table 4.3.

Table 4.1 Overview of which foods are good sources of which nutrient types

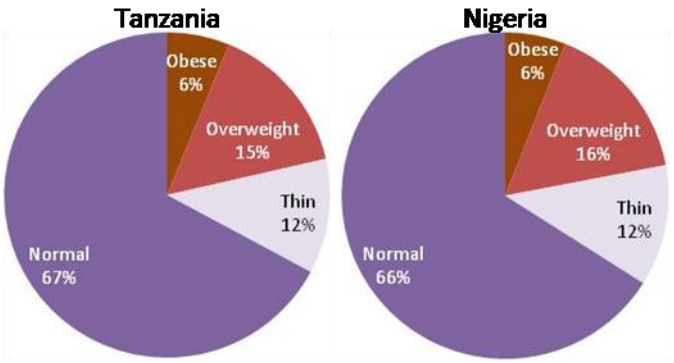
Nutrient types	Foods which are good sources of this nutrient type		
Carbohydrates *(energy giving)*	Roots, tubers and plantains	Sweetpotato, cassava, potato, yam, plantain, taro	
	Cereals and cereal products	Millet, sorghum, maize, wheat, rice, bread, biscuits, breakfast cereals, local dishes prepared with cereals (e.g. porridge, chapati)	
Proteins *(body building)*	Pulses, seeds and nuts	Beans, cowpeas, peas, pigeon peas, groundnuts, soya	
	Meat, poultry, fish, milk and milk products	Milk, eggs, goat meat, beef, chicken, pork, fish, flying ants/termites, mice, ice cream, yoghurt, infant formula, cheese	
Fats *(energy storage)*	Oils and fats	Groundnuts, soya flour, avocado, palm oil, sunflower oil, other cooking oils, pumpkin seed, margarine, coconut, sesame, olive oil	
Vitamins and Minerals *(body protective)*	Fruits	Mango, pawpaw/papaya, bananas, wild fruits, oranges, watermelon, pineapples, passion fruit, guava	
	Vegetables	Orange-fleshed sweetpotato, green leafy vegetables (e.g. Amaranth, Chinese cabbage, cassava leaves, pumpkin leaves, cowpea leaves, sweetpotato leaves, indigenous vegetable leaves e.g. *mlenda*, *mnafu*, *fweni*), tomatoes, carrots, pumpkins, green pepper, okra, cabbage, eggplant, cucumber, onions, garlic, green/ immature maize	

4.1.1 What are the consequences of poor nutrition?

Poor nutrition, or malnutrition, can have severe health effects. Economic growth and human development require well-nourished populations who can learn new skills, think critically and contribute to their communities. Adequate nutrition is particularly essential in early childhood to ensure healthy growth, proper organ formation and function, a strong immune system, and neurological and cognitive development. Malnutrition can be due to undernutrition (deficiencies in macronutrients and/or micronutrients) or overnutrition (e.g. obesity) (Figure 4.1).

Macronutrient deficiency refers to a lack of the nutrients which the human body requires in large amounts for normal growth and development, such as carbohydrates, proteins and fats. Macronutrient deficiency can lead to conditions such as stunting (low height to age) or wasting (low weight to height), and can occur due to a lack of food, poor quality of food, gastrointestinal illnesses (e.g. parasites or diarrhoea), poor sanitation, or chronic illness.

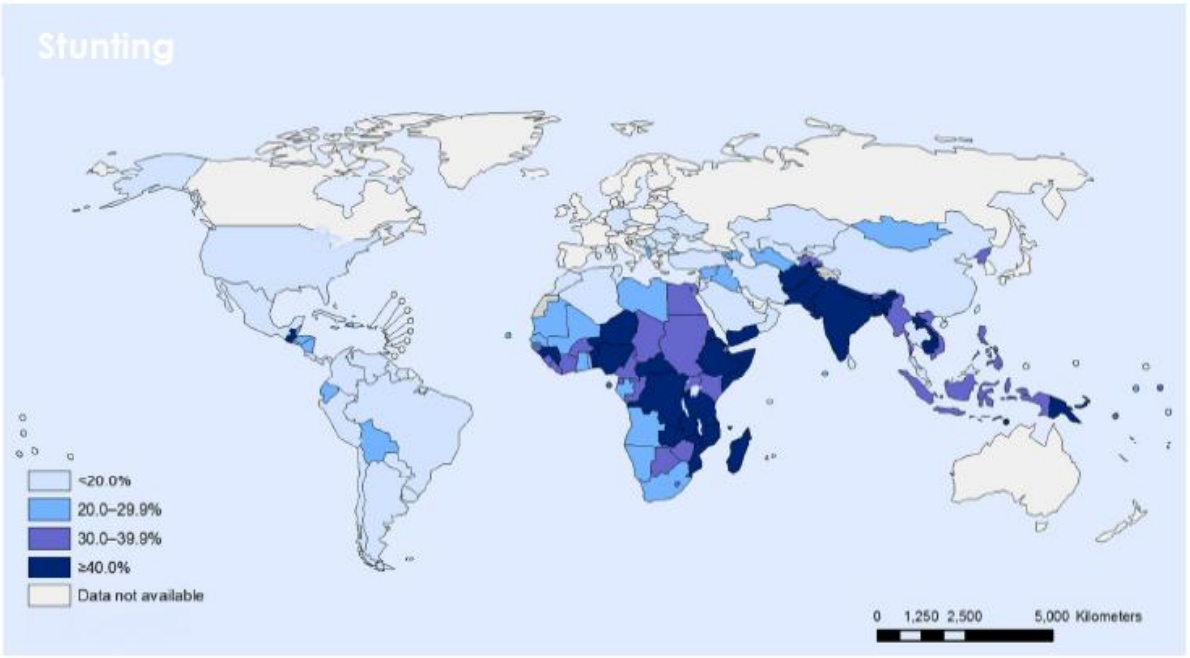
Figure 4.1 Women's nutritional status:
Percent distribution of women age 15-49



Source: National Demographic Health Surveys: 2010, 2008

Globally, an estimated 165 million children under-five years of age, or 26%, were stunted in 2011 — a 35% decrease from an estimated 253 million in 1990. The geographic prevalence of this stunting is shown in Figure 4.2. Thirty six percent of African children under 5 years old are stunted. Stunting is used as an indicator of chronic malnutrition. One-third of the deaths of under-five years old deaths are believed to be attributable to undernutrition.

Figure 4.2 Country prevalence estimates for stunting among children under-five years of age



Source: UNICEF et al., 2012

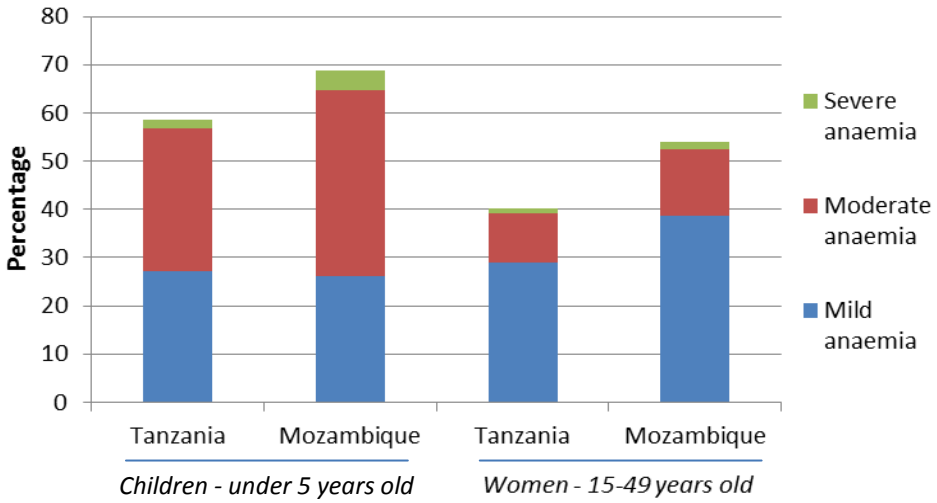
Micronutrient deficiency refers to a lack of vitamins and/ or minerals. Deficiencies in micronutrients, specifically, are detrimental to growth, immunity and overall health and are most common in children and women of reproductive age.

For example:

- Iron deficiency limits the mental capabilities of 2 billion children worldwide and is linked to approximately 25 percent of maternal deaths in developing countries.
- Iodine deficiency causes brain damage in almost 18 million newborns per year and is the primary cause of preventable mental disability.
- Vitamin A deficiency causes 500,000 children to go blind and kills almost 670,000 children under five years of age each year.
- Approximately 150,000 newborns experience acute birth defects each year as a result of folate deficiency.
- An estimated one-third of the world lives in areas at high-risk for zinc deficiency, which can result in decreased immunity and increased mortality from infections such as diarrhoea, particularly in children.

Over one-third of the world's population or over 3 billion people in 2013 are affected by deficiencies in the key micronutrients such as iron, iodine, vitamin A, folate and zinc. The high incidence of anaemia (iron deficiency) amongst young children and women in Tanzania and Mozambique is shown in Figure 4.3. National demographic health surveys typically record information on the specific micronutrient-rich types of food eaten by young children and women in the preceding 24 hours, and on any additional micronutrient supplements received. A summary of this data for the intake of vitamin A, iron and iodine rich foods and supplements in Tanzanian and Nigeria is shown in Table 4.2.

Figure 4.3. Anaemia (lack of iron) incidence in Tanzania and Mozambique



Source: National Demographic Health Surveys: 2010, 2011

Table 4.2. Intake of Vitamin A, Iron and Iodine rich foods and supplements by young children and women in Tanzania and Nigeria

	Micronutrient rich food use			Micronutrient supplement use		
	% who in the 24 hours prior to the survey ate foods rich in			*% of children 6-59 months old*		
	Children 6-35 months old		Women 15-49 years			
	Vitamin A	Iron	Vitamin A	given vitamin A supplements in the last 6 months	given iron supplements in the past 7 days	living in households with iodised salt
Tanzania	61.5	29.8	62.0	60.8	1.4	55.2
Nigeria	69.6	57.8	66.8	25.8	15.7	52.9

Source: National Demographic Health Surveys: 2010, 2008

In order to address widespread global malnutrition, a number of organizations including the World Health Organisation (WHO), the Food and Agriculture Organization (FAO) and the United States Institute of Medicine (National Academy of Sciences) have developed Recommended Daily Allowances (RDAs) and Adequate Intakes (AIs) of nutrients specific to an individual's age and reproductive status, Table 4.3 provides a summary of these.

The consistency of a food type has implications for its nutrient density; the amount of micronutrients in a particular food in relation to its total energy and in relation to the body's requirements. For instance a cup of thick porridge will have more nutrients than a cup of thin/watery porridge. The combination of the ingredients used to make the particular food will also determine the nutrient content. High nutrient density meals are particularly important for groups of people who typically eat small portion sizes such as young children, the elderly or people who are sick.

Table 4.3 Daily recommended individual intakes for energy and key nutrients

	Body Weight	Energy		Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
SEX/AGE	kg	kcal	MJ	g	g	mg	mg	mcg RAE	mg	mcg DFE
BOTH SEXES (Breastfed 1st year of life)										
0-6 months	6.0	524	2.19	9.1	ND	0.27	2	400	40	65
6-11 months	8.9	708	2.97	11	ND	11	3	500	50	80
1-3 years	12.1	1,022	4.28	13	19	7	3	300	15	150
4-6 years	18.2	1,352	5.66	19	25	10	5	400	25	200
7-8 years	25.2	1,698	7.1	19	25	10	5	400	25	200
GIRLS										
9-13 years	46.7	2,326	9.73	34	26	8	8	600	45	300
14-18 years	46.7	2,326	9.73	46	26	15	9	700	65	400
BOYS										
9-13 years	49.7	2,824	11.81	34	31	8	8	600	45	300
14-18 years	49.7	2,824	11.81	52	38	11	11	900	75	400
WOMEN	55.0									
19-59 years		2,408	10.08	46	25	18	8	700	75	400
Pregnant		*plus* 278	*plus* 1.17	71	28	27	11	770	85	600
Breastfeeding		*plus* 450	*plus* 1.90	71	29	9	12	1,300	120	500
60 & over		2,142	8.96	46	21	8	8	700	75	400
MEN	65.0									
19-59 years		3,091	12.93	56	38	8	11	900	90	400
60 & over		2,496	10.44	56	30	8	11	900	90	400

Sources:
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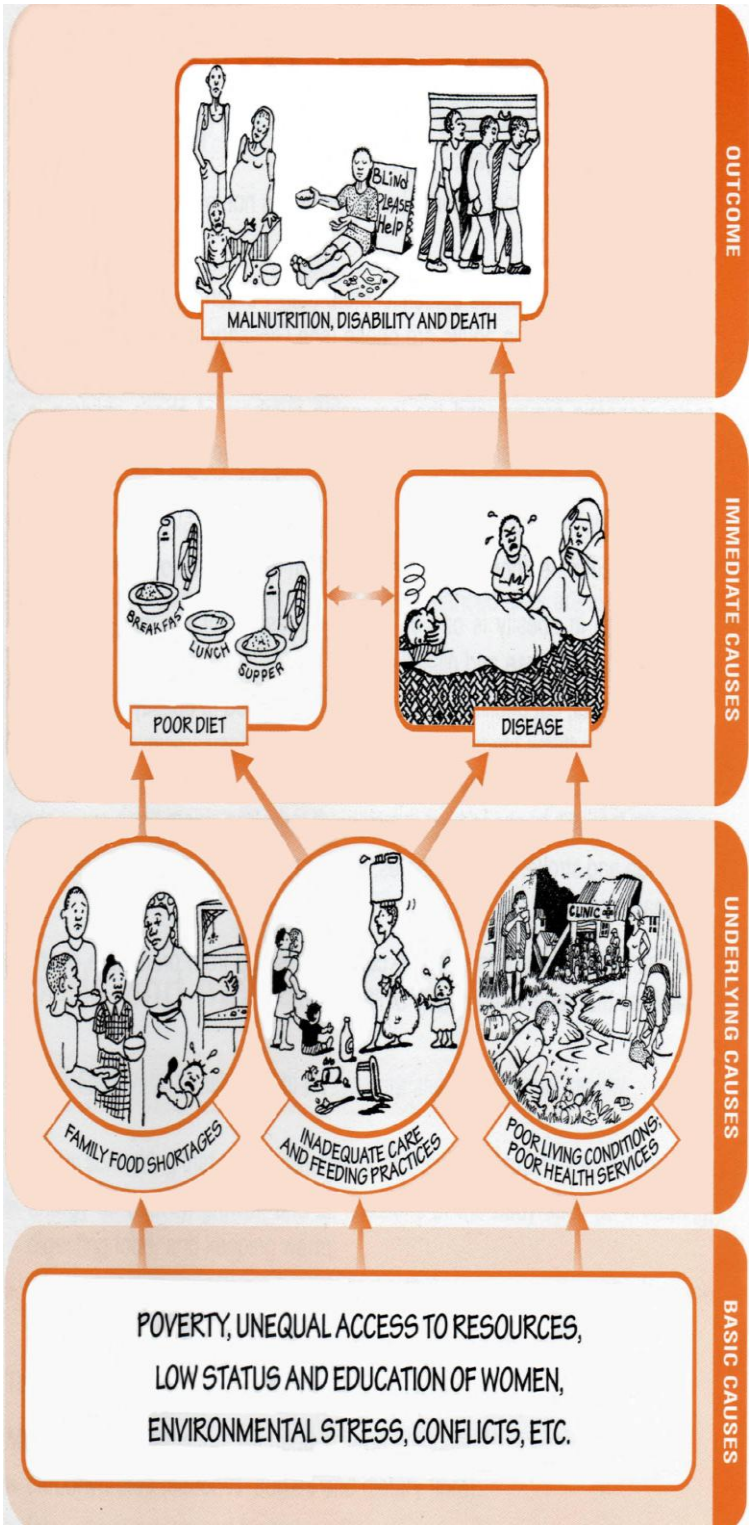
2)-4) Accessed via www.nap.edu.
kcal= kilocalorie; MJ = megajoules (1000 kcal = 4.18 MJ)
RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate = 0.6 mcg folic acid from fortified food or as a supplement taken with food.

4.1.2 What are the causes of malnutrition?

There are many reasons why people become undernourished. The causes are typically divided into immediate, underlying and basic causes as described in Figure 4.4.

Figure 4.4 Immediate, underlying and basic causes of malnutrition



Poor diet, due to: insufficient breastmilk; meals that are too small; poor variety of food; low concentrations of energy and nutrient in meals (too watery); infrequent meals

Disease. Sick people may: not eat much; absorb few nutrients; lose nutrients from the body; use up nutrients in the body more quickly (e.g. during fever)

Food shortages, due to: lack of money; low food production; poor food storage and preservation; poor choices and budgeting

Inadequate care and feeding practices: for young children, pregnant or breastfeeding women and sick and old people; poor hygiene and food preparation; poor prevention and treatment of illnesses and use of health facilities

Poor living conditions (e.g. insufficient water, inadequate sanitation and over-crowded housing) and poor health services

Overburdened women, with little control of resources

The deeper causes include: widespread poverty and lack of employment opportunities; unequal distribution and control of resources at community, district, country and international levels; low status and education of women; population pressures; environmental damage; political unrest and conflict; lack of health, education and other social services; and discrimination

Source: Adapted from UNICEF Framework in FAO (2004) Family Nutrition Guide

4.1.3 Approaches for addressing malnutrition

There are multiple strategies for addressing malnutrition, many of which can be managed within the home. One is by preparing balanced and nutritious meals. This does not need to be difficult or time consuming. Many nutrient rich foods can be prepared in advance. For example, nuts and millet can be ground beforehand. Nutrient rich foods, such as groundnut or sesame/simsim pastes, can also be added to any household's normal meal.

A good/balanced meal should contain:

1. An energy giving food listed in Table 4.1 above (e.g. cereals, sweetpotato or cassava roots, plantain)

2. Other foods that may be made into a sauce, stew or relish. These should include:

    a. legumes (beans/groundnuts) or foods from animals (meat, eggs, milk, etc.)

    b. at least one vegetable

    c. some fat or oil (but not too much) to increase the energy intake and improve taste

It is also good to eat fruits with a meal or as a snack and to drink plenty of water during the day. Try and vary which fruits and vegetables are eaten at different meals because different fruits and vegetables vary in the amount and kind of micronutrients they have. Care must be taken to store food safely and to prepare food hygienically, good hand washing before food preparation and eating can help to reduce the chances of illness resulting from contamination.

Malnutrition resulting in micronutrient deficiencies can be addressed using various approaches. These include supplementation, food fortification, crop *bio*fortification, dietary diversification, nutrition education and improved agricultural productivity. In many scenarios more than one of these approaches can be implemented either concurrently or sequentially.

Supplementation generally involves taking a tablet or capsule containing a sufficient amount of the deficient micronutrient(s) while artificial food fortification involves the addition of the micronutrient(s) to a food which can then be consumed. Foods that are fortified with micronutrients are often common household staples such as flour, cereals, vegetable oil, sugar and salt. Crop *bio*fortification refers to adding at least one important micronutrient in a significant amount to a staple food crop. Orange-fleshed sweetpotato (OFSP) varieties are those sweetpotato varieties that are naturally very rich in pro-vitamin A. Supplementation, food fortification, crop *bio*fortification, and the promotion of diet diversification, nutrition education and improved agricultural productivity are recommended interventions in countries where micronutrient deficiency is a health concern.

While large-scale implementation of food fortification is commercially sustainable, on its own it is not sufficient to address micronutrient deficiency. This is because the available fortified foods do not always meet the needs of potential consumers due to the diversity of consumers' micronutrient needs. The currently available fortified foods have been developed to provide micronutrient amounts appropriate for the average adult. Since micronutrient requirements differ based on a variety of factors such as age and health status, the fortified foods do not meet the needs of all populations (see Table 4.3). For example, fortified foods do not provide the high levels of micronutrients that children and pregnant women need for growth and reproduction functions. Access is also a problem because fortified foods are only accessible to those populations who regularly purchase packaged foods. Some of the pros and cons of the different approaches for addressing micronutrient deficiencies such as vitamin A deficiency are presented in Table 4.4.

Table 4.4 Pros and cons of different approaches for addressing micronutrient deficiencies

Approach	Pros	Cons
Supplementation e.g. high dose vitamin A capsule given to children 6-59 months old, twice per year	Can use a high-dose twice per year to reach a large population of young children, cost effectively if combined with effective health delivery programmes.	Targeted, difficult to reach the hard to reach population. Universal coverage hard to sustain. Risk that it inhibits the development of alternative and more sustainable programmes.
Food fortification e.g. cooking oils, sugar, flours, margarine, infant foods fortified with vitamin A	One input point (industry) can reach many people every day	Requires Public private partnership (PPP); may not reach all consumers; requires enforcement and strong political commitment; there have been difficulties sustaining these programmes
Crop *bio*fortification e.g. use of orange-fleshed sweetpotato varieties	Reaches rural areas Owned and managed by farmers	Takes time to obtain specific breeding qualities, and for promotion and uptake/ adoption to occur. Public awareness needed.
Dietary diversification e.g. consumption of a wide variety of foods including some which contain high levels of vitamin A	Long term impact as it embeds behavioural patterns that combat deficiency; complementarity with many other objectives; requires no external inputs	Requires public education and awareness about diets and nutrition; high start-up costs

In order to understand why eating orange-fleshed sweetpotato can promote good nutrition, it is important to learn more about vitamin A, one of the key micronutrients discussed in the previous sections.

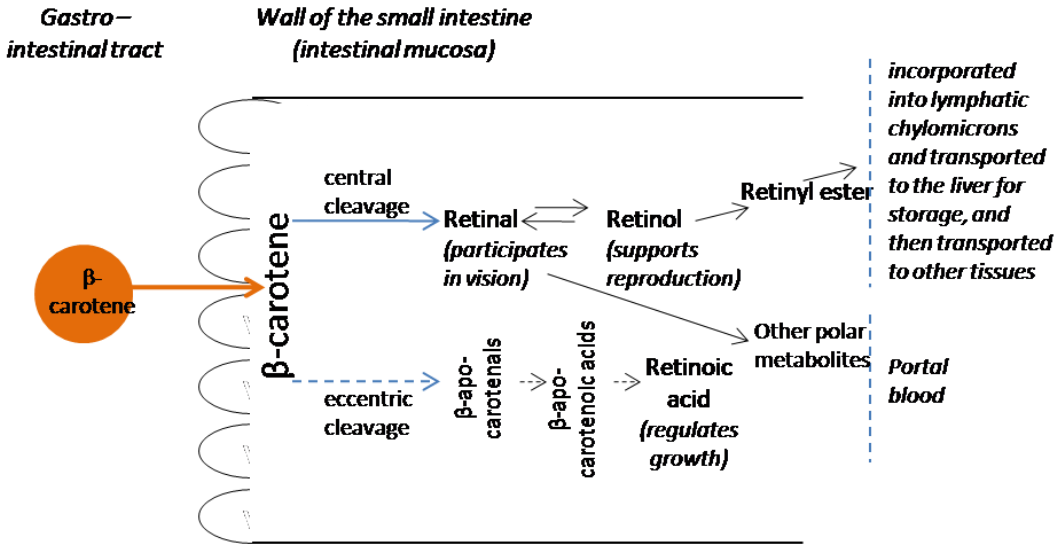
4.2 The importance of vitamin A

4.2.1 Functions of vitamin A

Vitamin A provides a variety of benefits for the body. It is essential for good vision, healthy skin, bone growth, reproduction, cell division and cell differentiation. Vitamin A also improves the body's immunity so that it is better able to resist infections. Some pro-vitamin A carotenoids also function as antioxidants, which help to protect our bodies against chronic diseases and premature ageing. When vitamin A rich foods are consumed, the body stores any extra vitamin A in the liver. If these stocks remain high, they will provide a reserve of vitamin A when intake is not sufficient, thus protecting the body from vitamin A deficiency.

In the human body, the β-carotene consumed is converted to vitamin A compounds in the wall of small intestine (see Figure 4.5).

Figure 4.5. Conversion of β-carotene to vitamin A compounds in the intestinal mucosa

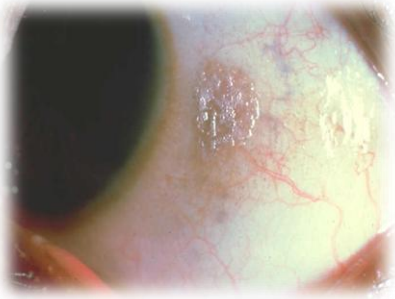


Source: adapted from Mulokozi, 2003.

4.2.2 Vitamin A deficiency

As described above, vitamin A deficiency is a serious public health problem in Sub-Saharan Africa. The most recent statistics indicate that 42% of children under five years old in Sub-Saharan Africa are deficient in vitamin A. This has a significant public health impact because children with vitamin A deficiency are at a higher risk for mortality from measles, diarrhoea and malaria. Young children are particularly at risk of vitamin A deficiency because: they are growing fast and so their vitamin A needs are greater; they get more infections; and they are often not fed enough of the right kinds of foods to meet their daily nutrient needs.

The consequences of vitamin A deficiency are significant, especially for children. If children do not get



enough vitamin A, either through eating vitamin A-rich foods or supplementation, they are at risk of developing night blindness (inability to see at dusk and in dim light), dry eye membranes (*xeropthalmia*), body development disorders and a compromised or weakened immune system. Weakened immunity hinders the body's ability to fight potentially fatal infections like measles and pneumonia. The consequences are explained in more detail in Table 4.5. It should be noted that a child can look perfectly healthy and still be vitamin A deficient, and may have no clinical signs of vitamin A deficiency (eye problems) until the deficiency becomes very severe. Eye disease caused by vitamin A deficiency is not commonly seen, and the effects on growth and infection are far more significant.

Adults also experience significant consequences from vitamin A deficiency including a compromised immune system and a slower recovery time after illness. Pregnant and lactating women, like children, are at a high risk for vitamin A deficiency because they have an increased need for the micronutrient. During pregnancy, vitamin A maintains essential tissues and contributes to the health and growth of the foetus. Vitamin A deficiency in pregnant and lactating women can result in severe health concerns for both mother and child including stunted growth and higher risks of mortality and anaemia.

Table 4.5 Consequences of vitamin A deficiency

Consequence of VAD	Explanation
Poor child growth and development	Children with vitamin A deficiency often have a poor appetite and lose weight and, as a result, become malnourished. Children who are malnourished have a lower resistance to infection and they are more likely to fall ill than well-nourished children. During serious infections, such as measles and diarrhoeal diseases, children lose a lot of weight. Frequent infections are therefore often associated with poor child growth.
Increased risk of infection	Children who are vitamin A deficient are more prone to infection, especially gastrointestinal (causing diarrhoea) and respiratory infections.
Increased severity of infection	The severity of infections, particularly measles, is greater among children who are vitamin A deficient.
Death	Children who are vitamin A deficient are more likely to die than well-nourished children.
Eye-related problems	One of the earliest signs of vitamin A deficiency is night blindness, which means difficulty or inability to see in dim light such as at dusk or night. This can progress to structural eye damage such as Bitot's spots (foamy white patches on the white part of the eye) and, in severe cases, irreversible blindness.

Source: Faber et al., 2010

4.2.3 Sources of vitamin A

Fruits and vegetables are the body's primary sources of vitamin A. A food's vitamin A content is generally linked to physical appearance: the deeper the colour of a fruit, vegetable or root, the higher the concentration of vitamin A. For example, the brightly coloured orange flesh of some sweetpotato varieties indicates a high pro-vitamin A content. Other vitamin A-rich foods include: pumpkin, pawpaw, mangoes, carrots, red pepper, red palm oil, fruits of the Néré/ African locust tree/ mkunde (*Parkia biglobosa*) tree, butternut squash, Spinach (*Amaranthus viridis*), African breadfruit/ mabungo (*Treculia africana*), pumpkin leaves, Amaranth leaves (*Amaranthus*). Carrot and

orange-fleshed sweetpotato have much higher levels of vitamin-A than pumpkin, butternut squash and spinach (Table 4.6).

In order to maximize the benefit from vitamin A rich foods, it is important to eat them in combination with fats such as groundnuts, coconut milk, vegetable oil or margarine. Fats help the body absorb and use vitamin A. Just adding a teaspoon of oil to a meal with OFSP really improves absorption. Certain preparation methods, such as chopping spinach or grating carrots, can also assist the body in absorbing vitamin A.

In addition to the plant sources, some animal sources are also rich in vitamin A, including liver, whole milk, egg yolks, fish, fish oils and some artificially fortified food products (margarine, oil).

Table 4.6 Nutrient content of 100g edible portions of vitamin A-rich foods

Food	Water	Energy_Kcal	Protein	Lipid_Total	Carbohydrate	Fibre_TD	Calcium	Iron	Magnesium	Phosphorus	Potassium	Zinc	Vitamin C	Thiamine	Riboflavin	Niacin	Vitamin B6	Folate_Total	Vitamin A (RAE)	Vitamin K
Unit	gm	kcal	gm	gm	gm	gm	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	mg	ug	ug	ug
Pumpkin, raw	91.6	26	1.0	0.1	6.5	0.5	21	0.8	12	44	340	0.32	9	0.05	0.11	0.6	0.06	16	369	1.1
Squash, cooked	91.1	30	1.5	0.4	6.5	2.9	10	0.3	13	14	214	0.1	6.5	0.04	0.03	0.3	0.10	10	200	
Yellow fleshed SP, cooked	80.1	76	1.4	0.1	17.7	2.5	27	0.7	18	32	230	0.2	12.8	0.06	0.05	0.5	0.17	6	162	2.1
OFSP, cooked	80.1	76	1.4	0.1	17.7	2.5	27	0.7	18	32	230	0.2	12.8	0.06	0.05	0.5	0.17	6	788	2.1
Carrots, cooked	90.2	35	0.8	0.2	8.2	3	30	0.3	10	30	235	0.2	3.6	0.07	0.04	0.6	0.15	2	845	14
Amaranthus leaf, cooked	91.5	21	2.1	0.2	4.1		209	2.3	55	72	641	0.88	41.1	0.02	0.13	0.6	0.18	57	139	
Pumpkin leaves, cooked	92.5	21	2.7	0.2	3.4	2.7	43	3.2	38	79	438	0.2	1	0.07	0.14	0.8	0.20	25	80	108
SP leaves, cooked	88.7	34	2.3	0.3	7.3	1.9	24	0.6	61	60	477	0.26	1.5	0.11	0.27	1.0	0.16	49	46	109
Mango, raw	81.7	65	0.5	0.3	17.0	1.8	10	0.1	9	11	156	0.04	27.7	0.06	0.06	0.6	0.13	14	38	4.2
Papaya, raw	88.8	39	0.6	0.1	9.8	1.8	24	0.1	10	5	257	0.07	61.8	0.03	0.03	0.3	0.02	38	55	2.6
Milk, whole fat	88.3	60	3.2	3.3	4.5	0	101	0.0	10	84	133	0.38	0	0.04	0.18	0.1	0.04	5	28	0.2
Egg, hard boiled	74.6	155	12.6	10.6	1.1	0	50	1.2	10	172	126	1.05	0	0.07	0.51	0.1	0.12	44	169	0.3
Chicken, stewed	53.1	285	26.9	18.9	0.0	0	13	1.4	20	180	182	1.77	0	0.09	0.24	5.8	0.25	5	39	
Lamb, LIVER, cooked	56.7	220	30.6	8.8	2.5	0	8	8.3	22	420	221	7.89	4	0.23	4.03	12.2	0.49	73	7491	

** OFSP = Orange-fleshed sweetpotato* *Source: USDA, 2003*

4.3 Why eat orange-fleshed sweetpotato?

4.3.1 Orange-fleshed sweetpotato as a source of vitamin A

Orange-fleshed varieties of sweetpotato are excellent sources of vitamin A because they have naturally high beta-carotene levels. The human body can easily transform beta-carotene, a natural pre-cursor of vitamin A, into vitamin A as needed (see Figure 4.5).

One small-to-medium boiled root (~125g or ~½ -1 cup) of most orange-fleshed sweetpotato varieties can supply the recommended daily amount of vitamin A for young children and non-breastfeeding women. This is particularly important in Sub-Saharan Africa and Asia where vitamin A deficiency is among the leading causes of blindness, disease and premature death among children under five and pregnant women.

Consumption of orange-fleshed sweetpotato during the seasons when it is available builds up the body's stores of vitamin A. If more vitamin A is consumed than can be immediately utilised, excess vitamin A is stored in the liver for several months. This enables the body to build up a reserve to avoid vitamin A deficiency during the times when access to vitamin A rich foods is limited.

Different sweetpotato varieties have different concentrations of beta-carotene. Orange-fleshed sweetpotato roots have a nutritional advantage over white- or cream-fleshed sweetpotato roots because their beta-carotene, and therefore vitamin A, content is higher. This is evidenced by the deep orange colour of the sweetpotato flesh, which is related to the higher beta-carotene and

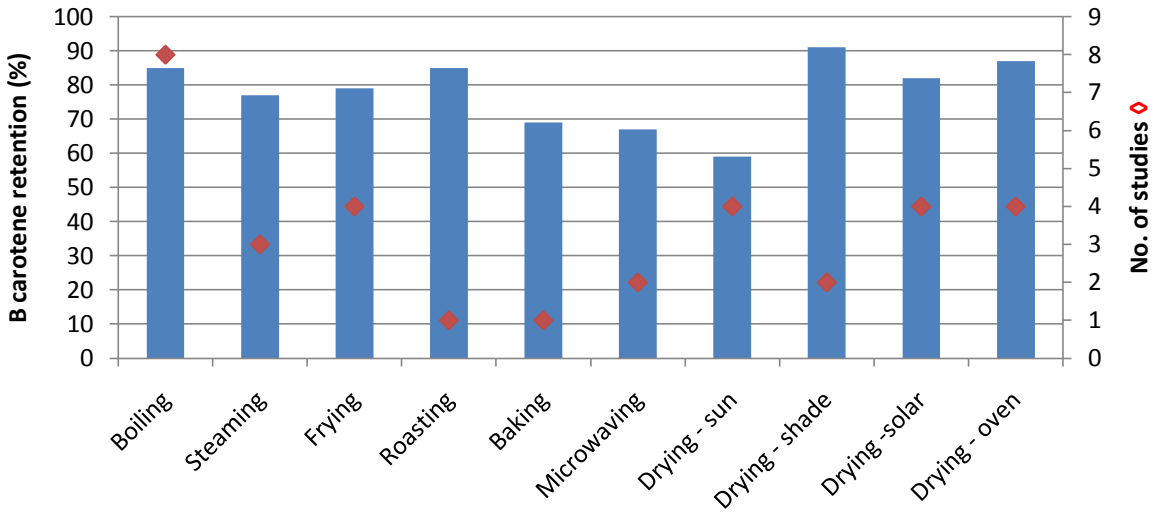
vitamin A content. The highest beta-carotene and vitamin A content is found in the deepest or most bright orange-fleshed varieties (see Beta-carotene colour chart in Appendix 3.2).

Orange-fleshed sweetpotato roots are also a recommended source of vitamin A because they are inexpensive. Studies in Zambézia province, Mozambique found orange-fleshed sweetpotato to be the cheapest source of vitamin A in the study region's food system. In this area, it costs less than one cent per day to meet the recommended daily allowance of vitamin A for a child under six years through the consumption of orange-fleshed sweetpotato.

In considering the orange-fleshed sweetpotato as a source of vitamin A, it should be noted that the cooking, drying and storage processes can affect the beta-carotene content and therefore the degree of vitamin A available during consumption. The findings from several studies on beta-carotene retention with different cooking and drying processes are combined in Figure 4.6. This data shows that with most cooking methods (boiling, steaming, frying and roasting) more than 75% of the beta-carotene in the root is retained. In the few available studies baking and micro-waving led to slightly higher losses. Drying of sweetpotato roots is an important food security strategy in many areas of Sub-Saharan Africa, the data in Figure 4.6 suggest that dried OFSP can act as a valuable source of vitamin A when other vitamin A rich foods are scarce. All the drying methods kept beta-carotene contents above 50% of those in the fresh roots, with sun-drying resulting in the highest beta-carotene losses. Sun-drying is currently the most common drying method practiced by smallholder rural households. While shade drying can improve the retention of beta-carotene it can also increase fermentation in the drying products. The thickness of the slices of sweetpotato and the depth of the layer or loading (g/m^2) also influence drying speeds and beat-carotene retention. In solar drier trials, wide slices (~5mm thick) and thin loads (~430 g/m^2) had much higher beta-carotene retention rates than narrow slices (~3mm thick) and thick loads (~715g/m^2).

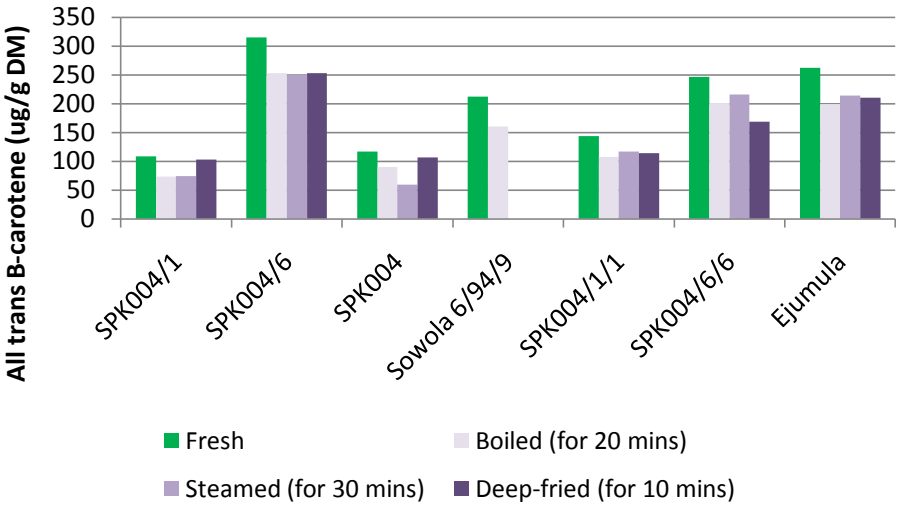
A comparison of beta-carotene contents of seven improved OFSP cultivars when boiled, steamed or fried is shown in Figure 4.7. These cooking methods retained most (>68%) of the beta-carotene in the fresh roots, however to maximise vitamin A intake roots of OFSP varieties with high initial beta-carotene contents should be consumed. If boiling or steaming OFSP roots, beta-carotene retention is improved by covering the pot with a lid and keeping the cooking period as short as possible, for leaves see section 4.3.3 and Table 4.11. It is assumed that boiling small or peeled pieces of OFSP roots increases the beta-carotene loss compared to boiling whole unpeeled OFSP roots, due to both the reduced surface area and the peel's protective effect. A detailed overview of sweetpotato storage and post-harvest practices appears in Topics 8 and 9.

Figure 4.6 Average beta-carotene retention and number of studies by OFSP processing technique



Source: Boy, 2009

Figure 4.7 Total trans beta-carotene in different Uganda OFSP cultivars before and after cooking



Source: Bengtsson et al., 2008

4.3.2 Other nutritional benefits of orange-fleshed sweetpotato roots

Orange-fleshed sweetpotato roots are a nutritious food for many reasons. In addition to providing high levels of vitamin A, orange-fleshed sweetpotato roots contain high levels of vitamins B, C, E and K, all of which help protect our bodies and assist in the illness recovery process. Orange-fleshed sweetpotato roots also have a high carbohydrate content, allowing them to produce more edible energy per hectare per day than other common sources of carbohydrates such as rice and maize. A comparison of energy yields of orange-fleshed sweetpotato and other commonly grown African crops is shown in Table 4.7.

Table 4.7 Comparative energy yields of sweetpotato and other major crops

Crop	Average Tropical Yield (Tons/ Hectare)	Edible Energy Value (MJ/kg)	Proportion of Edible Energy (%)	Edible Energy per Hectare (10^3 MJ)	Mean Growth Period (Days)	Edible Energy (MJ/ha/day)
Sweetpotato	7	4,8	88	27,2	140	194
Cassava	9	6,3	83	45,6	330	138
Yam	7	4,4	85	26,2	280	94
Banana	13	5,4	59	41,4	365	113
Rice[b]	2	14,8	70	20,8	140	149
Maize	1	15,2	100	18,8	130	145
Sorghum	<1	14,9	90	11,1	110	101
Millet	<1	15,0	100	8,2	100	82

Source: Woolfe (1992), p. 4 Notes: de Vries *et al.*, 1967.[a] Cereals, air-dry; roots/tubers/bananas fresh. [b] Paddy Rice.

An overview of the nutrition-related characteristics of sweetpotato along with those for cassava, potatoes and yams is given in Table 4.8. A further nutritional comparison of roots and leaves of sweetpotato with cassava and maize is given in Table 4.9.

Table 4.8 Nutritional characteristics of sweetpotato, cassava, potatoes and yams

Characteristics	Sweetpotato root	Cassava root	Potato tuber	Yam tuber
Dry matter (% FW)	19-40	30-40	20-35	21-40
Starch (%FW)	6-20	27-36	20-30	18-25
Total sugars (%FW)	1.5-5.0	0.5-2.5	0-2.0	0.5-1.0
Protein (% FW)	1.5-2.5	0.5-2.0	2.0	2.5
Lipids (% FW)	0.5-6.5	0.5	0.1	0.2
Ash (% FW)	1.0	0.5-1.5	1.0-1.5	0.5-1.0
Energy (KJ/100 g)	490	607	318	439
Beta-carotene (ug/100 g)	0-30,000	0-900	Trace	84
Vitamin A (ug RAE/ 100g FW)	0-2500 (300-1200)*	0-75	Trace	0-7
Vitamin C (mg/100 g FW)	22-35	21-50	20-31	17-24
Iron (mg/100g)	0.19-0.65	0.27-1.9	0.34-1.01	0.54-2.4
Zinc (mg/100g)	0.09-0.46	0.34-1.4	0.28-0.95	0.24-2.25
Vitamin B1 (mg/100 g)	0.078	0.087	0.081	0.112
Vitamin B2 (mg/100g)	0.061	0.048	0.031	0.032
Vitamin B3 (mg/100g)	0.557	0.854	1.149	0.552
Vitamin B5 (mg/100g)	0.800	0.107	0.279	0.314
Vitamin B6 (mg/100g)	0.209	0.088	0.17	0.293
Vitamin E (mg/100g)	0.26	0.19	0.01	0.39
Vitamin K (mg/100g)	1.8	1.9	2.9	2.6
Calcium (mg/100g)	30	16	10-13	17

Anti-nutritional factors	Trypsin inhibitors	Cyanogens	Solanine	Alkaloids, tannins
Starch Extraction Rate (% FW)	10-15	22-25	8-12	Na
Starch Grain Size (microns)	2-42	5-50	15-100	1-70
Amylose (% total Starch)	8-32	15-29	22-25	10-30
Gelatinization temp. (°C)	58-85	49-73	63-66	69-88

Source: Scott *et al*., (2000) for all information except on vitamins and minerals.
USDA Food composition table, version 16 on vitamins and minerals.
Pfeiffer and McClafferty, (2007) on maximum values for beta-carotene, vitamin A, iron, and zinc.

Table 4.9 Nutritional composition of sweetpotato, cassava and maize

Nutrients	Units/ 100g	Sweetpotato				Cassava		Maize
		Orange fleshed raw roots	Yellow fleshed raw roots	White fleshed raw roots	Leaves, raw	Raw roots	Leaves	White flour
Vitamin A (RAE)	ug	727	150	3	51	1	115.4	0
Iron	mg	0.61	0.61	0.61	1.01	0.27	7.6	2.38
Zinc	mg	0.3	0.3	0.3	0.29	0.34		1.73
Thiamine (B1)	mg	0.078	0.078	0.078	0.156	0.087		0.246
Riboflavin (B2)	mg	0.061	0.061	0.061	0.345	0.048		0.08
Niacin (B3)	mg	0.557	0.557	0.557	1.13	0.854	2.4	1.9
Vitamin B6	mg	0.209	0.209	0.209	0.19	0.088		0.37
Folate (total)	ug	14	14	14	80	27		25
Vitamin E	mg	0.26	0.26	0.26		0.19		0.42
Vitamin C	mg	22.7	22.7	22.7	11	20.6	310	0
Protein	g	1.57	1.57	1.57	4	1.36	7	6.39
Fibre	g	3	3	3	2	1.8	4	9.6

Source:USDA, 2003.

4.3.3 Benefits of sweetpotato leaves and vines

Sweetpotato leaves and vines can also be eaten and, like the sweetpotato root, they have nutritional benefits. Sweetpotato leaves and vines are excellent sources of vitamins A, B (thiamine, niacin, and pyridoxine) and C and contain comparatively high levels of protein (~3% of fresh weight basis), calcium and antioxidants (see Table 4.10).

Sweetpotato leaves are commonly eaten as a vegetable dish throughout Sub-Saharan Africa with the exception of a few countries such as Kenya, Uganda and Nigeria where farmers prioritise using them for animal feed. They can be used as a backyard crop, harvested continuously to provide an on-going nutritional addition to meals.

Sweetpotato leaves are a convenient option because they are usually available during the dry season when there are few other vegetables present. People typically prefer the leaves of certain sweetpotato varieties over others, so it can be important to experiment with different varieties to determine personal preference. For example, in Tanzania and Malawi they prefer narrow leaves with deep lobes over those varieties with broader leaves. Depending on preference, the leaves can be consumed fresh or sundried. During harvesting, transport and marketing the leaves should be handled carefully to reduce bruising and kept in cool shady places, they should be utilised as rapidly as possible. The traditional drying technique involves placing fresh leaves to wither in the sun, parboiling them for 20-30 minutes after they have dried, removing the excess water and then sun-drying them. When cooking the fresh leaves, they should be cooked for the minimum time possible, and the water in which they were cooked should also be consumed, as it contains water-soluble vitamins lost by leaching. The effect of different processing methods on the β-carotene content of various leafy vegetables is shown in Table 4.11. Sweetpotato leaf recipes are given in Topic 10.

As discussed in this section, orange-fleshed sweetpotato roots and leaves have significant nutritional benefits. These natural nutritional benefits, along with their low cost and accessibility, make the orange-fleshed sweetpotato an ideal crop for cultivation.

Table 4.10 Comparison of protein, minerals, oxalate and vitamins in leafy vegetables (raw fwb)

	Total	Minerals			Oxalate	Vitamins						
Vegetable	protein (g/100g)	Ca (mg/ 100g)	Fe (mg/ 100g)	Zn (mg/ 100g)	(%)	B-carotene equiv.(ug)	Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Pyridoxine (mg)	Folic acid (ug)	Ascorbic acid (mg)
Sweetpotato leaves	2.9	183	2.4	0.5	0.37	2700	0.13	0.35	0.9	0.21	88	41-103
Sweetpotato tips		75	3.9			2290-7050		0.29-0.41	0.9			32-136
Amaranthus	2.8	176	2.8		0.82	6545	0.04	0.22	0.7		85	23
Cassava leaves	7.0	160	2.4		0.517	8280	0.16	0.32	1.8			82
Chinese cabbage						1200	0.04	0.14	0.5			40
Taro leaves	3.3	96	0.95		0.426	5535	0.13	0.34	1.5	0.19	163	63
Cabbage	1.9	44	0.4	0.3	0.002	trace	0.06	0.05	0.6	0.15	26	40

Source: Woolfe,1992; Stathers et al., 2005

Table 4.11 Comparison B-carotene content of leafy vegetables during processing (ug/g DW) -*Mulokozi (undated)*

		Blanched	Solar dried		Open sun-dried	
Leafy vegetable	n	(ug/g DW)	(ug/g DW)	%	(ug/g DW)	%
Mgagani	3	917 ± 55	776 ± 45	88	484 ± 31	53
Amaranth	3	677 ± 44	449 ± 46	66	367 ± 15	54
Cowpea	3	526 ± 58	462 ± 41	88	296 ± 25	56
Sweetpotato	2	771 ± 6	522 ± 23	68	425 ± 69	55
Pumpkin	2	630 ± 61	427 ± 2	68	264 ± 33	42
Ngwiba	2	554 ± 16	499 ± 17	90	308 ± 43	55
Nsonga	1	633	545	86	407	64
Maimbe	1	588	338	57	272	46
Mean ± SD		662 ± 128	502 ± 128	76	353 ± 80	53

4.4 Biofortification and the orange-fleshed sweetpotato

4.4.1 What are biofortified crops?

Biofortification is the process of breeding food crops to have a high micronutrient content. The technique is an approach to addressing micronutrient deficiency and allows low-income households to meet their micronutrient needs through their own food production. If eaten regularly, biofortified staple foods can contribute to the body's stores of micronutrients and prevent deficiencies. The advantage of biofortification is its ability to reach malnourished rural populations who may have limited access to commercially marketed fortified foods and supplements. Moreover, as marketed surpluses of these biofortified crops make their way into retail outlets, they can reach consumers in both rural and urban areas. The direction of the flow is from rural to urban areas, which is in contrast to complementary interventions that begin in urban centres.

HarvestPlus, pioneers of the biofortification process, are working to increase access to three key micronutrients, zinc, iron and vitamin A, by biofortifying seven staple crops: beans, cassava, maize, pearl millet, rice, sweetpotato and wheat. Although some biofortification processes apply genetic engineering, orange-fleshed sweetpotato is bred using conventional breeding techniques.

4.4.2 Biofortified orange-fleshed sweetpotato

Conventional selective breeding techniques have been used to produce a biofortified orange-fleshed sweetpotato that provides high levels of zinc and iron and has high levels of vitamin A. The production and distribution of a biofortified orange-fleshed sweetpotato could significantly contribute to reducing the global public health problem of vitamin A, zinc and iron deficiencies, particularly in high-risk populations.

4.5 Nutrition modules for community level interventions – Good examples

The following links lead to detailed information on community level nutrition approaches.

1. Care Group Model: http://pdf.usaid.gov/pdf_docs/PNADP104.pdf

2. Community Nutrition Education (CNE) Logic Model:
http://www.nifa.usda.gov/nea/food/fsne/logic.html

4.6 Nutritional behaviour change through demand creation campaigns

Orange-fleshed sweetpotato has the potential to improve the health of micronutrient deficient children around the world. But how can new food habits and agricultural practices necessary for consumption be promoted? In other words, how can consumer demand be created?

Promotional campaigns have been a successful method for introducing new nutritional behaviours. Following a promotion campaign in Mozambique, three-quarters of consumers said they preferred orange-fleshed sweetpotato roots to white-fleshed sweetpotato roots. An effective promotion strategy for orange-fleshed sweetpotato should include elements of target audience identification, creative communication and nutrition education.

In order for a promotional campaign to be effective and efficient, target audiences must be identified. For example, an orange-fleshed sweetpotato promotional campaign might target food processors who could substitute orange-fleshed sweetpotato puree or flour for wheat or other ingredients in their products. The target audience could also be traders who sell sweetpotato, farming households who grow their own sweetpotato or consumers who purchase sweetpotato.

If a new technology is disseminated, a supply is generated. However, if the potential consumers of that technology do not demand it, rates of adoption will be low. The promotion of solutions to micronutrient malnutrition is particularly challenging because micronutrient deficiencies, or "the hidden hunger" are often hard to detect and can go unnoticed until the deficiency is severe. If people do not realise they have a problem, they will be less likely to take up behaviours presented as solutions.

Therefore, creating demand is a complex yet essential component in orange-fleshed sweetpotato promotion projects. The process of fostering demand has two elements:

1) Creating **awareness** about:
    - the importance of vitamin A
    - the high vitamin A content in orange-fleshed sweetpotato

2) Designing and implementing programs that will **enable actual behavioural change**, typically related to:

    - improving young child feeding practices
    - diversifying the overall diet at the household level
    - improving marketing chains for sweetpotato roots and/or leaves and products

In order to develop appropriate messages and materials for a promotional campaign with the above components, it is important to understand the existing food and marketing customs, preferences of the target community and to operate with sensitivity surrounding cultural norms. For this reason, a pre-campaign situation analysis is beneficial. Information collected will help determine which messages will be most effective in creating demand for orange-fleshed sweetpotato and how messages must differ for different segments of the population.

The type of information collected during this diagnostic stage could include:

1. The target audiences (including those who influence nutritional behaviours) and their existing behaviours, knowledge, channels of information and attitudes toward orange-fleshed sweetpotato.
2. Identification of national and sub-national policy makers who could influence resource allocation and support policies to facilitate the introduction of new sweetpotato varieties.
3. Community level dynamics and networks that could support the introduction of orange-fleshed sweetpotato varieties or pose challenges to an intervention. An understanding of existing consumer preferences for certain varieties of sweetpotato and beliefs concerning sweetpotato consumption as compared to other staple foods and vitamin A rich foods.
4. Household level dynamics and practices that might act as barriers or facilitators to developing behaviour change communication.

The diagnostic data can provide a basis for determining appropriate communication programs to target difference audiences. As human and financial resources allow, communication programs should:

1. Identify the key entry points into the communities and target groups of interest
2. Segment and prioritize target audiences and develop specific activities for each audience
3. Position promotional messages and identify any barriers to adoption and how to best address them
4. Include a monitoring system to see if the desired behavioural change is present
5. Use the most effective channels or pathways for message delivery

These demand creation strategies of collecting diagnostic data and developing relevant communications strategies were utilised in the Towards Sustainable Nutrition Improvement (TSNI) project in Mozambique and the Reaching End Users Project (REU) in Uganda and Mozambique and resulted in significant increases in orange-fleshed sweetpotato and vitamin A intakes among children under five years of age.

Demand creation activities that can create awareness about orange-fleshed sweetpotato include:

1. Slogans painted on vehicles, caps and wraps worn by women. For example, "*O Doce que dá Saúde*" or "*the Sweet that gives Health*."

2. Wide coverage radio programs (~15 minutes) to cover a target issue. Some examples include the importance of vitamin A, the value of orange-fleshed sweetpotato and how to grow the crop, good child feeding practices, the basic food groups and the range of vitamin A rich foods.
3. Short radio announcements (~30 seconds) on the value of orange-fleshed sweetpotato and where to obtain sweetpotato products.
4. Market stalls painted orange and decorated with key messages.
5. Professional or local community theatre performances (edutainment - that informs and educates the audience), including songs (sticky messages which typically last a long time).
6. Orange painted push-carts for selling sweetpotato with key promotional messages.

Examples of demand creation activities linked to behavioural change include:

1. Stakeholder meetings with leaders of the community or health service personnel to provide key campaign messages.
2. Group nutrition sessions with various stakeholder groups (including those who influence nutritional behaviours e.g. fathers, grandmothers, traders and local leaders as opposed to just mothers), led by trained extension personnel or community health workers, supported with job aids such as counselling cards or posters. Some key areas to cover include:
   a. Frequency of feeding the young child
   b. The importance of giving the first milk (colostrum) after birth
   c. Exclusive breastfeeding until 6 months of age (*no* other liquids, including water)
   d. What to feed your young child at different stages in life
   e. What are vitamin A rich foods and why are they so important
   f. Monitoring the growth of your child

3. Cooking demonstrations led by trained extension personnel or community health workers, with an emphasis on utilising locally available foods and integrating new orange-fleshed sweetpotato varieties.
4. One-on-one counselling sessions with mothers of malnourished children.
5. Demonstration crop plots to compare the new varieties to the existing varieties, with associated community field days.

6. Advertising campaigns that subsidize access to new orange-fleshed sweetpotato-based products and planting materials (e.g. offer sweetpotato products or planting materials at a reduced price).
7. Holding special sessions with men and others (such as local leaders and mother-in-laws) who influence dietary practices of the children and the overall household.

4.7 Gender and diversity aspects of orange-fleshed sweetpotato and nutrition

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in Topic 11. Key gender and diversity issues are also woven into the text on each topic and those relevant to orange-fleshed sweetpotato and nutrition are highlighted here.

- Nutritional requirements including Vitamin A requirements vary by age, sex and workloads.
- As with any training or promotion activity, in nutrition training attention needs to be paid not only to imparting appropriate and practical information to those who will be involved in preparing the food (mothers, women), but also to those who control access to the raw materials and food (husbands) and who influence consumption patterns (grandmothers, husbands, traders, community leaders).Timing, duration, location, delivery language, approach and participant composition of training events also need to be considered to ensure certain groups are not unintentionally prevented from accessing it.
- It is important to understand local nutritional practices and beliefs and how these can be combined with improved nutritional behaviours and outcomes.
- It is important to monitor and evaluate nutrition activities in order to learn whether promotional messages and activities are being correctly understood, and utilised by the target audiences for whom they were designed; and if not, what changes are needed in order to improve their effectiveness.

4.8 Ideas for learning-by-doing activities on nutrition and orange-fleshed sweetpotato

These learning by doing activities have been designed to provide hands-on discovery learning opportunities for the participants of the 10-day Training of Trainers (ToT) course '*Everything You Ever Wanted to Know about Sweetpotato*'. We hope by learning about sweetpotato in a hands-on way, these trainers will then train others using a practical learning-by-doing approach.

The full 10-day ToT course programme is described in Topic 13 of this manual. Below is a list of Nutrition and orange-fleshed sweetpotato activities that could occur on Day 3 of the course. Although designed as part of a 10-day course, these activities can also be used by trainers as stand-alone learning activities and as part of other training courses. Topic 13 also includes an outline for a 5-day training course.

Day	Topics	Intended Learning Outcomes	Activities
3	Nutrition and OFSP	*Participants will:* - Understand what a balanced diet is and why it is important - Know how OFSP can contribute to reducing Vitamin A deficiency - Be able to select appropriate local ingredients to prepare child-friendly, and nutritious OFSP meals - Understand the importance of the gender aspects of household nutrition	- *Brainstorming*: What is a balanced diet? [10 mins] - *Presentation 4a* and *Activity 4.8.1: How well balanced are our diets?* What is good nutrition*?(see 4.8.1 below)* [10 & 40 mins] - *Presentation 4b* and *Activity 4.8.2 Dining from a vitamin A rich menu*. Vitamin A, why OFSP helps combat VAD & who is at risk from VAD (see 4.8.2) [10 & 20mins] - *Activity 4.8.3: Virtual porridge making (see 4.8.3 below) {Note: actual porridge making occurs on Day1; other OFSP recipes are made on Day 9}* [1 hour] - *Activity 4.8.4: Raising awareness and creating demand for OFSP (see 4.8.4)* [55 mins] - Group discussion on strengths and weaknesses of approaches and tools. Are we integrating gender well? [45 mins]

4.8.1 How well-balanced are our diets?

Intended Learning Outcome: gain an understanding of how local diets can be made more nutritious
Estimated Activity Time: 40 mins
Materials: Presentation 4a, prior knowledge from the brainstorming and presentation on good nutrition, flip chart, pens and masking tape.
Suggested steps:

1. With the trainees working in groups of 5 or 6 ask them to identify at least two meals that are commonly eaten by the community in their area. Note: they may wish to think about a meal that is eaten by a poor household and another by a medium wealth group household, or by a rural household and an urban household. [5 mins]
2. Ask the group to analyse the adequacy of these meals in terms of the food categories that are needed by the body (e.g. energy giving-cereals, roots, tubers, plantains; body building – pulses, seeds, nuts, milk, eggs, fish, meat; energy storage – fats and oils; body protective – fruits and vegetables). After each small group has presented their analysed meals, open up a general discussion to enable the participants to highlight gaps, questions or differences of opinions regarding the meals and their food/nutrient type categories. Ensure the discussion covers: adequacy in terms or quality, quantity, and value; seasonality and common food substitution practices; gendered aspects of food consumption and sharing; and food hygiene.[20 mins]
3. In their small groups ask the participants to discuss the challenges of preparing balanced diets in the community, and any solutions they know of. [5 min]
4. Then go around the room asking each group to share one key challenge to preparing a balanced diet and suggested solutions for overcoming it. List these on a flip chart, and open the topic up for a few minutes of general discussion to see if any extra suggestions can be added.[10 mins]

4.8.2 Dining from a vitamin A rich menu

Intended Learning Outcome: understand how to prepare balanced meals with locally available vitamin A rich foods
Estimated Activity Time: 20 mins
Materials: Presentation4b, A4 sheets of paper and pens (Actual examples of vitamin A rich local foods such as pumpkins, pawpaw, OFSP, local and exotic green leafy vegetables etc. if available)
Suggested steps:

1. Divide the trainees into 4 groups and let each group come up with two meal plans that contain locally available vitamin A rich foods (including orange-fleshed sweetpotato). Ask each group to write their meal plans on A4 sheets of paper, and then stick these on the wall. [10 mins]
2. Give participants a few minutes to look through the other groups' vitamin A rich meal plans and open up a short general discussion addressing any issues the participants want to discuss or raise. Probe for ways in which the meals could be improved. Emphasise the importance of having oil in the dishes as the fats help in absorption of vitamin A and therefore make it more accessible to the body. [10 mins]
3. Arrange for the vitamin A meal plans to be typed up onto a page that will then be photocopied for the participants to take away with them. [after the session]

4.8.3 Virtual porridge making

Intended Learning Outcome: be able to prepare a nutritious porridge suitable for children from OFSP
Estimated Activity Time: 1 hour (Note: the actual porridge making activity planned on Day 1 will also link to this)
Materials: 4 sets of the virtual porridge cards with photos and descriptions of different ingredients that could be used to make a nutritious child's porridge (see Handout 4.8.3a); masking tape, flip chart paper and pens. The porridge can only have a maximum of 4 ingredients.
Suggested steps:

1. Divide the trainees into 4 groups, give each group a set of the 25 ingredient cards, ask them to use the cards to develop nutritious and acceptable porridge recipes that a typical household could use to feed children from 6 to 24 months old. Discuss how these recipes will change as the child grows and new foods are incorporated into their diet. Explain that it is very important for the porridge to be dense; it should NOT drip off the spoon. Children have small stomachs, so they need to come up with a recipe that does not weigh more than 150 grams, yet is nutritious. Explain that they will need to present their recipe to the whole group at the end, note that a recipe includes the steps as well as the ingredients. [20 mins]
2. Invite each of the 4 small groups to present their porridge recipes to the whole group. [5 mins each = 20 mins]
3. Ask the participants to discuss the differences in the choices of ingredients between the recipes presented, the pros and cons of the different ingredients used, the practicalities of obtaining the ingredients and the importance of food diversity and varying the recipes. They should make notes about their selected recipes and the reasons behind choosing them. [20 mins]

4.8.4 Raising awareness and creating demand for orange-fleshed sweetpotato

Intended Learning Outcome: gain experience in using a range of tools to raise community awareness about OFSP
Estimated Activity Time: 55 mins
Materials: Topic 4 of the manual
Suggested steps:

1. Divide the trainees into 4 groups. Explain that due to the 'hidden' nature of micronutrient malnutrition, it is often necessary to create demand for orange-fleshed sweetpotato. Explain that they are going to practice using different orange-fleshed sweetpotato community awareness raising techniques. Give them 15 minutes to discuss and practice before sharing with the rest of the participants in a 5 minute presentation. [20 mins]
    - One group will develop a short play using a theatre script
    - One group will create a short song
    - One group will act out a potential radio or television advertisement
    - One group will give a short speech
2. Give each group 5 minutes to present their community awareness activity or strategy. [20 mins]
3. Ask the participants to discuss the practicalities and pros and cons of using the different techniques and any ideas they have for other orange-fleshed sweetpotato awareness raising methods. They should make notes on the awareness creation techniques presented, their pros and cons and any other good ideas. [15 mins]

Handout 4.8.3a Virtual porridge making ingredient cards (photocopy and cut into separate cards)

AVOCADO, fresh and ripe

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	16	0.2	0.67	0.055	0.064	0.7	1	5.8
30 grams	48	0.6	2.01	0.165	0.192	2.1	3	17.4
100 grams	160	2	6.7	0.55	0.64	7	10	58

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

PUMPKIN, cooked

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	3	0.148	0.29	0.028	0.01	20	0.65	1
30 grams	9	0.444	0.87	0.084	0.03	60	1.95	3
100 grams	30	1.48	2.9	0.28	0.1	200	6.5	10

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

SUGAR, granulated

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	38.7	0	0	0.001	0	0	0	0
30 grams	116.1	0	0	0.003	0	0	0	0
100 grams	387	0	0	0.01	0	0	0	0

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

GROUNDNUTS, boiled and mashed

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	31.8	1.35	0.88	0.101	0.183	0	0	7.5
30 grams	95.4	4.05	2.64	0.303	0.549	0	0	22.5
100 grams	318	13.5	8.8	1.01	1.83	0	0	75

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

RICE, cooked

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	13	0.238	0.03	0.149	0.042	0	0	9.7
30 grams	39	0.714	0.09	0.447	0.126	0	0	29.1
100 grams	130	2.38	0.3	1.49	0.42	0	0	97

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

COCONUT MILK, expressed from grated coconut meat and water

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	*mg*	mg	mcg RAE	mg	mcg DFE
10 grams	23	0.229	0.22	*0.164*	0.067	0	0.28	1.6
30 grams	69	0.687	0.66	*0.492*	0.201	0	0.84	4.8
100 grams	230	2.29	2.2	*1.64*	0.67	0	2.8	16

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

CASSAVA flour

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	32	0.16	0.17	0.026	0.034	0	0.4	2.7
30 grams	96	0.48	0.51	0.078	0.102	0	1.2	8.1
100 grams	320	1.6	1.7	0.26	0.34	0	4	27

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

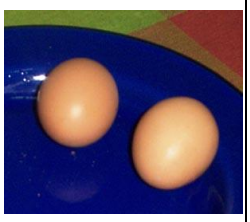
CABBAGE, boiled

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	2.2	0.102	0.19	0.017	0.009	0.7	2.01	2
30 grams	6.6	0.306	0.57	0.051	0.027	2.1	6.03	6
100 grams	22	1.02	1.9	0.17	0.09	7	20.1	20

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

EGG, raw

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	14.7	1.258	0	0.183	0.111	14	0	4.7
30 grams	44.1	3.774	0	0.549	0.333	42	0	14.1
100 grams	147	12.58	0	1.83	1.11	140	0	47



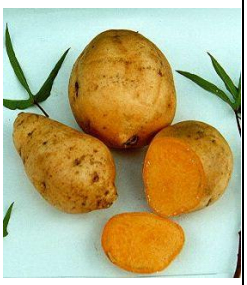
kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

PUMPKIN leaves

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	2.1	0.272	0.27	0.32	0.02	8	0.1	2.5
30 grams	6.3	0.816	0.81	0.96	0.06	24	0.3	7.5
100 grams	21	2.72	2.7	3.2	0.2	80	1	25

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

ORANGE FLESHED SWEETPOTATO ROOTS, boiled and mashed



	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	7.6	0.137	0.25	0.072	0.02	58.8	1.28	0.6
30 grams	22.8	0.411	0.75	0.216	0.06	176.4	3.84	1.8
100 grams	76	1.37	2.5	0.72	0.2	588	12.8	6

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

VEGETABLE OIL

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	88.4	0	0	0	0	0	0	0
30 grams	265.2	0	0	0	0	0	0	0
100 grams	884	0	0	0	0	0	0	0

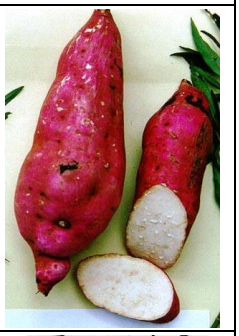
kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

BEANS, boiled and mashed

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	12.7	0.867	0.64	0.222	0.1	0	0.12	13
30 grams	38.1	2.601	1.92	0.666	0.3	0	0.36	39
100 grams	127	8.67	6.4	2.22	1	0	1.2	130

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

WHITE-FLESHED SWEETPOTATO ROOTS, boiled and mashed



	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	7.6	0.137	0.25	0.072	0.02	0	1.28	0.6
30 grams	22.8	0.411	0.75	0.216	0.06	0	3.84	1.8
100 grams	76	1.37	2.5	0.72	0.2	0	12.8	6

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

SWEETPOTATO LEAVES, cooked

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	3.4	0.232	0.19	0.06	0.026	4.6	0.15	4.9
30 grams	10.2	0.696	0.57	0.18	0.078	13.8	0.45	14.7
100 grams	34	2.32	1.9	0.6	0.26	46	1.5	49

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

WHITE MAIZE flour

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	36.1	0.693	0.96	0.238	0.173	0	0	2.5
30 grams	108.3	2.079	2.88	0.714	0.519	0	0	7.5
100 grams	361	6.93	9.6	2.38	1.73	0	0	25

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

FISH, Sardines

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	11.2	2.14	0	0.09	0.04	4.3	0	1.1
30 grams	33.6	6.42	0	0.27	0.12	12.9	0	3.3
100 grams	112	21.4	0	0.9	0.4	43	0	11

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

FISH, small, dried, freshwater

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	33.5	5.86	0	0.25	0.52	0	0	2.8
30 grams	100.5	17.58	0	0.75	1.56	0	0	8.4
100 grams	335	58.6	0	2.5	5.2	0	0	28

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

RED PALM OIL

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	86.2	0	0	0	0	500	0	0
30 grams	258.6	0	0	0	0	1500	0	0
100 grams	862	0	0	0	0	5000	0	0

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

BANANA, fresh and ripe

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	8.9	0.11	0.26	0.03	0.02	0.3	0.87	2
30 grams	26.7	0.33	0.78	0.09	0.06	0.9	2.61	6
100 grams	89	1.1	2.6	0.3	0.2	3	8.7	20

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

BAOBAB, pulp

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	30.5	0.42	0.51	0.19	0.03	0	20.1	1.3
30 grams	91.5	1.26	1.53	0.57	0.09	0	60.3	3.9
100 grams	305	4.2	5.1	1.9	0.3	0	201	13

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

Juice from an ORANGE

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	4.7	0.094	0	0.01	0.007	1.1	5.32	3
30 grams	14.1	0.282	0	0.03	0.021	3.3	15.96	9
100 grams	47	0.94	0	0.1	0.07	11	53.2	30

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

MANGO, ripe

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	6.5	0.05	0.18	0.01	0	3.8	2.77	0.6
30 grams	19.5	0.15	0.54	0.03	0	11.4	8.31	1.8
100 grams	65	0.5	1.8	0.1	0	38	27.7	6

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

PAPAYA, ripe

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	3.9	0.06	0.18	0.01	0.01	13.5	6.2	3.8
30 grams	11.7	0.18	0.54	0.03	0.03	40.5	18.6	11.4
100 grams	39	0.6	1.8	0.1	0.1	135	62	38

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

WATERMELON, raw

	Energy	Protein	Fibre	Iron	Zinc	Vitamin A	Vitamin C	Folate
	kcal	g	g	mg	mg	mcg RAE	mg	mcg DFE
10 grams	3.9	0.06	0.04	0.02	0.01	2.8	0.81	0.3
30 grams	11.7	0.18	0.12	0.06	0.03	8.4	2.43	0.9
100 grams	39	0.6	0.4	0.2	0.1	28	8.1	3

kcal= kilocalorie. RAE: retinol activity equivalent: 1 RAE = 1 mcg retinol, 12 mcg beta-carotene.
DFE: dietary folate equivalent: 1 DFE= 1 mcg food folate

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Notes on: ***Orange-fleshed Sweetpotato and Nutrition***