

# Everything You Ever Wanted to Know about Sweetpotato

Reaching Agents of Change ToT training manual



## VOLUME 5

Topic 8: Harvesting and Postharvest Management

Topic 9: Processing and Utilisation

Topic 10: Marketing and Entrepreneurship



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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	IPPM	Integrated Pest&Production Management
AIs	Adequate Intakes	IRETA	Institute for Research Extension and Training in Agriculture
ARMTI	Agricultural and Rural Management Training Institute	K	Potassium
ASCII	American Standard Code for Information Interchange	LGA	Local Government Areas
AVRDC	The World Vegetable Centre	LGB	Larger Grain Borer
BMGF	Bill and Melinda Gates Foundation	LZARDI	Lake Zone Agricultural Research and Development Institute (Tanzania)
CBO	Community Based Organisation	M&E	Monitoring and Evaluation
CGIAR	Consultative Group on International Agricultural Research	MAP	Months After Planting
CIAT	International Centre for Tropical Agriculture	m.a.s.l.	metres above sea level
CIP	International Potato Center	MM	Mass Multiplication
DAP	Days After Planting	MRC	Medical Research Council, South Africa
DFE	Dietary Folate Equivalents	MSC	Most Significant Change
DONATA	Dissemination of New Agricultural Technologies in Africa	N	Nitrogen
DVM	Decentralised Vine Multipliers	NARO	National Agricultural Research Organisation
EMU	Eduardo Mondlane University	NAS	National Academy of Sciences
dwb	Dry weight basis	NBS	National Bureau of Statistics
FAEF	Faculty of Agronomy and Forestry Engineering	NGO	Non Government Organisations
FAO	Food and Agriculture Organisation of the United Nations	NHV	Negative Horizontal Ventilation
FC	Food Consumption	NPC	National Population Commission
FW	Fresh Weight	NPCK	National Potato Council of Kenya
GI	Glycemic Index	NPK	Nitrogen, Phosphorus, and Potassium
HH	Household	NRI	Natural Resources Institute
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome	OFSP	Orange-fleshed sweetpotato
HKI	Helen Keller International	P	Phosphorous
IBPGR	Bioversity International	PMCA	Participatory Market Chain Approach
IFPRI	International Food Policy Research Institute	PMS	Primary Multiplication Site
IIAM	Institute of Agricultural Research Mozambique	PPP	Public Private Partnership
IIED	International Institute for Environment and Development	PVC	Polyvinyl chloride
IIRR	International Institute of Rural Reconstruction	QDPM	Quality Declared Planting Material
IITA	International Institute of Tropical Agriculture	QDS	Quality Declared Seed
IMMPACT	International Micronutrient Malnutrition Prevention and Control Program	RAC	Reaching Agents of Change
IPGRI	International Plant Genetic Resources Institute	RAE	Retinol Activity Equivalents
IPM	Integrated Pest Management	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	UNICEF	United Nations Children’s Fund
SPKP	Sweetpotato Knowledge Portal	UNU	United Nations University
SPVD	Sweetpotato Virus Disease	USA	United States of America
SSA	Sub-Saharan Africa	USAID	United States Agency for International Development
SUA	Sokoine University of Agriculture	USD	United States Dollar
TFNC	Tanzania Food and Nutrition Centre	USDA	United States Department of Agriculture
ToT	Training of Trainers	Ushs.	Ugandan Shillings
TMS	Tertiary Multiplication Site	USIM	United States Institute of Medicine
Tshs.	Tanzanian Shillings	VAD	Vitamin A Deficiency
TSNI	Towards Sustainable Nutrition Improvement	WAP	Weeks After Planting
UN HABITAT	United Nations Human settlement Programme	WFP	World Food Program
UNESCO	United Nations Educational, Scientific and Cultural Organization	WHO	World Health Organisation
		WTP	Willingness To Pay

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## 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](mailto:j.low@cgiar.org) and where possible we will incorporate them into new editions.

# TOPIC 8: HARVESTING AND POST-HARVEST MANAGEMENT

## IN

# EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

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## Topic 8: Harvesting and post-harvest management

### 8.1 Prolonging the sweetpotato harvest

Sweetpotato is a fairly flexible crop in terms of its harvesting time. Many farmers use a piecemeal approach to harvesting sweetpotato, whereby when roots are required by the household for food or for small-scale marketing just a few are dug up from a number of plants, and the remaining roots of these plants are then recovered with soil and left to continue bulking. This enables the roots to remain in the field until required and elongates the supply period to the house or markets.

However, mature roots become more vulnerable to theft by humans and monkeys so in some areas this strategy may not be sensible. Piecemeal harvesting can help with better pest management, as if the field is being regularly visited for piecemeal harvesting the farmers will likely check the field for cracks or exposed roots and fill cracks and replace the soil over any protruding roots that they don't harvest. By filling the cracks and recovering any remaining roots the farmers are helping to prevent weevils from accessing the sweetpotato roots and the roots from being damaged by exposure to the sun.

The growing of several different varieties with different maturing periods, and the staggering of the planting time (e.g. so different portions of the field are planted every few weeks as planting materials become available) can also increase the fresh root harvesting period. However, despite the increased flexibility afforded by piecemeal harvesting practices and use of a mixture of varieties and staggered planting times, in many parts of Sub-Saharan Africa with prolonged dry season there is still a long period of the year when no sweetpotato roots can be harvested.

Unlike cassava crops where the roots can be left in the field until required, if sweetpotato roots are left for too long in the field during the dry season, they typically get heavily attacked by weevils that access the roots via cracks in the soil as it dries out. Most people prefer to eat sweetpotato roots that have been freshly harvested as opposed to using reconstituted sun-dried pieces of sweetpotato.

This highly seasonal supply of fresh sweetpotato roots hinders the increased consumption of sweetpotato and the income earning opportunities for sales of fresh roots and for sweetpotato processing and products.

Farmers have developed ways of preserving freshly harvested sweetpotato roots to try and access the higher market prices paid for fresh sweetpotato roots during the off season (these are described in section 8.5).



## 8.2 When and how to harvest

As described above sweetpotato roots can be harvested over a period of several months, either piecemeal style (taking a few roots from each plant and then leaving the others to continue developing) or by harvesting different portions of the field or different varieties at different times.

The time of harvest of sweetpotato roots is therefore determined by:

- the variety's maturity period and its capacity for prolonged harvest
- the environmental conditions (soil condition, weather, water supply etc.)
- pest and diseases incidence
- market demand and price
- need to use the field for planting the next/ consecutive crop
- economic value of the next/ consecutive crop
- labour availability

Sweetpotato roots are typically ready for harvesting between 3 and 8 months after planting. Some of the earliest maturing varieties are ready 3 months after planting, while other varieties are normally ready from 4.5 - 5 months after planting.

Low yields can result if the crop is harvested too early or too late. If too early, the storage roots will not have had enough time to develop to their maximum size. If too late, the storage roots may have become fibrous or have been attacked by weevils or root rots. However, other factors such as immediate need for food, cash or land may be bigger priorities than the amount of lost potential yield.

Sweetpotato roots have thin, delicate skin that is easily damaged by cuts and abrasions. Harvesting is typically done manually using sharp sticks, machetes or hand hoes, and farmers need to take care to avoid wounding the roots during harvesting. When sweetpotato roots are wounded during harvesting they not only then have an inferior appearance which can affect their market value, but diseases are also likely to enter through the wounds and cause rotting.

Harvesting of a whole field at once is likely to happen only if the sweetpotato is all being targeted to the market, and farmers will then typically harvest using a hand hoe. When piecemeal harvesting, particular care is taken not to injure the roots which will remain on the plant to bulk for longer. Some farmers' piecemeal harvest one area of their field, and completely harvest another area, depending on what they wish to do with the roots. In order to help protect the roots from damage, the vines can be cut off the plants up to 2-4 days prior to harvesting, this pre-harvest curing practice causes the skins of the roots to become firmer making them less vulnerable to bruising during harvesting (see section 8.4 for further details).

If harvesting for home consumption it is often women who do the harvesting and they will typically harvest just enough roots for a couple of days' meals. Different varieties respond differently to piecemeal harvesting; some produce larger or smaller roots as a result of it, some have a longer time period during which piecemeal harvesting can occur. Varieties with longer maturity periods are usually more suitable for piecemeal harvesting than varieties with short maturity periods where all the storage roots tends to mature at the same time. Piecemeal harvesting can go on for a period of nine months depending on the variety, demand and pest pressure. But in dry conditions is unlikely to last for so



*Manual harvesting of sweetpotato*

long as the plants tend to dry up due to the disturbance of the root system and weevil pressure is high. Varieties with roots that form deeper down in the soil can typically be left for longer in the ground.

Due to the extended harvesting period which occurs when farmers practice piecemeal harvesting, the yield of sweetpotato fields is often underestimated. It is much easier for farmers or researchers to accurately assess the yield of a field when all the roots are harvested at the same time and can then be weighed and recorded immediately. However, studies have shown that piecemeal harvesting maximizes yields, as when mature roots are removed, space is created for expansion of the remaining roots.

Roots are typically carried home in baskets as head loads, or in sacks on bicycles, or by ox-carts.

Depending on the intended use of the harvested roots, they are sorted manually by shape, colour, size, damage levels etc. This can occur in the field or homestead or at the market. The harvested sweetpotato roots should be protected from direct sunshine as this can cause shrinkage and shrivelling. It is important for development workers to understand the roles played by men and women in sweetpotato post-harvest activities; so that training and activities can be effectively targeted to those doing the activity and can also involve those with influence over decisions or resources affecting the activities.

Sometimes traders will arrange to purchase a whole field of sweetpotato roots, they will often estimate the yield, agree on a price with the farmer and then bring their own labourers and transport and harvest the whole field at once. If farmers are to optimise their income from such arrangements they need to be able to calculate the likely yield of the field before it is harvested. This can be done by digging up at least ten plants across the field (not just in one corner) and weighing each plant's roots, and then multiplying the

average weight of roots per plant by the number of plants in the field (see Box 8.1), and then multiplying that kg amount by the per kg current price of roots. If the trader is buying fields of different varieties, then the above calculation should be done for each variety, as they will differ significantly. If farmers are accurately able to estimate the weight of the roots on each plant after they have dug them up, they can then use these estimates to work out the average weight of roots per plant, and then multiply this by the number of plants in the field.

Where very large-scale commercial sweetpotato production is done such as in USA, Japan and China, the roots are harvested mechanically, usually shortly after the vines have been removed. The field rows are usually ploughed with a modified disk or moldboard plough with a spiral attachment. The roots are moved to surface of the soil and then collected by hand. Mechanical harvesting can damage sweetpotato roots, and if the roots are left in the field for more than 30 minutes in hot sunshine they may be scalded by the sun and develop purplish-brown areas and become more susceptible to rots during storage.

**Box 8.1 Working out the yield of your field prior to harvesting**

- Dig up at least 10 plants randomly selected from across your field, and weigh the roots from each of them.
- Record the weight of roots for each plant. E.g.

1	2	3	4	5	6	7	8	9	10
1.2	2.3	2.6	3.0	2.3	1.7	2.0	2.3	2.7	1.9

- Then calculate the average weight of roots per plant. To do this, add up all the weights you recorded and then divide by the number of plants you sampled. E.g. 22kgs / 10 plants = 2.2kg/plant.
- To work out the yield of your whole field. Count how many plants there are in your field, and multiply that number by the average yield (e.g. average yield = 2.2kg in this example). So if you had 4,000 sweetpotato plants in your field, you would multiply 2.2 x 4,000. You can then estimate that your field has 8,800 kgs of sweetpotato roots in it.



*Mechanical harvesting of sweetpotato*



### 8.3 How to safely pack and transport fresh sweetpotato roots

Sweetpotato roots intended for market are typically packed into sacks in the field after they have been harvested. The unpacked and packed roots should be kept in the shade to maintain their quality. The roots should not be thrown or stepped on as they damage easily.

While packing, farmers often strategically place the largest roots at the top of the sack to attract buyers. To avoid root quality deterioration, care should be taken not to physically damage the roots during packing or transport. While sacks should not be overfilled, they also should not be underfilled as vibration can cause abrasions on the roots due to them moving against each other. Good aeration is also important.



*Poor packing and handling of sweetpotato roots; root quality will be damaged*

Although sacks are the main packaging used for sweetpotato roots in most parts of Sub-Saharan Africa, roots can easily be damaged when packed in sacks particularly when the sacks are overfilled as is common.

Ideally, farmers should carefully pack their harvested sweetpotato roots into plastic or wooden crates or cardboard boxes to help reduce damage during transport. These containers should not be overfilled as this then prevents proper stacking and will damage the excess roots.



*Packing sweetpotato roots in wooden or plastic crates or cardboard boxes can reduce damage during transport*

Care should also be taken during transport of the packed roots, whether by head load, bicycle, ox-cart, or truck. Market traders in Nairobi and Kampala typically try and sell all their sweetpotato roots within 3-4 days after arrival before rotting occurs.

### 8.4 Pre-harvest and post-harvest curing

Sweetpotato roots can be easily damaged during harvest. While this does not matter so much for those fresh roots which are to be consumed immediately, it does however have serious consequences for roots that are to be marketed or stored as rots can easily enter the roots through the wound sites, and root weight loss is more rapid.

Fresh sweetpotato roots are perishable, and even if undamaged their quality declines rapidly after harvest because they lose water and weight during storage which adversely affects their taste and texture, they can also be attacked by diseases such as root rots, and existing insect pest infestations can cause serious damage.

**Pre-harvest in-ground curing:** is a process commonly used with root and tuber crops to heal wounds, protect them against disease, reduce shrinkage and extend storage. By removing the foliage (dehauling) of sweetpotato plants up to 2-4 days before harvesting, the post-harvest root losses can be significantly reduced and the shelf-life increased.

**Post-harvest curing:** by exposing the harvested sweetpotato roots to moderate temperatures of 25-30°C and high humidity (90-95% RH (relative humidity)) for 4-7 days, a toughening of the skin of the roots occurs, which helps protect the root from damage and heal any existing wounds reducing the risk of post-harvest disease infection. In India, a research institute developed a method of in a well-ventilated place covering the freshly harvested roots with a polythene sheet raised ~15-20cm above the layer of roots. The polythene sheet was removed each night. Several days of this curing process led to increased shelf life of the sweetpotato roots and dramatically reduced fungal infection. In the USA after harvesting and grading, sweetpotato roots are typically cured by keeping them at ~30°C and 85-95% RH for 5-7 days, they are then put into storage warehouses at 12.5-18°C until they are needed for marketing. In commercial operations in South Africa, roots are washed, dipped in a fungicide, then air-dried prior to curing.

## 8.5 Managing fresh storage of sweetpotato roots

Fresh sweetpotato roots outside of the main harvest season fetch a much higher market price than sundried sweetpotato root slices or pieces. However, despite significant efforts to find effective ways of storing fresh sweetpotato roots so that they can be used at home or sold to the market over a longer period of time, there is very little use of these methods in Sub-Saharan Africa. Fresh sweetpotato roots are categorised as perishable because once detached from the plant, unless they are cut into small pieces and sun-dried they cannot be stored for long periods of time, unlike grain crops.

In Bangladesh, Vietnam and Nigeria freshly harvested roots are commonly stored in a heap on the floor inside the house or on a raised platform or shelves or suspended from the roof for periods of 2 to 4 months, and then used for household consumption. They are usually covered with paddy straw or dry grass, and in some places ash which helps prevent fungal decay (and probably weevil damage). Fires may also be lit near to them once or twice a week to help smoke fumigate the roots. However, high losses are experienced.

In the Philippines, fresh sweetpotato roots are sometimes stored in a 50cm deep trench, covered with sand and sheltered by a roof. Pit and clamp type stores (e.g. mounds of sweetpotato stored in grass lined pits, often sprinkled with wood ash, and covered with soil) have been used traditionally in some areas of India, Papua New Guinea, Malawi, Cameroon, Southern Tanzania, Northern Nigeria and Zimbabwe. In Malawi, the pits were typically dug underneath maize or groundnut granaries. In India they are commonly dug in a corner of the house, lined and covered with paddy straw and then plastered with mud.

Researchers have used these traditional stores as the basis from which to try and develop improved fresh root storage. Uptake of fresh root storage is dependent on the expected root price difference between that at harvest time and that a few months later on. As sweetpotato roots are low value and bulky, a significant number would need to be stored in a relatively large pit to make it economical to do so. If out of season fresh root prices are high, farmers might invest in storing some fresh roots in a pit or clamp store. A cost benefit analysis of fresh root stores for home consumption in Uganda showed much higher rates of return than any other sweetpotato enterprise.

Some of the reasons a farmer might decide to store fresh sweetpotato roots include:

- so that the land can be made available for other crops
- so that the family can eat fresh sweetpotato roots for a longer period after harvest
- so that the 'fresh' roots can be sold for a higher price during the off season
- to reduce the level of root losses to sweetpotato weevils
- as an emergency food and cash supply during the dry season

For successful fresh sweetpotato root storage, farmers must:

- select only the top quality roots without any signs of handling or pest or disease damage for storage. Damaged roots are much more susceptible to disease attack in storage which will then spread to the other roots.
- keep the selected roots in specially designed stores (pit or clamp instructions are given below), and avoid temperature build-up in the stores, the stores should be carefully sited to ensure they are shaded from direct sunlight and cannot be flooded by rainwater. (Note: some studies suggest the store should not be lined with grass).
- monitor the stores at regular intervals, every 1-2 weeks and check roots for rotting and insect or rodent damage. If roots become insect damaged or start to rot, remove all the roots from the store and discard them. If roots are undamaged, reseal and re-cover the store. Regularly check the roof structure and repair it as needed. As snakes are occasionally found inside the stores, care must be taken during inspections.

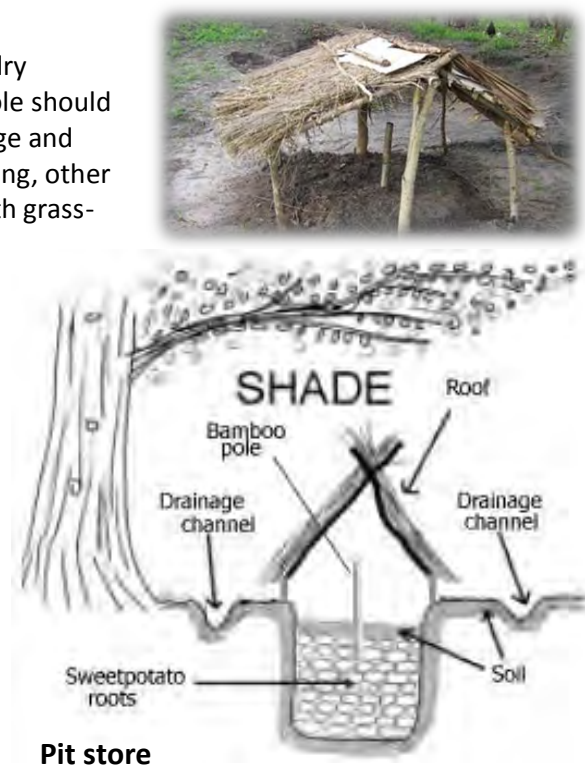
The two main types of stores used for fresh root storage by smallholder farmers are pit or clamp stores.

### 8.5.1 Pit stores

To construct a pit store, a hole is dug in an area of dry ground. Whilst it is often recommended that the hole should be lined with dry grass to cushion roots from damage and absorb moisture helping to prevent roots from rotting, other studies suggest it is important not to line the pit with grass- so you may wish to experiment with both methods. Place roots carefully into the pit, cover completely with more dry grass (if you are using it) and then seal with dry soil up to normal ground level. A bamboo pole should be carefully inserted through the soil above the roots to act as a ventilation pipe. Ensure that its top end is high enough above ground level to reduce the chances of weevils crawling down it. Cover the pit with a raised sloping roof to shade the pit store, and protect it from rain that could cause rotting. Size and shape of hole depends on the number of roots to be stored. Add a drainage channel around the store to divert rainwater.

Pit stores can be used again the following season,

but they must be sterilised before being re-used to prevent any carry-over of pests or diseases. They can be sterilised by lighting a fire in them. New grass and fresh soil should be used for lining and covering them each year. Farmers can also experiment with different sizes and shapes of stores, and in locating them in different places, and using different sweetpotato varieties to find out which combinations work best for them. If any problems with rotting were encountered, the farmer should



**Pit store**

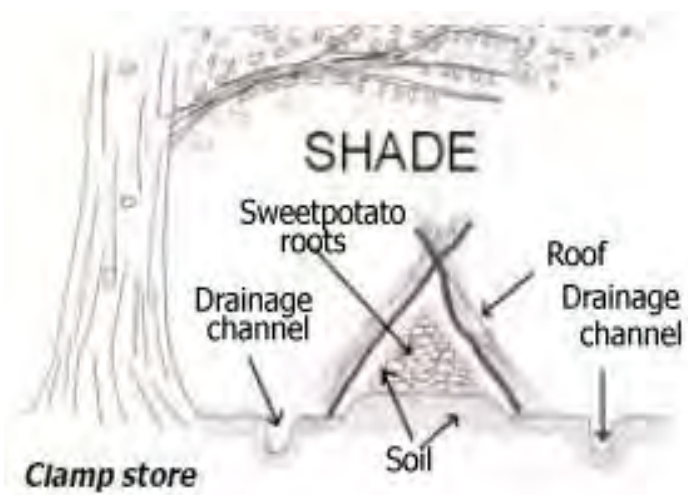
build a new pit store in a drier position, or alter the depth and size of the existing one and dig a drainage ditch around it. If insect pests were encountered, more careful selection of the roots is needed, and the store could be covered with a thicker layer of soil.

Pre-harvest in-ground curing (e.g. removal of all foliage up to 2-4 days prior to harvest) has been found to lead to improved root quality during pit storage of these roots.

Whilst theoretically the storage of fresh roots should enable farmers to sell them into the market during periods when the root price is high, in Tanzania most of the farmers involved in testing the pit stores used the stored roots for home consumption, saying that local market traders may not be keen on selling stored roots. This highlights the importance of involving traders and consumers in the development of such strategies.

### 8.5.2 Clamp store

The clamp store should be made on a flat mound of earth raised about 10cm above ground level. Cover the flat mound (~1m wide) with dry grass for cushioning and to absorb moisture (note: you may wish to experiment with and without the dry grass layer). Carefully pile undamaged sweetpotato roots on top, then cover with more dry grass and then with a 10-20cm thick layer of dry soil. Cover the structure with a thatched roof to protect it from sun and rain, allow a gap all the way round between the roof and mound for ventilation. Add a drainage channel around the store to divert rainwater.



Clamp stores can be used again the following season, but they must be sterilised before being re-used to prevent any carry-over of pests or diseases. They can be sterilised by lighting a fire on them. New grass and fresh soil should be used for lining and covering them each year. Farmers can also experiment with different sizes and shapes of stores, and in locating them in different places, and using different sweetpotato varieties to find out which combinations work best for them.

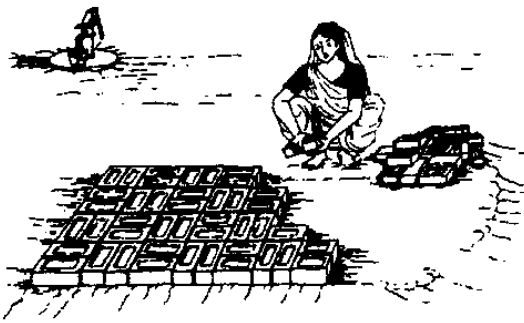
### 8.5.3 Zero energy cool chamber

Zero energy cool chambers typically stay 10-15°C cooler than the outside temperature and maintain about 90% relative humidity. They can be built out of locally available materials such as brick, sand, bamboo, straw and sacks (see Figure 8.1 for step-by-step instructions). They depend on cooling by evaporation and do not require electricity. As water evaporates it has a considerable cooling effect and the faster the rate of evaporation the greater the cooling. Evaporative cooling occurs when air, which is not already saturated with water, passes over a wet surface. The technology works best when the humidity of the surrounding air is low. Very dry low humidity air can absorb a lot of moisture and so considerable cooling can occur. When the surrounding air is already saturated with moisture, no evaporation can take place and no cooling then occurs.

Zero energy cool chambers are being promoted in India, and are seen as a promising technology for improving the shelf-life and supply of fresh sweetpotato roots as well as other fruits and vegetables in Sub-Saharan Africa.

The development and introduction of post-harvest sweetpotato technologies needs to understand the current and likely future roles played by men and women in order to ensure that the technologies and tools are appropriate, and to recognise any gender impacts of introductions of new technologies and knowledge.

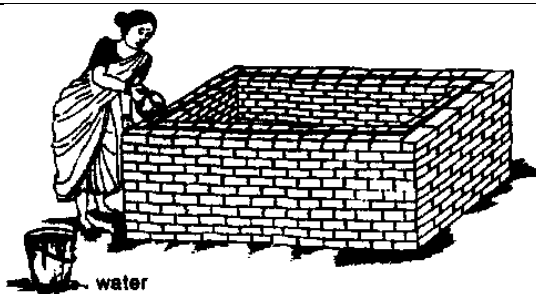
**Figure 8.1 Constructing a zero energy cool chamber**



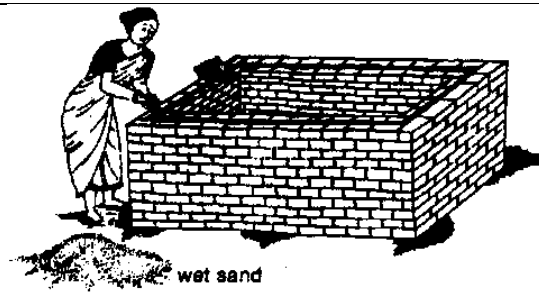
1. Select a raised site close to a source of water, where the breeze blows.
2. Make a floor with clean unbroken porous bricks.



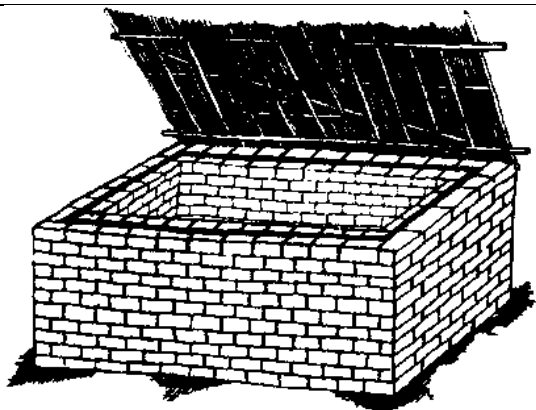
3. Erect a double wall 70 cm high, leaving a cavity of 7.5cm wide between the two walls



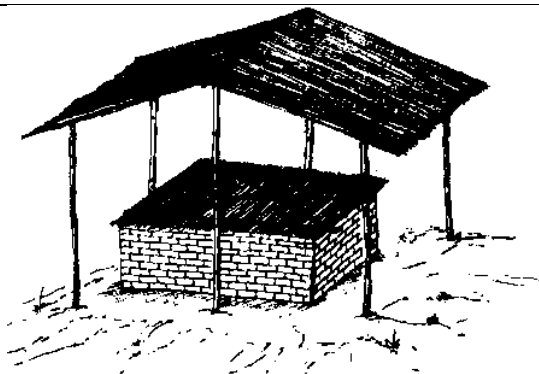
4. Drench the chamber in water



5. Soak fine, clean river-bed sand with water
6. Fill the cavity between the double wall with this wet sand



7. Make a cover frame of bamboo and dry grass



8. Build a thatched roof shed over the chamber to shield it from direct sun and rain

**Operation:**

Keep the sand, bricks and top cover of the chamber wet. Water twice daily, morning and evening. A drip system can be built with plastic pipes connected to an overhead water tank.

Store your fruits and vegetables in perforated plastic crates. Do not use bamboo or wooden boxes as these will be damaged by moisture. Cover the crates of containing fruits or vegetables with a thin polyethylene sheet.

Rebuild the chamber every 3 years as the bricks pores will have become blocked over time.



Source: IIRR, 1996

### 8.5.4 Modern large scale storage facility

A modern properly built storage facility maintains the temperature and humidity required for curing and long-term storage of sweetpotato.

A storage unit with negative horizontal ventilation (NHV) is recommended. The NHV system uses a slight negative pressure to pull the ventilation air horizontally past the pallet bins. Mount fans internally along the top of a plenum wall on one end of the room to create the negative pressure. Air first enters the mass of sweetpotato at the end of the room opposite the plenum wall. Air then moves horizontally through the sweetpotato bins/crates toward openings in the plenum wall. Once in the plenum, the air rises and passes through the fans and back out into the room, where it moves horizontally in the opposite direction back over the top of the stacked bins.

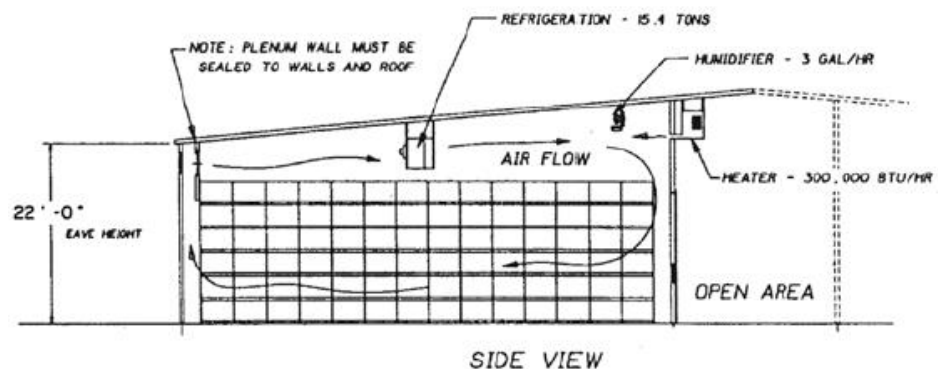
The NHV system allows good air mixing, so there is little internal variation in temperature or humidity throughout the room. For the system to operate properly, the pallet bins must be placed tightly together, in straight rows, with as little space between bins as possible.

A series of motorized dampers are located on the exterior wall across the plenum from the fans. While these dampers remain closed, only internal air is circulated through the pallet bins. These dampers are opened when outside air is required for ventilation or cooling. Air is pulled into these openings because of the slight negative pressure the fans create in the plenum. The size and number of these dampers are determined by the capacity of the room. When correctly designed, approximately one-third of the air passing through the fans will be pulled from outside, with the remainder of the air recirculated from the stack of pallet bins. The air displaced by the incoming air exits the room

through gravity shutters located near floor level at the end of the room opposite the plenum. Instructions for constructing a NHV store are given in the report by Edmunds et al., 2008.



*External and internal view of a modern NHV sweetpotato store in USA*



*Side view of a construction diagram for a negative horizontal ventilation (NHV) store*

### 8.5.5 Effect of fresh root storage on beta-carotene content

Few studies have been done on the retention of beta-carotene during fresh root storage. However in contrast to processed sweetpotato roots, the beta-carotene in the stored fresh roots is protected from external factors, and therefore the content is typically maintained. It has been noted that depending on the timing of the harvest, the temperature and humidity, and the variety the beta-carotene content in some roots slightly increases and in others decreases. In general, fresh storage does not affect the beta-carotene levels significantly.

### 8.5.6 Causes of post-harvest losses in fresh sweetpotato roots

Fresh sweetpotato roots are highly perishable due to their high moisture content (60-70%), sugar content (4-15%), delicate thin skin, their high respiratory rate immediately after harvest which produces heat and leads to softening of the roots. Shelf life varies by variety. Leaving the harvested storage roots in the sun for a short period is believed to help increase shelf-life, but can also lead to increased moisture loss and softening.

Physical causes of post-harvest losses include:

- *mechanical damage*: cuts, skinning, and bruises are usually caused during harvesting, transport or marketing
- *cracking*: often caused by soil nematode damage
- *chilling*: cold wet soils or subsequent exposure to temperatures below 13°C result in tissue breakdown and souring of the root flavour.

Physiological causes of post-harvest losses include:

- *respiration*: contributes to weight loss of the roots and altered appearance, wounding can increase the respiration rate and weight loss. Varieties with high dry matter content have less weight loss following harvest. Respiration rate is higher at higher temperatures.
- *sprouting*: if roots are stored at high temperature and humidity, sprouting happens very quickly.

Biological causes of post-harvest losses include:

- *pests*: the sweetpotato weevil (*Cylas* spp.) is a serious field and post-harvest pest of sweetpotato. Weevil feeding damage not only causes unsightly holes in the roots but also causes a bitter taste and unpleasant smell to develop in the roots.
- *diseases*: fungal and bacterial rots (often gaining access through wound sites on roots due to harvesting or weevil damage or through infected planting materials) result in soft and sunken areas developing on the roots, and may cause the roots to taste bitter. There are a wide number of different rots each with specific symptoms.



Root rotting



Rodent damage



*Cylas* weevil damage

## 8.6 Enhancing market value of fresh sweetpotato roots through improved post-harvest handling

**Washing:** When the fresh sweetpotato roots are ready to be taken to the market, their value can be enhanced by improving their presentation through washing. This should be a rinsing as opposed to a physical scrubbing which will damage the skin. A gentle rinsing should be sufficient to remove the loose soil on the roots. To reduce rinsing related decay, the grower can add a small amount of an antimicrobial agent such as sodium hypochlorite (liquid bleach) to the rinsing water.

**Grading and sizing:** After rinsing to remove the soil, the sweetpotato roots should be sorted by hand to remove any rotting or otherwise unmarketable roots. Workers who directly handle roots could wear gloves to protect roots from fingernail scratches and human pathogens and also protect workers from any fungicides or other chemicals which may have been used to preserve the roots.

Though grading and sizing is not commonly done in most parts of Africa, growers, wholesalers and retailers should be encouraged to practice roots sizing. Sorting sweetpotato into uniform sizes should be a key function of packing and improving the value of the product in the market.

**Packaging:** Proper packaging is an important step in the journey from the grower to the final consumer. Packing and packaging materials will add some significant cost to the price of the final product. However, if it is done to target different consumers it can add value and help to differentiate the product from other commonly marketed sweetpotato roots. Much of the root wastage which occurs in the market and the associated complaints are due to inappropriate packaging. Across most of Sub-Saharan Africa, sweetpotato is packed and transported to market in large sacks that are heavy to carry and hence, often dropped. This causes bruises and other mechanical damage to the roots which encourages rotting and reduces the storage and shelf-life of the roots, and may discourage consumers from purchasing sweetpotato roots. Pre and/or post-harvest curing can help reduce root damage (see section 8.4).

A significant percentage of buyer and consumer complaints can be traced to inferior container design or inappropriate container selection and use. A properly designed sweetpotato container will contain, protect, and identify the sweetpotato, satisfying everyone from grower to consumer. The container must enclose the sweetpotato roots in convenient units for handling and distribution. It must protect the sweetpotato roots from mechanical damage and environmental conditions during handling and distribution. The container or packaging should identify and provide useful information about the contents. Provision of information such as product name, brand, size, grade, cultivar, net weight, count, fungicide treatment, grower, shipper, and country of origin adds value in the eyes of the consumer. When marketing orange-fleshed sweetpotato roots it is also important to include nutritional information, and even recipes and other useful information directed specifically at the consumer.

This labelling can help growers and others in the value chain keep track of the source of the roots as well as the shipping destination. Traceability is the ability to follow a piece of produce from the grower through to the consumer, and enables the source of any problems to be easily identified and then dealt with.

**Transporting quality roots:** Transporters should avoid using sacks to pack and carry sweetpotato. The thin delicate skin of sweetpotato roots means they are easily bruised during transportation if packed in sacks and particularly so if the sacks are overfilled and the roads are bumpy. It is recommended that wooden or plastic pallets which can be stacked on top of each other are encouraged. This will lower root losses and improve the shelf life of the roots. As the importance of sweetpotato increases, growers, brokers, truckers, and receivers need to become well informed regarding the specific handling requirements of sweetpotato in order to reduce losses and improve quality.



**Examples of high tech post-harvest handling of sweetpotato roots as used in the USA**



*Pouring sweetpotato roots into water using a fork-lift mounted bin rotator device*



*High volume water rinse used to clean sweetpotato roots*



*Workers grading roots*



*Fungicide application using a waterfall curtain*



*Automatic box fillers integrated into electronic sizing equipment*



*Cardboard box packaging*



*Bulk bins for transporting roots to processors*



*Branding on sweetpotato packaging*



*Packing*

*Source of images: Edmunds et al., 2008*

## 8.7 Managing dried chip storage of sweetpotato roots

In some parts of Sub-Saharan Africa, sweetpotato is traditionally sun-dried in slices or small pieces and then stored as a food stock for consumption during the rest of the year, with occasional small sales to local markets. The dried sweetpotato pieces are typically rehydrated and used in stews or made into a mixed cereal-root porridge.

The processing of sweetpotato into dried chips and flour for use in locally sold commercial products is now increasing. The process used for making high quality dried sweetpotato chips and flour is given in box 8.2. Detailed information on processing is given in Topic 10.

During sun-drying, beta-carotene contained in the slices or chips of sweet potato is exposed to air (oxygen), temperature and light that are damaging to it. As a result the beta-carotene can be destroyed. However, beta-carotene degradation can be limited to less than 35% loss through the use of good drying management. Good drying management should ensure: 1) chips or slices are regularly mixed or turned during drying (i.e. every 2 hours) so they don't overdry on one side; 2) the density of the chips spread on the dryer is not too great (about 4kg/m<sup>2</sup> for shredded sweet potato = chips); 3) samples should be removed in the event of rain and placed in a dry place until drying conditions improve (e.g. sun shining again); 4) samples are removed from the dryer as soon as they are dried – overdrying is not good.

Storage of dried sweetpotato at room temperature for several months results in an extremely high degradation of beta-carotene (e.g. 70-80% loss from the initial dried products after 4 months).

Storage of dried sweetpotato is the main cause of beta-carotene degradation. In order to limit beta-carotene degradation the storage duration should be limited to no more than 2 months (the shorter the better for beta-carotene retention) and the product stored in a cool room (low temperature) and in closed/opaque containers. If possible air should be excluded from the packaging, as this substantially increases the shelf life of the product, however it is not often possible because of the type of specific vacuum packaging then required.

Traditionally dried sweetpotato is stored in a range of structures including sacks in the house, woven and mud plastered granary baskets placed inside or outside the house.

Whatever storage structure is used, it should be raised off the ground (on stones, bricks or a wooden pallet/ frame built from branches) to prevent uptake of ground moisture into the stored sweetpotato, and to allow air to flow around it. If a pallet is not available, sacks should be stacked on a plastic sheet. Storage sacks should not be allowed to touch the walls of a store room, and the sacks should be stacked carefully to prevent collapse. Bags stores are convenient for many reasons, they can be easily removed for consumption, sales,

### Box 8.2. Making high quality dried sweetpotato chips and flour

1. Carefully select healthy fresh sweetpotato roots
2. Clean and peel the roots
3. Wash the roots in clean water (a washing drum can be used for large scale production)
4. Pre-dry the roots on a clean surface in the sun for 10 minutes.
5. Cut the roots into slices about 5mm thick using a clean sharp knife or into thinner chips using a mechanised slicer or chipper for large scale production).
6. Sun-dry the slices on a raised tray
7. The dried slices can then be stored in clean opaque polypropylene sacks, or milled into flour and stored in opaque polythene bags.



*Traditional granary used for storing dried sweetpotato chips*

inspection or a further sun-drying, or in case of an emergency (fire, flooding etc.). But are also conveniently packed for easy theft, so should be kept somewhere secure.

If a woven or brick granary structure is outside, a thatched roof should be placed over it to protect it from rain and sun. Mud plastering of woven baskets helps to protect them from insect entry and theft. Padlocking the doors of brick granaries is advisable. Ensure there are no overhanging branches of trees which rodents could use to access the stored product. If possible a store should be raised to 1m above ground height, and rodent guards should be placed on the legs.



*Sun-dried slices of sweetpotato roots stored in a sack*

**Good storage hygiene:** No matter what storage structure is used, before loading the freshly dried sweetpotato slices, the structure should be thoroughly cleaned to remove all traces of last season's stored food and to reduce the likelihood of carryover of storage pests and diseases from one storage season to the next. Bags can be brushed clean and then if possible dipped into boiling water then hung up to dry in the sun. The area around the sacks or store needs to be kept clean, and clear of any household items which could provide hiding or breeding places or easy entry points for insects or rodents. Make sure the walls and roof of a store are also swept clean of any previous crop residues or insect life stages. Any cracks in the wall or floor of a store should be filled. Mud walls can be re-plastered each season to help ensure insects that are hiding in the crevices are not able to infest the new crop as soon as it is placed in the store. Some storage insects pests can bore into the timber pole structures of a store, if you notice insect infestation of the timber in a store it is best to remove the infested timber and replace it with new timber as otherwise it will act as an easy source of re-infestation. The discarded wood should be burnt quickly to prevent the insects in it infesting new products.

**Only store good quality products:** Make sure the product you are storing is of a good quality. If any of the dried slices or chips look diseased or have recent insect feeding holes in them, discard them as they will otherwise act as a source of infestation while in storage. Remove any foreign matter e.g. stones, straw, dirt from the product to be stored as these materials will hold water and could cause the product to become mouldy during storage.

**Regular monitoring:** Inspect the stored sweetpotato regularly for signs of any damage by insects or rodents (e.g. insect feeding dust, rodent droppings and spillages, distinctive smells), any rotting or dampness. If the signs are spotted early, action can be taken before the damage becomes severe.

**Protecting your stored commodity from rodents:** A good store should keep the product cool and dry, and protect it from rodents, birds, livestock and thieves; most stores do not manage to prevent insects from entering. If rodents become a problem in an indoor bag store, traps can be placed on the floor along the wall or in the corners, as rodents like to run along next to the edges. Rodent poisons can also be used, but should be avoided if young children or livestock are present, as they are lethal to humans and farm animals. Rodent poisons should NEVER be placed in the stored food commodity as if any of it accidentally got mixed up with the stored sweetpotato it would poison the person who ate it. For outside stores, ensure there are no overhanging branches of trees which rodents could use to access the stored product. If possible a store should be raised to 1m above ground height, and rodent guards should be placed on the legs to prevent rodents from being able to access the stored commodity.

**Protecting your stored sweetpotato from storage insect pests:** A wide range of stored product insect beetle pests are known to attack dried sweetpotato and dried cassava (see section 7.7). The adult beetles are <1cm in size, and often bore holes into the dried sweetpotato and then lay their eggs inside these holes. On emerging their larvae feed inside the dried sweetpotato pieces forming tunnels and greatly reducing the quantity and quality of the stored product. Signs of such infestation

include small feeding holes on the sweetpotato chips and presence of insect feeding dust. Most storage insect pests take about a month to complete their lifecycle from egg to adult. So if the dried sweetpotato is only going to be stored for a couple of months, pest damage is unlikely to be high. Pest management practices should be implemented if the product is to be stored for longer than two months.

There are many practices which farmers can use singly or together to reduce storage insect damage to dried sweetpotato. These include:

*Sun-drying:* If insect pest damage is observed in the stored sweetpotato, it can be taken out of the store and re-dried in the sun. Make sure you place the dried sweetpotato on a clean mat, plastic sheet or tarpaulin, and that it is spread in a thin layer e.g. ~2cm thick. Leave it in the hot sun for a few hours, and the heat will destroy many of the developing pupae, larvae and eggs within the commodity. Make sure livestock cannot reach it. Re-drying the product at regular intervals during the storage season can help reduce the moisture content and insect infestation levels.

*Parboiling:* If the sweetpotato slices are par-boiled for 5 minutes before sun-drying, this will harden the resulting chips making them less attractive to storage insects. Alternatively, fresh sweetpotato roots can be boiled for 30-60 minutes prior to peeling, slicing and sun-drying.

*Salting:* Adding 20-30g of salt per kg of freshly sliced sweetpotato chips has been found to reduce insect storage pest attack.

*Insect proof containers:* Storing dried sweetpotato chips inside clay pots with sealed lids, can prevent insects from infesting the product as long as it was not already infested prior to storage.

*Traditional protectants:* Ash and dried plant materials are often mixed in with stored products to help repel or kill insect storage pests. The removal of these materials can often be a big job though as large quantities are usually required for effective pest management, and need to be removed before consumption. Some plant materials may be toxic to humans, and it is therefore important to make use of relevant practices and knowledge already existing in the community.

## 8.8 Gender and diversity aspects of sweetpotato harvesting and post-harvest management

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in Topic 11. Key gender and diversity issues relevant to sweetpotato harvesting and post-harvest management include:



- Understanding sweetpotato harvesting and post-harvest roles and access to resources in the community.
- Building on the understanding of gender and diversity roles to ensure appropriate tools for harvesting, transporting the roots home from the field or storing the fresh roots already exist or are being introduced or developed.
- Fresh root pit and clamp stores require significant labour to construct and maintain them, if those who would benefit from fresh root storage cannot access the required labour, these technologies may not be adopted.
- Manually chipping and drying sweetpotato roots is labour intensive, labour saving technologies exist but are they accessible to those typically involved in chipping and drying sweetpotato roots?
- As with all activities it is important to not only target those groups who will be involved in doing the focal post-harvest activity but also those who control the resources involved and who have a say in relevant decisions which affect the process including community leaders.

## 8.9 Ideas for sweetpotato harvesting and post-harvest learning-by-doing activities

These learning by doing activities have been designed to provide hands-on discovery learning opportunities for the participants of the 10 day ToT course on '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. The training on Harvesting and Post-harvest Management and on Processing and Utilisation will be combined into Day 8 of the ToT course. An overview of the suggested Day 8 programme is given below. However, we hope these activities will also be used by trainers as stand-alone learning activities and in other training courses.

Day	Topics	Intended Learning Outcomes	Activities
8	Harvesting, post-harvest management, and processing	<p><i>Participants will:</i></p> <ul style="list-style-type: none"> <li>- Know about the main aspects of sweetpotato harvesting, post-harvest management and processing</li> <li>- Understand how the processing and storage of OFSP affects its beta-carotene content</li> <li>- Understand the importance of involving different groups in processing training and awareness</li> </ul>	<ul style="list-style-type: none"> <li>- <i>Activity 8.9.1: Increasing profits through storing fresh sweetpotato roots.</i> Field exercise to harvest roots, separate out damaged roots; set up a protected fresh root pit store (NB grass, bamboo pool and wood for cover need to be arranged in advance and hole dug in advance) (see Activity 8.9.1) [2hrs]</li> <li>- <i>Activity 8.9.2: Effect of sun-drying and storage on beta-carotene content of OFSP.</i> Participants observe the differences between samples of OFSP chips which have been sun-dried for 7, 5, or 2 days. Beta-carotene content estimates are provided to illustrate how the beta-carotene content declines over time during storage. (see Activity 8.9.2) [30 mins]</li> <li>- <i>Presentation 8.</i> Piecemeal harvesting, chip drying and curing for improved shelf-life; including gender aspects. Post-harvest management of fresh roots and dried chips; storage containers, protection from pests and monitoring over time. Discuss who in the household is responsible for storage, and how to ensure information reaches them? [45 mins]</li> <li>- <i>Activity 9.8.1: Substituting sweetpotato flour for wheat flour in a chapati recipe AND Activity 9.8.2 Making sweetpotato juice AND Activity 9.8.3 Making sweetpotato flossis.</i> Split the group into halves and in small groups have them follow either Activity 9.8.1 or (9.8.2 &amp; 9.8.3). [2hrs 30 mins]</li> <li>- <i>Presentation 9.</i> Processing and discussion on who to target for processing training, such as people who are already micro-food processors and might incorporate OFSP, discussion regards the importance of involving men even though women do the food preparation usually, but men are still influential in deciding what foods to plant or purchase. [45 mins]</li> </ul>

Note the training on Harvesting and Post-harvest Management and on Processing and Utilisation will be combined into Day 8 of the ToT course. The suggested processing and utilisation activities are described in Section 9.8. Two 'harvesting and post-harvest management' learning by doing activities are described below.

### 8.9.1 Increasing profits through storing fresh sweetpotato roots

*Intended Learning Outcome:* Participants will:

- be able to estimate the yield and value of a field of sweetpotato roots
- understand good harvesting practices in order to minimise losses during harvesting and post-harvest
- know how to set up a pit store for fresh root storage, select undamaged roots to place in it, and be aware of the key fresh storage problems

*Timing:* 2 hours

*Materials:* nearby sweetpotato field which is ready for harvest and where the participants can dig up 10 plants per group to work out the yield; scales; sacks; calculator; pen and paper; spades; hoes; dry grass; bamboo poles; harvesting sticks; branches, thatching grass and string

*Advanced preparations:* Identify or plant a nearby sweetpotato plot that the trainees can harvest in order to calculate yield.

*Suggested steps:*

1. Ask the participants to work in groups of ~8 people. Explain to them that they will be visiting a field and will firstly have to estimate the yield of the field and harvest some roots which they will then use to set up either a pit or a clamp store in which they can store the fresh roots. Walk to the field. [10 mins]
2. Once at the field, remind them that in order to store fresh roots, the roots need to be undamaged, so they should be carefully while they are harvesting and weighing the roots of their plants. [5 mins]
3. Ask each group to work out the sweetpotato yield of the field, using the following method. They should then compare their findings between groups, and then discuss the current per kg price of this variety of sweetpotato and use that to calculate the value of the sweetpotato in the field. [30 mins]

#### ***Working out the yield of your field prior to harvesting***

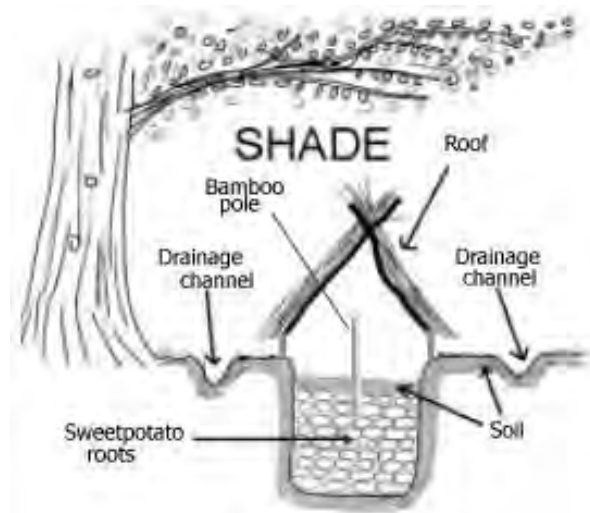
- Dig up at least 10 plants randomly selected from across your field, and weigh the roots from each of them.
- Record the weight of roots for each plant. e.g.

1	2	3	4	5	6	7	8	9	10
1.2	2.3	2.6	3.0	2.3	1.7	2.0	2.3	2.7	1.9

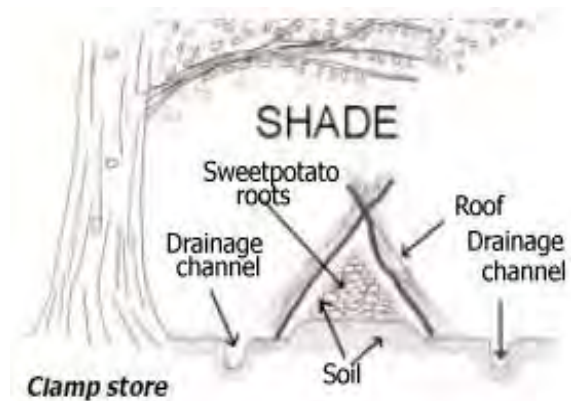
- Then calculate the average weight of roots per plant. To do this, add up all the weights you recorded and then divide by the number of plants you sampled. e.g. 22kgs / 10 plants= 2.2kg/plant.
- To work out the yield of your whole field. Count how many plants there are in your field, and multiply that number by the average yield (e.g. average yield = 2.2kg in this example). So if you had 4,000 sweetpotato plants in your field, you would multiply 2.2 x 4,000. You can then estimate that your field has 8,800 kgs of sweetpotato roots in it.

4. Explain that each group can decide whether to construct a pit or a clamp store for storing their fresh sweetpotato roots. (The facilitator should however ensure that both types of fresh root store are being constructed). Remind the participants that they should think carefully about where they will site the store. [1 hour]

**Pit stores:** Hole dug in an area of dry ground. Whilst it is often recommended that the hole should be lined with dry grass to cushion roots from damage and absorb moisture helping to prevent roots from rotting, other studies suggest it is important not to line the pit with grass- so you may wish to experiment with both methods. Place roots carefully into the pit, cover completely with more dry grass (if you are using it) and then seal with dry soil up to normal ground level. A bamboo pole should be carefully inserted through the soil to act as a ventilation pipe, ensure that its top end is high enough above ground level to reduce the chances of weevils crawling down it. Cover the pit with a raised sloping roof to shade the pit store, and protect it from rain that could cause rotting. Size and shape of hole depends on the number of roots to be stored. Add a drainage channel around the store to divert rainwater.



**Clamp store:** This structure should be made on a flat mound of earth raised about 10cm above ground level. Cover the flat mound (~1m wide) with dry grass for cushioning and to absorb moisture (note: you may wish to experiment with and without the dry grass layer). Carefully pile undamaged sweetpotato roots on top, then cover with more dry grass and then with a 10-20cm thick layer of dry soil. Cover the structure with a thatched roof to protect it from sun and rain, allow a gap all the way round between the roof and mound for ventilation. Add a drainage channel around the store to divert rainwater.



5. After the groups have looked at each others' clamp or pit stores, facilitate a discussion regards the issues associated with fresh root storage (e.g. off-season market prices, rotting, need for undamaged roots, where to site the fresh root stores, monitoring of fresh root stores, re-use of fresh root stores). [15 mins]

## 8.9.2 Effect of sun-drying and storage on beta-carotene content of orange-fleshed sweetpotato

*Intended Learning Outcome:* Participants will understand how the processing and storage of OFSP affects its beta-carotene content

*Timing:* 30 mins

*Advanced preparation:* On the first day of the 10 day ToT course, prepare a small quantity of OFSP chips and place them out on a raised rack to sun-dry (this will become the 'sun-drying for 7 days sample'), on day 3 of the ToT course, chip some more OFSP and place it on the same raised rack but do not mix it with the first sample. Make sure the samples are clearly labelled and protected. On day 6 of the ToT course, chip some more OFSP and place it on the same raised rack to sun-dry, and ensure it is clearly labelled and not mixed with the earlier samples. On Day 9 of the ToT carefully collect the three samples (keep them separate) and take them into the training room and place them on a side table.

*Materials:* ~50 orange-fleshed sweetpotato roots, chipping machine, raised drying rack, at least 3 sample bags, labels, marker pens, data set showing how beta-carotene content decreases with prolonged sun-drying, sufficient photocopies of the data set showing how beta-carotene content decreases with prolonged storage (Handout 8.9.2a).

*Suggested steps:*

1. You will have chipped and sun-dried the different batches of OFSP in advance (see advanced preparation above). Carefully collect the three samples, and keeping them separate carry them into the training room and display them on a side table, each should have a clear label that states how long they were sun-dried for.
2. Ask the participants to quietly observe the different samples, and then ask them to suggest what differences they saw between the samples and why they think these differences exist, and why they might be important. [15 mins]
3. If possible provide beta-carotene content estimates of the different samples and ask the participants what conclusion they can draw from this information and how does it affect sun-drying practices. (*Note: when chips of Ejumula variety were sun-dried for 1 day the beta-carotene loss was 10%, and after 3 days sun-drying it was 48% in Uganda*). [5 mins]
4. In addition to sun-drying, storage also affects the beta-carotene content. Provide the participants with beta-carotene content data from samples that were stored for different periods of time (Handout 8.9.2a). Give them a few minutes to study the data and discuss it with their neighbour and then ask them to explain what happens to the beta-carotene content over time and how temperature influences this. Ask them to explain what implications this has for storage practice this information has (e.g. cool room, opaque packaging). [10 mins]
5. In summary draw out or explain that:
  - the key issue for beta-carotene retention in dried chips is storage period and not drying. **"It doesn't matter how well you dry your sweet potatoes, if you store them for four months, you will have lost your beta-carotene."**
  - the initial beta-carotene level is also important: if you have little beta-carotene at the beginning, you will get less in the end product. If you have high levels at the start then you will lose some but still have enough beta-carotene at the end for the food to be nutritious.
  - other quality issues can also occur during storage leading to off-smells, rancidity etc.

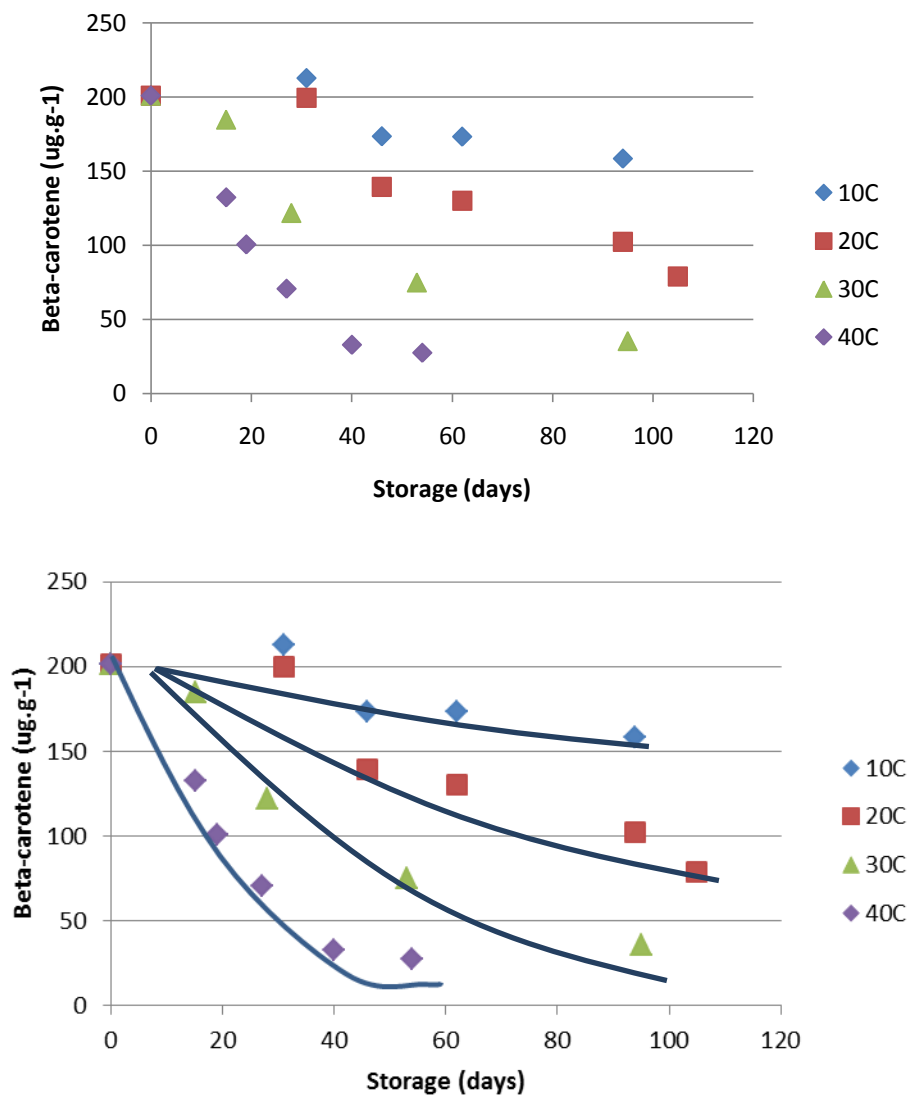


**Handout 8.9.2a** Beta-carotene concentration of dried sweetpotato chips over different storage periods and at different temperatures.

Data set

at 10°C		at 20°C		at 30°C		at 40°C	
Storage (days)	Average beta-carotene concentration (ug/g dwb)	Storage (days)	Average beta-carotene concentration (ug/g dwb)	Storage (days)	Average beta-carotene concentration (ug/g dwb)	Storage (days)	Average beta-carotene concentration (ug/g dwb)
0	201.0	0	201.0	0	201.0	0	201.0
31	212.8	31	199.6	15	184.9	15	132.4
46	173.6	46	139.3	28	121.9	19	100.7
62	173.3	62	130.1	53	75.0	27	70.8
94	158.5	94	102.2	95	35.5	40	32.9
105		105	78.8			54	27.6

**Logarithmic degradation of beta-carotene during storage of dried sweetpotato chips of Ejumula variety at 4 different temperatures**



## 8.10 References used

- Ameu, M., Carey, E., (2011). TOT training manual on sweetpotato vine multiplication.
- Bechoff, A., Westby, A., Menya, G., Tomlins, K.I., (2011). Effect of pre-treatments for retaining total carotenoids in dried and stored orange fleshed-sweetpotato chips. *Journal of Food Quality*, 34, 259–267.
- Edmunds, B., Boyette, M., Clark, C., Ferrin, D., Smith, T., Homes, G., (2008). Post harvest handling of sweetpotatoes. North Carolina Cooperative Extension Service. 56pp.  
[http://www.bae.ncsu.edu/people/faculty/boyette/pubs/sweetpotatoes\\_postharvest-1.pdf](http://www.bae.ncsu.edu/people/faculty/boyette/pubs/sweetpotatoes_postharvest-1.pdf)
- Ezell, B.D. and Wilcox, M.S., (1952). Influence of storage temperature on carotene, total carotenoids and ascorbic acid content of sweetpotatoes. *Plant Physiology*, 27(1): 81-94.
- IIRR (1996). Environmentally sound technologies for women in agriculture. 213pp.  
<http://collections.infocollections.org/ukedu/uk/d/Jii01ee/4.4.html>
- Low, J., Lynam, J., Lemaga, B., Crissman, C., Barker, I., Thiele, G., Namanda, S., Wheatley, C., Andrade, M., (2009). Chapter 16 Sweetpotato in sub-Saharan Africa. In: *The Sweetpotato*. Loebenstein, G., Thottappilly, G., (Eds.). Springer. pp359-390.
- NRI, LZARDI, TFNC, (undated). Storing sweetpotato made simple. 2pg leaflet. NRI, UK.
- Omosa, M., (1997). Current and potential demand for fresh and processed sweetpotato products in Nairobi and Kisumu, Kenya. CIP, Lima.
- Ray, R.C., Ravi, V., Hegde, V., Rajasekhara Rao, K., Tomlins, K., (2010). Chapter 2 Post harvest handling, storage methods, pests and diseases of sweet potato. In: *Sweet Potato: Post Harvest Aspects in Food, Feed and Industry*. R.C. Ray, K.I. Tomlins (Eds.). Nova Science Publishers, New York. 316pp.
- Roy, S.R., (undated). Presentation on: On-farm storage technology can save energy and raise farm income.  
<http://ucce.ucdavis.edu/files/datastore/234-2143.pdf>
- Smit, N., (1997). Integrated pest management for sweetpotato in Eastern Africa. Thesis (PhD), Wageningen Agricultural University, The Netherlands, 151pp.
- Stathers, T., Namanda, S., Mwanga, R.O.M., Khisa, G., Kapinga, R., (2005). Manual for sweetpotato integrated production and pest management farmer field school in sub-Saharan Africa. CIP, Uganda. pp168+xxxi
- Tomlins, K., Ndunguru, G., Kimenya, F., Ngendello, T., Rwiza, E., Amour, R., van Oirschot, Q., Westby, A., (2007). On-farm evaluation of methods for storing fresh sweet potato roots in East Africa, *Tropical Science*, 47, 197-210
- Tomlins, K., Rees, D., Coote, C., Bechoff, A., Okwadi, J., Massingue, J., Ray, R., Westby, A., (2010). Chapter 10 Sweet potato utilization, storage, small-scale processing and marketing in Africa. In: *Sweet Potato: Post Harvest Aspects in Food, Feed and Industry*. R.C. Ray, K.I. Tomlins (Eds.). Nova Science Publishers, New York. pp. 271-293.
- Wheatley, C., Loechl, C., (2008). A critical review of sweetpotato processing research conducted by CIP and partners in sub-Saharan Africa. CIP, Lima, Peru. Social Sciences Working Paper 2008-3. 48pp.

# TOPIC 9: PROCESSING AND UTILISATION

## IN

### EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

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## Topic 9: Processing and Utilisation

### 9.1 How to process orange-fleshed sweetpotato, retain the beta-carotene content and add value

Orange-fleshed sweetpotato (OFSP) is usually cooked before being consumed. Traditional methods of preparing OFSP in Sub-Saharan Africa include boiling, steaming, roasting and drying (Table 10.1).

**Table 10.1 Traditional methods of preparing orange fleshed sweetpotato**

<b>Boiling</b>	<ul style="list-style-type: none"><li>• Use clean water.</li><li>• Wash sweetpotato roots.</li><li>• Peel the roots (optional); the peel has lots of dietary fibre.</li><li>• Boil the sweetpotato roots until they are soft.</li></ul>	 A photograph showing several slices of boiled orange-fleshed sweetpotato on a white plate. The slices are cut lengthwise, showing the bright orange interior and the yellowish peel.
<b>Steaming</b>	<ul style="list-style-type: none"><li>• Use clean water.</li><li>• Wash the sweetpotato roots.</li><li>• Peel the roots (optional).</li><li>• Wrap them in banana leaves.</li><li>• Steam them over boiling water until they are soft.</li></ul>	 A photograph showing a person's hands wrapping sweetpotato roots in large green banana leaves. The roots are placed in a white bowl, and the leaves are being folded over them.
<b>Roasting</b>	<ul style="list-style-type: none"><li>• Wash the sweetpotato roots and wipe them to remove moisture.</li><li>• Either wrap the sweetpotato roots in banana leaves and place them in the ashes of a fire until they are cooked or place on a grill above charcoal.</li><li>• Sweetpotato roots can also be roasted in an oven.</li></ul>	 A photograph showing sweetpotato roots and other vegetables like corn cobs being roasted over a fire. The roots are in a metal basket or grill, and the fire is visible below.
<b>Drying</b>	<ul style="list-style-type: none"><li>• Wash sweetpotato roots and wipe or pre-dry them in the sun to remove external moisture.</li><li>• If possible use a chipper or a slicer to cut the roots into thin pieces that dry fast. Alternatively roots can be sliced by hand but bigger pieces will take longer to dry.</li><li>• Spread the pieces on a clean surface (for example a black plastic sheet or a mosquito mesh) and leave it in the sun until dry (do not dry it on the ground as it can get contaminated with dirt). The total drying time should not exceed 3 days.</li><li>• Pack the dried pieces in opaque bags and seal them. Store in a clean, cool and dry place with limited sun light.</li><li>• Mill the dried pieces into flour.</li></ul>	 A photograph showing a man standing next to several long, narrow trays filled with sliced sweetpotato roots. The trays are placed outdoors in the sun, and the slices are being dried. The man is wearing a purple shirt.

During the preparation of OFSP, some of the micronutrients that it contains such as beta-carotene can be lost (by washing) or destroyed (by cooking, sun exposure, long-term storage). Processes causing the least to the greatest beta-carotene loss in OFSP roots are roasting > boiling > frying > steaming > sun-drying (see Figure 4.6. in section 4.3.1).

### How to retain the beta-carotene content?

- *Process quickly:* beta-carotene degrades when exposed to long preparation times and high temperatures. Don't overboil, oversteam, over-roast or overdry your OFSP.
- *Process with the skin:* peeling is not a necessary stage of preparation as the peel can be removed after cooking or when it is dried. Not peeling the roots before processing will save time. If the OFSP is properly washed and clean, it is not necessary to peel it. Leaving the skin on the sweetpotato root can help retain more of the beta-carotene and other vitamins during processing.
- *Do not store the processed OFSP for long periods.* Beta-carotene is degraded during storage of the processed product. Dried OFSP that is stored for more than 1 month starts to lose its beta-carotene. The longer the dried product is stored the more the beta-carotene is destroyed. If dried OFSP needs to be stored, it should be in a cool and dried place and in opaque packaging (so sun-light cannot destroy the beta-carotene in the product).



### How to add value?

In addition to the traditional preparations described above, there are multiple novel ways of preparing OFSP to add value to it. In order to tackle vitamin A deficiency and increase consumption of OFSP, the CIP and HarvestPlus Challenge project have developed various recipes with OFSP.

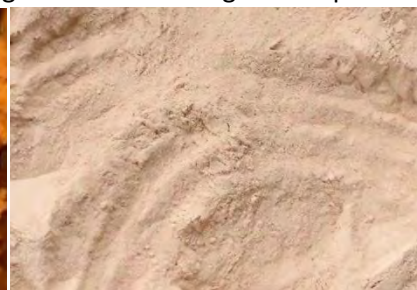
There are three primary products from OFSP that can be used as ingredients for a range of recipes:



Fresh-grated sweetpotato



Boiled and mashed sweetpotato often referred to as puree



Sweetpotato flour

These three primary products can replace some of the wheat flour in commonly consumed food products. They can be incorporated into bread, bakery products such as mandazi (traditional doughnut), chapati, cakes, biscuits, croissants, pies etc. Consuming two OFSP mandazi is equivalent to  $\frac{3}{4}$  of the vitamin A daily intake requirement for a child. Consuming one OFSP chapati is equivalent to 100% of the vitamin A daily requirement for a child.

In addition, sweetpotato flour can be mixed with other flours (roasted soybean, roasted maize, millet, cassava, Amaranthus) to produce composite flour that can be used to make porridges. These porridges can be consumed by children. Consuming one mug of porridge containing 30% OFSP would provide a child with about 20% of his/her vitamin A daily nutritional requirement. Other products from OFSP include sweetpotato jam, ketchup etc. In addition to these products, the sweetpotato leaves can also be used to prepare relish. Recipes are provided in section 9.3.



Mandazi from OFSP: wheat (30:70) flours



Porridge from OFSP: soybean: maize (30:35:35) flours



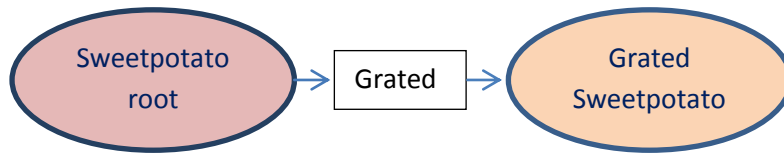
Ingredients for sweetpotato jam



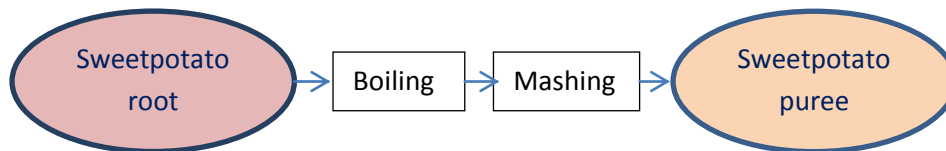
Relish made from sweetpotato leaves

## 9.2 Sweetpotato flour versus grated sweetpotato or sweetpotato puree

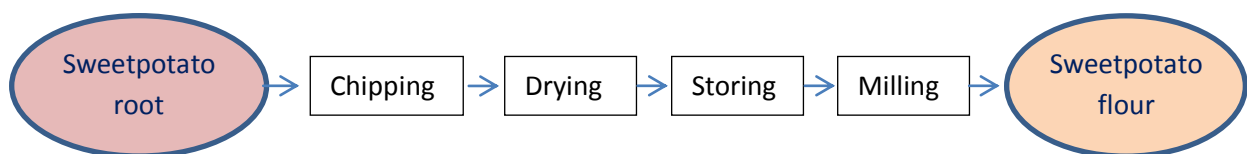
*Grated sweetpotato* is made from raw and grated (shredded) sweetpotato:



*Sweetpotato puree* is made from boiled and mashed sweetpotato:



*Sweetpotato flour* is made from dried and milled sweetpotato:



Making sweetpotato flour is a more complex and longer process than making grated sweetpotato or puree. The disadvantage of flour preparation is that the beta-carotene can be easily lost during the process. This is particularly true if the product is stored for some time. The drying process also has greater labour and equipment (a dryer) requirements than the boiling process. Good drying conditions as well as qualified personnel/ processors are necessary to perform the operations.

On the other hand, sweetpotato flour has some advantages over grated sweetpotato or puree: since the water is removed from the product, it is then lighter, making transport and storage easier. Additionally the beta-carotene content is more concentrated in a product that contains little water and in some cases higher contents of beta-carotene can be achieved. In addition, sweetpotato flour can be easily incorporated into products that usually use wheat flour. Sweetpotato flour can favourably replace 25-50% of the wheat flour used in several high-value bakery product recipes for biscuits, croissants and doughnuts. The use of mashed and boiled sweetpotato (puree) requires changing the proportions of other ingredients when making baked products and the dough is more difficult to work with for processors. The final products made with a mixture of wheat flour and sweetpotato puree have a different texture from the original products made with only wheat flour, whilst those products made by substituting sweetpotato flour for some of the wheat flour do not differ. The changed texture might affect the taste, and consumer preference. However, in our experience, most consumers prefer the taste and appearance of the product containing the sweetpotato puree over the product with only wheat flour.

Bread and mandazi have been successfully made from composite flours of OFSP and wheat (~20%/80%). The price of the different flours determines how cost effective this is. Raw and grated OFSP roots or puree may be preferred for bread making when the price of flour is high. Porridge prepared from OFSP-sorghum (70%/30%) composite flour (similar to *atap*) had high beta-carotene levels. When the traditional Ugandan cassava flour and banana pulp deep fried pancake (Kabakagala) was made using sweetpotato flour instead of cassava flour it attracted significant consumer interest. While attempts in Kenya to prepare the staple dish Ugali (normally made from maize or sorghum flour) from sweetpotato flour, led to complaints that the product was too sweet. Most new products need some promotional activities to help develop market demand for them. These aspects are discussed in Topic 10 of this manual.

The substitution of wheat flour, either with fresh grated OFSP, boiled and mashed OFSP or OFSP flour, is gaining a foothold in the snack product market in East Africa. However, the profit is dependent on the relative cost of sweetpotato roots or flour to wheat flour and the degree of substitution. It takes 4-5 kilograms of fresh sweetpotato roots to make a kilogram of flour; while just 1.25 kilograms of fresh roots to make a kilogram of puree. For example in Rwanda, bread is being made using up to 30% sweetpotato puree, mandazi up to 40% sweetpotato puree, and biscuits up to 45% sweetpotato puree.

There are pros and cons for the use of 'fresh and grated', 'boiled and mashed (puree)' and 'dried and milled (flour)' sweetpotato products and each case should be considered individually in order to find the most practical and economically feasible way of using the sweetpotato. For some recipes you will want to use varieties with high dry matter content, and for others such as weaning foods varieties with low dry matter content are more suitable.

### 9.3 Using sweetpotato to add nutritional value at the household level

For rural households, emphasis should be put on including sweetpotato particularly orange-fleshed sweetpotato (OFSP) in their existing diet if it is not already being eaten several times a week. For example, if the household cooks a stew, sweetpotato chunks can be added to the stew. In many countries, there is a traditional sweetpotato with groundnut dish. This is a really healthy food, especially when made with OFSP roots, as they contain vitamins A, C, and several B vitamins and minerals (see Topic 4) and the groundnuts have protein and fat. The use of OFSP roots as a breakfast food should be promoted as it is much more nutritious than bread and much more filling. Children can carry boiled or baked OFSP roots to school as a healthy snack. Better-off households may be making bakery products in which OFSP roots can become an ingredient. Boiled, fried, and baked sweetpotato can be rotated on the weekly menu, diversifying how it is prepared, often leads to increased frequency of consumption.

Families should also be encouraged to select young and tender sweetpotato leaves for use as a vegetable. These may be cooked in the same way other popular African leafy vegetables such as Amaranthus are cooked. They can also be prepared by frying with a little oil, and then cooked with tomatoes and onions for a few minutes, adding pounded groundnuts if they are available (see section 9.4).

When infants turn 6 months of age, sweetpotato can be one of the first complementary weaning foods they receive. Unfortunately, in most SSA countries young children are given thin, runny porridges of just maize meal or cassava meal. Infants have small stomachs, and need them filled frequently with nutrients, not with water. We need to encourage care givers of infants to prepare *enriched* porridges. An enriched porridge is thick - it does not fall off the spoon easily. An enriched porridge contains each of the following types of food, mashed before adding them to the porridge:

1. A source of energy (carbohydrates and fats): e.g. sweetpotato, maize, wheat, cassava, potato and fats/oils (groundnuts, vegetable oil, coconut, avocado) - just a little oil packs a lot of energy
2. A protective food (vitamins and minerals): e.g. orange-fleshed sweetpotato (vitamins A, C), mango and other fruits and vegetables like pumpkin and dark green leaves, eggs, milk
3. A body building food (proteins): e.g. beans, eggs, milk, meats, chicken, fish, sesame, groundnuts, some insects

Actually, all family members should eat from each of these three food groups at each meal (see Topic 4 for details). To be healthy, people must eat *enough* food and the *right* foods. Orange-fleshed sweetpotato roots provide both energy and vitamins and so they are superior to cassava tubers that are just a source of energy only. Sugar is *not* a good food for infants and should *not* be added to porridges and young children should *not* be given sugary drinks. Use fruits and orange-fleshed sweetpotato to add a sugary taste to children's foods.

## 9.4 How to cook delicious sweetpotato recipes

A wide range of delicious recipes can be made using sweetpotato, the following pages contain recipes for a selection of popular ones. However, it should be remembered that the healthiest way to eat your orange-fleshed sweetpotato is to boil and mash it and add just a teaspoon of oil to increase vitamin A absorption. Deep fat fried products (chips, crisps) are much less healthy than boiled or baked products.

Quantity conversions are given in section 9.4.23, however due to varying cup sizes in the different places these recipes have originated from, it is not advisable to convert the measurements in these recipes.

### 9.4.1. Sweetpotato porridge

#### *Ingredients:*

- 1 heaped tablespoon sweetpotato flour
- 4 heaped tablespoons millet, sorghum, cassava or maize flour
- 1 heaped tablespoon soya flour
- 1 small lemon
- 2 tablespoons sugar
- 6 cups water

#### *Procedure:*

1. Bring five cups of water to boil.
2. Mix the cereal/root crop flours with the soya flour and make a paste with the remaining one cup of water.
3. Pour the paste into the boiling water and keep stirring to prevent lumps.
4. Squeeze the juice of the lemon into a cup while the pot continues to boil for 20 minutes.
5. The cooked product should jell.
6. Remove from fire; add the lemon juice and sugar.
7. Cool, then serve warm. Milk can be added if desired.

Other popular formulations of composite flours for making porridge are:

- Sweetpotato-maize-soybean (30:35:35);
- Sweetpotato-maize-amaranthus (30:35:35),
- Sweetpotato-maize-groundnut (25:50:25);
- Sweetpotato-millet-soybean (35:30:35);
- Sweetpotato-millet-amaranthus (35:30:35);
- Sweetpotato-millet-groundnut (30:40:30);
- Sweetpotato-soya (50:50).



*Lady preparing porridge from OFSP:soybean:maize (30:35:35) flour, Kawanda, Uganda - Feb. 2010*



### 9.4.2. Sweetpotato mandazi

#### Ingredients:

- ½ cup sweetpotato mash or sweetpotato flour (30%)
- 2 cups wheat flour (70%)
- 2 tablespoons sugar
- Pinch of salt
- 2 cups cooking oil
- 1 tablespoon baking powder
- Adequate lukewarm water



*Sweetpotato mandazi*

#### Procedure:

1. Put the sweetpotato mash in a mixing bowl and sift in the dry ingredients.
2. Add water and mix into a dough.
3. Knead the dough well while adding 2 tablespoons of oil.
4. On a floured surface, roll the dough to about 1 cm thickness.
5. Cut into desired shapes.
6. Deep fry while turning till golden brown.
7. Remove from oil, drain and serve warm or cold.



### 9.4.3. Sweetpotato-soya chapati

#### Ingredients:

- 1 cup grated, boiled and mashed sweetpotato or sweetpotato flour
- 2 cups wheat flour
- 1 cup soya flour
- 1 teaspoon salt
- Adequate lukewarm water
- ½ cup oil

#### Procedure:

1. Mix the dry ingredients together in a bowl.
2. Add the grated sweetpotato and mix.
3. Add 1 tablespoon of oil and mix well.
4. Add the lukewarm water to the mixture in the bowl and knead till a stiff smooth paste is formed.
5. Divide the dough into 8-10 equal balls.
6. On a lightly floured surface roll one ball at a time.
7. Fold each ball at a time to form a strip.
8. Coil each strip to form a circle and put aside for 20 minutes.
9. On a floured surface, roll out each coiled circle into a thin circular sheet.
10. Grease a shallow frying pan.
11. Fry each circular sheet on both sides till golden brown, make sure both sides are greased.
12. The resulting chapatti can be served with stew or sauce or tea.



*Chapatis from OFSP: wheat (30:70) flours, Bwaise, Uganda - Feb. 2010*

#### 9.4.4. Sweetpotato “mshenye”

*Ingredients:*

- 10 medium sized sweetpotato roots
- 2 cups maize kernels
- 4 cups beans/ cowpeas or greengrams
- Salt to taste
- Adequate water

*Procedure:*

1. Sort maize and beans and pre-soak for 6-8 hours.
2. Boil the maize and beans till almost cooked.
3. Remove any soil from the sweetpotato roots and peel them.
4. Wash and slice the sweetpotato roots.
5. Add the sliced sweetpotato roots to the maize and beans and let cook.
6. When sweetpotato roots are soft and maize and beans are well cooked, mash them.
7. Add salt to taste and serve as balls or a mound heaped on a plate.



*Sweetpotato ‘mshenye’*



#### 9.4.5. Sweetpotato crisps

*Ingredients:*

- 6 medium sized sweetpotato roots
- 2 cups oil
- Salt and red pepper to taste
- 2 containers water for preparing the roots

*Procedure:*

1. Remove soil from roots and then peel and place the roots in clean water.
2. Slice roots into very thin pieces using a knife or the larger blade of a grater.
3. Drain off the water.
4. Heat the oil and deep fry till the crisps start to turn golden brown.
5. When golden brown remove and drain.
6. Add salt and red pepper to taste, serve warm or cold.



*Sweetpotato crisps*

#### 9.4.6. Sweetpotato doughnuts

*Ingredients:*

½ cup grated sweetpotato root  
2 cups wheat flour  
1 teaspoon yeast  
2 tablespoons sugar  
Pinch of salt  
2 cups oil  
1 tablespoon cooking fat  
2 teaspoons grated lemon peel  
Adequate lukewarm water  
Optional - milk/egg



*Sweetpotato doughnuts*

*Procedure:*

1. Put yeast and 1 tablespoon of sugar into a cup.
2. Add 3 tablespoons of warm water and leave for 10 minutes to rise.
3. Put the grated sweetpotato into a mixing bowl and sift in the dry ingredients.
4. Add in the grated lemon peel and mix.
5. Rub in the cooking fat and then add the risen yeast and mix.
6. Add water and knead into a dough.
7. On a floured surface, roll the dough slightly.
8. Make the dough into a ball and return to mixing bowl.
9. Cover the mixing bowl with wet warm cloth and leave to dough to double in size. Placing the bowl in the sun for 10 minutes helps it rise.
10. Re-knead the dough after doubling and roll onto a floured surface.
11. Cut into desired shapes and deep fry till golden brown.



#### 9.4.7. Sweetpotato crackies

*Ingredients:*

1 cup sweetpotato flour or 1½ cups sweetpotato mash  
2 kgs (~10 cups) wheat flour  
3 teaspoons salt  
5 small pieces garlic  
12-15 pieces local green hot pepper local or 3 pieces exotic green hot pepper  
0.8 litres sunflower oil  
Lukewarm water



*Sweetpotato crackies*

*Procedure:*

1. Sift all dry ingredients in a mixing bowl.
2. Add sunflower oil.
3. Knead to form a smooth dough, till it leaves the bowl clean.
4. Add a little lukewarm water and keep mixing until hard and smooth. Cover it immediately with a clean cotton cloth.
5. Cut and make into small balls, roll them till flat and transparent. Add juice from crushed green hot peppers depending on the consumer's preference.
6. Heat oil and fry the flat crackies in it, when lightly brown remove them from the oil, drain the oil and let cool in a covered container.

#### 9.4.8. Sweetpotato drop scone style pancakes

*Ingredients:*

- 1 ¼ cups sweetpotato mash
- 1 ½ cups wheat flour
- 3 ½ teaspoons baking powder
- 1 teaspoon salt
- ½ teaspoon ground nutmeg
- 2 eggs, beaten
- 1 ½ cups milk
- ¼ cup butter, melted



*Sweetpotato drop scones*

*Procedure:*

1. Sieve all the dry ingredients into a mixing bowl.
2. Combine the remaining ingredients, and then add them to the flour mixture.
3. Melt a small knob of butter in a frying pan.
4. Drop tablespoons of the batter into the hot frying pan.
5. Fry, turning the pancakes over once, until browned on both sides.



#### 9.4.9. Golden bread sweetpotato buns

*Ingredients (for 44 small buns):*

- 3 cups (each 300ml) or 950g of boiled and mashed orange fleshed sweetpotato (cooked and peeled before mashing) OR re-hydrate 350g of dried orange-fleshed sweetpotato chips (to re-hydrate soak the chips in water for 20 minutes then boil until soft enough to mash).
- 1.5kgs (~7½ cups) wheat flour
- 2 tablespoons of yeast
- ½ teaspoon of improver (a product sold especially for bread making) – *optional*
- 1 teaspoon salt (use as little as possible as it makes the buns rise less)
- 1 litre of water (approximate)



*Golden bread sweetpotato buns*

*Procedure:*

1. Begin warming the oven to 180°C (350°F) or light the charcoal in the charcoal oven.
2. Wash 5 medium sized roots of orange fleshed sweetpotato and cook them in boiling water.
3. Peel and mash the cooked roots.
4. Mix together the wheat flour, yeast, improver and salt.
5. Add the mashed sweetpotato to the flour mixture and mix again.
6. Add half the water and knead well for 5-10 minutes.
7. Continue adding water little by little, while continuing to knead the dough until it does not stick to your hands.
8. Make the dough into the buns of the size you want. It is not necessary, nor desired to let the dough rise before shaping it into buns.
9. Cover the buns with a clean cotton cloth and leave to rise for 25 minutes in a warm place, for example in the direct sunlight outside.
10. Sprinkle a small amount of wheat flour on the surface of the baking tray/sheet, before placing the raw buns on top.
11. Bake in a hot oven at 180°C (350°F) for about 15-20 minutes or until they are golden brown.

#### 9.4.10. Sweetpotato bread

*Ingredients:*

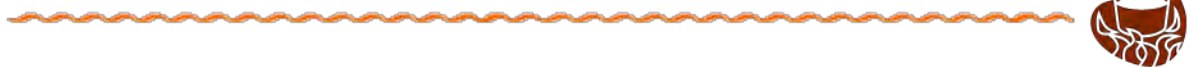
- ½ cup grated sweetpotato
- 2 cups wheat flour
- 1 teaspoon yeast
- 1 tablespoon sugar
- Pinch of salt
- 2 tablespoons oil
- Adequate lukewarm water or milk

*Procedure:*

1. Mix yeast and sugar in a cup.
2. Add 3 tablespoons of water or milk to the cup and leave to rise.
3. To quicken the rising process, cover cup with a warm cloth and put in the sun for 5 minutes or 10 minutes at room temperature.
4. Mix grated sweetpotato with other dry ingredients in a mixing bowl.
5. Add the yeast mix and water into mixing bowl.
6. Knead into dough and add the oil to make it smooth.
7. Divide into two parts.
8. Grease bread tins and shape each dough and place in tin.
9. Leave to rise until it has doubled in size.
10. Bake in oven at 200°C (400°F) for 15 - 20 minutes.
11. Remove and allow to cool and then wrap.



*Sweetpotato bread*



#### 9.4.11. Sweetpotato onion bites

*Ingredients:*

- 1 cup sweetpotato mash
- 2 cups wheat flour
- 3 teaspoons baking powder
- ¾ teaspoons chilli pepper
- 1 teaspoon salt
- ½ cup spring onion leaves
- 1 teaspoon cooking fat
- Water

*Procedure:*

1. Sift all dry ingredients in a mixing bowl. Pound the onions.
2. Add the sweetpotato mash and cooking fat and mix well to a dough.
3. Add water a little at a time and knead to a light texture, let it relax for 10-15 minutes.
4. Heat oil in a pan.
5. Make small sized balls and drop them into the hot oil.
6. Cook till brown drain and serve.



*Sweetpotato onion bites*

#### 9.4.12. Sweetpotato flossis

*Ingredients:*

300g wheat flour  
50g margarine  
200g sweetpotato puree  
65g sugar  
2 eggs  
Oil for frying  
2 teaspoons baking powder

*Procedure:*

1. Beat the margarine and sugar together.
2. Add the eggs and then the sweetpotato puree, keep mixing.
3. Gradually add the flour and baking powder, keep mixing.
4. Knead the dough well until it stops sticking to your hands.
5. Roll small pieces of the dough into little sausage shapes and then tie each in a loose knot or bow
6. Fry in oil (not too hot).



*Sweetpotato flossis*



#### 9.4.13. Sweetpotato steamed cup cakes

*Ingredients:*

2 medium sized roots of orange or purple  
fleshed sweetpotato  
2 ½ cups wheat flour  
1 tablespoon yeast  
½ cup sugar  
1 egg  
100 ml (~ ½ cup) coconut milk (coconut cream)  
¼ tablespoon salt  
5 tablespoons water



*Sweetpotato-steamed orange and purple  
fleshed cup cakes*

*Procedure:*

1. Steam the sweetpotato roots, then peel and mash them and set aside in a bowl.
2. Add 5 tablespoons of water and 1 tablespoon of yeast to 50g of wheat flour and stir it until smooth. Set aside for 20 minutes.
3. Add the sugar, egg, salt, and remaining 200g of wheat flour to the bowl of mashed sweetpotato roots, stir while adding the coconut milk little-by-little into the bowl.
4. Pour the contents of the two bowls in together, mix very well and then leave the mixture to rise for 45 min.
5. Boil water in a steam-pot.
6. Place the paper cup cases into the cups of the baking tray, spoon the batter carefully into each cup case until they are each about ¾ full.
7. Place the baking tray in the steam-pot.
8. Wrap the lid of the pot with a tea-cloth to prevent steam from condensing and dripping on the cup cakes, and then close the lid very tightly. Let the cakes steam for 20 minutes.
9. Remove the cup cakes from the baking tray and allow to cool.

#### 9.4.14. Sweetpotato cake

##### *Ingredients:*

- 1 cup sweetpotato mash
- 3 cups wheat flour
- 4 eggs
- 5 tablespoons margarine/ sunflower oil
- 3 teaspoons baking powder
- 1 medium lemon
- 3 tablespoons sugar
- Adequate water or milk



*Sweetpotato cake*

##### *Procedure:*

1. Sift all dry ingredients in a bowl.
2. Add the sweetpotato mash and 4 tablespoons of margarine and rub in.
3. Beat the eggs and add to the bowl and mix well.
4. Grate lemon rind and add to the bowl and mix.
5. Make juice from the lemon and add to the contents in the bowl and mix well.
6. If consistency is not runny, add a little water or milk.
7. Grease baking pan and pour in contents.
8. Bake in oven at 175°C (360°F) for 30 minutes or till golden brown.
9. Alternatively bake on an open-fire (see tips on open-fire baking below).

#### 9.4.15. Tips on open-fire baking

##### *Method 1.*

1. Pre heat the charcoal stove /jiko.
2. Grease a heavy pan with a lid, pour the mixed dough contents into the pan then cover the pan with the lid.
3. Remove fire from stove and place on the lid evenly.
4. Leave very little fire in the fire – box/stove and cover with ash.
5. Place covered pan with fire on the lid onto the ash covered stove.
6. Keep the fire on the lid burning by adding twigs for 2 minutes.
7. Let cook for another 30 – 40 minutes depending on type of charcoal.
8. Remove the lid with fire/coals on it, test cake with a knife by piercing it in the middle.
9. If done knife should come out dry - if not done knife will be wet with uncooked contents, the cake should also be starting to come away from the sides of the pan.
10. If done remove and cool cake on rack. If not done return and replace lid with fire for a while.

##### *Method 2.*

Alternatively, some people use two pans to bake a cake over a fire. One large, thick base and walled pan with a lid (which becomes the oven), the other a smaller cake pan, which is greased and then the cake mixture is poured into it.

1. Allow the wood to burn down and then use the coals to bake with.
2. Place your large (oven) pan just above the coals (if it gets too hot the cake can burn). You will then need to place a metal riser or some dry stones (N.B. – not wet stones from the river as they may explode in the oven due to their contained moisture!). Put the stones inside the large pan (oven) to enable the smaller pan to be raised off the base so that hot air can circulate around it.
3. Place the cake pan with the mixture in it into the larger (oven) pan, and let it cook for 20 minutes.
4. Then take the larger (oven) pan off the coals/fire, and put it aside and place the coals instead on to its lid. Cook for a further 20 minutes, and then lift the lid and test whether the cake is ready (e.g. the knife comes out clean and not covered in uncooked ingredients).
5. When the cake is ready, remove the cake pan from the larger (oven) pan and let it cool.

#### 9.4.16. Liberian sweetpotato pone

*Ingredients:*

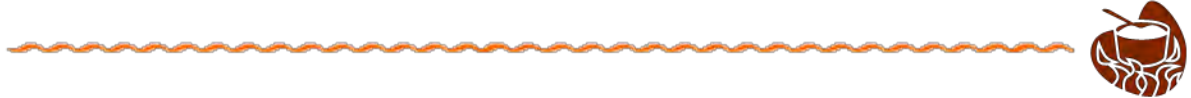
- 3 cups grated raw sweetpotato roots
- 1 cup molasses or 1 cup dark cane syrup
- 2 teaspoons ground ginger
- 2 teaspoons baking powder
- 1 teaspoon salt
- $\frac{1}{3}$  cup vegetable oil

*Procedure:*

1. Combine all ingredients in a saucepan and simmer slowly, stirring constantly, for 10 minutes.
2. Pour into a well-greased 9-inch baking pan.
3. Bake at 170°C (325°F) for 30 minutes, stirring it up every 5 minutes for the first 20 minutes.
4. Smooth down the top and allow to brown.
5. Cut into squares and serve either hot or cold.



*Liberian sweetpotato pone*



#### 9.4.17. Baked sweetpotato wedges with chicken wings

*Ingredients:*

- 2 large sweetpotato roots
- 1 tablespoon olive oil
- 12 pieces of chicken wings
- 1 tablespoon oil
- 1 teaspoon chilli flakes
- Juice of 1 lime
- 2 tablespoons African dark honey
- Salt, black pepper, thyme and chilli powder to taste



*Baked sweetpotato wedges with chicken wings*

*Procedure:*

1. Wash and cut the sweetpotato roots into wedges.
2. Toss the sweetpotato wedges with olive oil, salt, thyme and chilli. Set aside.
3. Combine the chicken wings with salt, black pepper and oil.
4. In a different bowl, combine the chilli flakes, dark honey and lime juice. Set aside.
5. Arrange the chicken and potatoes on an oiled tray, and bake for 25 minutes at 180C (350F).
6. Remove the tray from the oven and turn the sweetpotato wedges over.
7. Add the precooked chicken wings to honey mixture and coat them generously.
8. Return the chicken wings to the baking tray, and spoon over any of the left-over honey sauce.
9. Return the tray to the oven and bake for another 15 minutes.



#### 9.4.18. Sweetpotato jam

*Ingredients:*

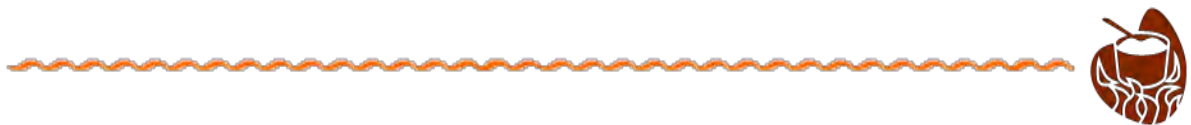
3-4 medium sweetpotato roots  
1 kg sugar  
Juice of 1 lemon or orange (as a preservative and for taste)  
1 cup water

*Procedure:*

1. Peel sweetpotato roots and boil till soft, then mash while still hot.
2. Prepare syrup by mixing 1 cup of water to 1 kg of sugar, then boil while mixing with a wooden spoon.
3. Add the mash to the boiling syrup and allow it to simmer until the jam becomes amber in colour.
4. Remove from heat, taking care not to let it burn. Mix in the lemon/orange juice.
5. Bottle, seal and label the jam.



*Sweetpotato jam*



#### 9.4.19. Sweetpotato juice

*Ingredients:*

4 cups sugar  
8 medium sized boiled peeled sweetpotato roots  
Juice from 5 lemons or 3 teaspoons of citric acid  
5 litres boiled and cooled water  
1 drop of fruit flavouring (optional) or add tamarind or passion or orange or pineapple to taste

*Procedure:*

1. Boil water and sugar and then leave to cool.
2. Mash boiled sweetpotato or blend, mix the product with the boiled water and then sieve/ filter.
3. Add lemon juice or citric acid and fruit flavour if desired and mix well.
4. Pour into a jug, chill if possible and serve cold as fresh juice.



*Sweetpotato juice*



#### 9.4.20. Relish from fresh sweetpotato-cocoyam leaves

##### *Ingredients:*

4 handfuls (~200g) sweetpotato leaves (*note: the leaves of some sweetpotato varieties are tastier than others*)  
10 small leaves (~200 g) cocoyam leaves  
4 level tablespoons (~60 g) roasted groundnut paste  
2 level teaspoons salt  
½ litre water

##### *Procedure:*

1. Break the middle portion of cocoyam leaves to separate from the middle veins of the leaves.
2. Mix the tender cocoyam leaves with sweetpotato leaves and put in the sun to wilt.
3. Wash the wilted vegetables and cut into smaller pieces.
4. Boil water and place the cut pieces of vegetables into boiling water to cook.
5. Add salt when vegetables are almost ready.
6. Mix the groundnut paste with a little cold water until a smooth flowing paste is formed.
7. When the vegetables are ready, add the groundnut paste mixture to the vegetables and simmer for about 5 minutes.



*Sweetpotato and cocoyam relish*



#### 9.4.21. Liberian sweetpotato leaves (potato greens)

##### *Ingredients:*

4 cups (pressed down) fresh sweetpotato leaves  
2 onions, chopped  
1 lb (450g) beef, cut into small pieces  
1 medium sized dried fish  
Some pieces of chicken  
Salt  
Buillion (stock) cubes  
1 ½ cups palm oil  
Dried shrimp (optional)  
1 or 2 pods hot pepper (optional)

##### *Procedure:*

1. Season the beef and chicken using chopped onion, buillion (stock) cubes, pepper and salt. Allow to sit for some time.
2. Make a seasoned soup with the beef, chicken, dried fish and dried shrimp. Boil the meat first until it is tender before adding the other ingredients.
3. Remove the stems and wash the sweetpotato leaves two or three times. Cut or shred the leaves very finely.
4. Add the sweetpotato greens to the soup and let it cook slowly until almost all the liquid (soup) has dried out.
5. Add palm oil and let simmer until all the soup has dried.
6. Serve with rice or cassava.



*Liberian sweetpotato leaves*

#### 9.4.22. Filipino sweetpotato leaves (kamote tops)

##### Ingredients:

- 1 medium bunch of sweet potato leaves, trimmed
- 5 cups water
- 2 medium tomatoes, sliced or quartered
- 1 medium onion, minced
- 1 thumb-sized ginger, minced
- Juice of 1 lemon
- 1 tablespoon olive oil
- 3 tablespoons soy sauce



Filipino sweetpotato leaves

##### Procedure:

1. Combine the ginger, lemon juice, olive oil and soy sauce in a small bowl.
2. Boil water in a pan, add the sweetpotato leaves and blanch for 30 seconds. Drain. Transfer to a serving dish
3. Pour the lemon juice mixture over the blanched sweetpotato leaves, add the tomato slices and onions, and mix well. Serve with piping-hot rice.



#### 9.4.23. Green leaves of sweetpotato with groundnuts

##### Ingredients:

- 3 large bunches of fresh sweetpotato leaves (stalks removed)
- 1 onion (cut into half moon)
- 3 very ripe medium sized tomatoes
- 2 cups groundnuts (pounded into flour)
- 6 cups water
- Pinch of salt



##### Procedure:

1. Wash the sweetpotato leaves well, and put in a pan with the tomato sliced into small pieces, chopped onion and 1 cup of water. Cook on a low heat.
2. Add the groundnut flour to 5 cups of water and then strain the mixture using a sieve/ colander.
3. When the sweetpotato leaves, tomato and onion are cooked pour the peanuts in and cook until the peanuts are well cooked. Eat as a snack or with maize or cassava or rice.



#### 9.4.24. Conversion table

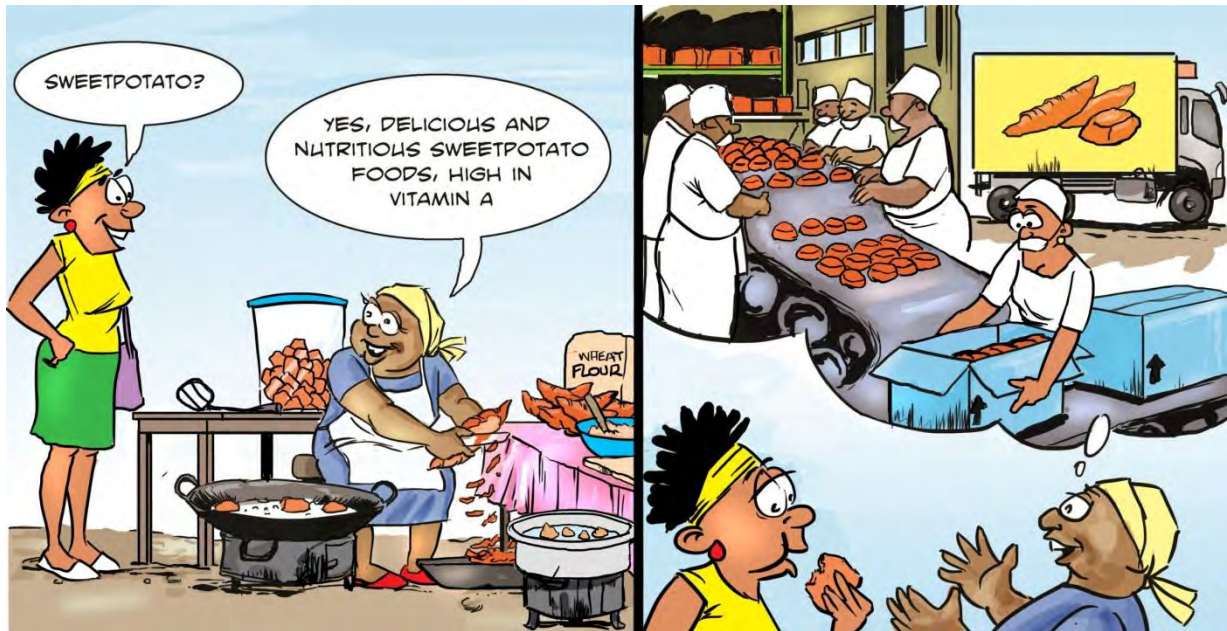
If you wish to convert the quantities suggested in these recipes into alternative measurement systems you can use Table 10.2 to help. However, please note that many of these recipes have been developed in rural villages where the 'cup' measurement is not the standard 'recipe cup' measurement (e.g. a 'village' cup of water may range between 200 and 300ml of water). It is therefore not advisable to convert the recipes quantities. If all the ingredients are measured using the same cup, the proportions will remain correct no matter what size the cup is.

**Table 10.2 Conversion of standard recipe cups to grams** (note: please read the above paragraph)

Ingredient	Cups (standard recipe cup)*	Grams or Litres
Wheat flour - white	1	100g
Sugar – caster	1	225g
Sweetpotato mash	1	200g
Sweetpotato root sliced	1	150g
Water	1	230 ml (just less than a ¼ litre)

\*Note: the cups used in rural villages may differ in size, and therefore it is best just to measure all ingredients using one cup and not to try and convert cup measurements into grams.

## 9.5 Large-scale commercial processing of sweetpotato products



Currently, the orange-fleshed sweetpotato products with the most commercial potential being produced in Sub-Saharan Africa are:

1. Fried products, such as chips, crisps, chapatis, and doughnuts
2. Baked products, such as breads and biscuits
3. Juice

Pointers for when it makes sense to develop a processed product are described in Topic 10.8.

In Rwanda, the sweetpotato Superfoods project is working with large-scale processors to produce orange-fleshed sweetpotato biscuits and mandazi, and attractive product packaging.



*Sweetpotato biscuits and mandazi being produced in a factory in Rwanda, and nicely packaged sweetpotato products being promoted at a trade fair.*

China produces a wide range of commercial sweetpotato products.



*Sweetpotato noodle extrusion, sheeting noodle production line, packaged sweetpotato noodles for cooking*



*Factory producing and packaging instant noodles made from sweetpotato*



*Cornflake breakfast cereal made from sweetpotato and corn flakes, sweetpotato snacks and crackers*



*Sweetpotato dumplings, crackers made from purple fleshed sweetpotato, sweetpotato candy, noodles*

Sweetpotato is regularly processed packaged into ready to cook french fries (chips) in the USA.



*Different sweetpotato varieties in a supermarket, production of sweetpotato French fries, packaged chips*

## 9.6 Sweetpotato as animal feed

In Sub-Saharan Africa, sweetpotato is almost entirely used for feeding humans contrary to other regions of the world such as Asia where more than half of the sweetpotato produced is used for animal feed or industrial processes.

Both sweetpotato roots and vines are good materials for animal feed. The roots provide energy derived from starch while vines provide protein and fibre. It is recommended that sweetpotato forage should either be wilted or dried if intended for provision of basal diet to the animals. Roots are generally fed to pigs while the vines are feed for a variety of animals, including goats, pigs, cows, chickens and rabbits.



*Pig eating OFSP roots*

To process and preserve sweetpotato animal feed, farmers commonly chop the roots and dry them as chips and cut the vines and dry them as hay. The high water content of the roots and vines also makes the crop suitable for silage, which can be less labour intensive than chopping and drying sweetpotato roots. The vines left in the field after harvest and the peelings left from processed roots can be useful feed components but are often left as waste. Dual purpose sweetpotato varieties with high root and vine yields can help address both household and livestock nutrition; although care needs to be taken not to harvest the vines too frequently or the root yields become so reduced that the duality is lost. Compared to many browse/ multipurpose trees and shrubs sweetpotato vines have a fast rate of re-growth.

### 9.6.1 Using sweetpotato roots as animal feed

Use of the root for feeding pigs is well developed in much of Asia, but not yet exploited in Sub-Saharan Africa. Pigs can convert the low-value sweetpotato into highly desired meat and/or marketable commodities, and simultaneously provide manure for maintaining soil fertility or biogas production. However, improvements in pig nutrition need to be combined with improvements in pig husbandry and health to reduce pig diseases.

The roots can also be used as an ingredient for broiler chickens (in the finisher as opposed to the starter diets) and rabbit feeds, and can replace maize in many feeds.



*Chickens eating OFSP roots*

A few considerations need to be kept in mind when using **sweetpotato roots** as animal feed:

- **Trypsin inhibitors:** Some sweetpotato roots, depending on the variety, possess chemicals that inhibit the digestive enzyme trypsin. This leads to reduced nutrient absorption from the sweetpotato roots and other feeds consumed at the same time. Cooking or drying the sweetpotato roots before feeding them to animals, breaks down the trypsin inhibitor and prevents this problem. Varieties with low trypsin inhibitor activity should be selected, or the roots should be dried or cooked before feeding them to livestock. However, this cooking obviously has associated labour and fuel costs.
- **Starch digestibility:** The starch of some sweetpotato varieties is difficult to digest and absorb. Slicing and drying the roots seems to break down the starch structure and improve the digestibility.
- **Starch content:** For animal feed it is better to choose roots of sweetpotato varieties that are high in starch content and lower in yield than those that are low in starch but high in yield. Low starch content means high water content in the roots and pigs can become bloated if the root moisture content is too high.

- *Low protein content:* Unlike the vines, the roots contain insignificant levels of protein (~1.3% - 10% on a dry weight basis). This can pose a major constraint to pig growth in a sweetpotato based diet. Farmers can overcome this by supplementing the feed with rice bran, fish meal, soy beans or residue, sweetpotato leaves or cassava leaves, or commercial supplements. Farmers in Asia commonly allow the pigs to forage for additional protein from soil fauna, particularly earthworms.

In China they have been working on developing dry pellet feeds that use sweetpotato as the major ingredient instead of maize. They added amino acids, minerals, vitamins and a protein concentrate, and increased feed efficiency and reduced the feed/kg weight gain cost by 15-20%.

### 9.6.2 Using sweetpotato vines as animal feed

When using **sweetpotato vines** as animal feed, it is good to consider the following factors:

- *Vine production:* If vines are the objective of production, the sweetpotato can be planted on flat fields at a spacing of 30-40 cm between plants and 40-50 cm between rows. Planting too close limits the efficiency of photosynthesis. Depending on the rainfall levels, vines can be harvested 30-45 days after planting and every 15-25 days after that. The optimal way to cut multiple vines is to cut 1-2 of the longest branches of each plant leaving about 10 cms for resprouting. In Vietnam they developed a cheap vine-chopping machine to reduce the hours spent cutting vines prior to ensiling them.
- *Vine feed:* Vines can be fed fresh, dried, fermented, or made into silage. The most common practice is to feed fresh vines during harvest season (if sweetpotato is grown for roots or root/vine), but if the vines are dried and stored as hay or made into silage after harvest the feeding period can be prolonged. In Uganda it was found that vines harvested during the wet season recorded significantly higher crude protein, fibre and acid contents. Processing and preserving the vines allows farmers to use them as feed for an extended period.
  - Drying: some farmers like to cut the vines before drying because the dried vines are difficult to cut, while others hang the whole vines on trees, fences, walls or other structures that are strong and high enough to support the vines.
  - Fermentation: fermented vines are favoured by pigs and provide protein at the lowest cost. The feed is made from a mix of chopped vines, rice bran, and salt and is ready to be fed after 10 days of fermenting.



*Feeding cattle, pigs and goats with sweetpotato vines*

- Silage: this method is less common, but provides the advantages that the silage can be stored for use during times when feed is limited; and cost wise vines are much cheaper during the harvest season so can be ensiled then, avoiding the need to purchase during the off season when vines are expensive. If the ensiling involves a fermentation process the nitrogen can be converted into protein which increases the nutritional value and feed efficiency. In this case, vines are firmly pressed into a tank with a layer of salt placed on top before covering the tank. Sweetpotato forage can be ensiled in earth pits lined with either banana leaves or polythene sheeting. Polythene bags could also be used to ensile sweetpotato vines and a brochure describing how to make an improved sweetpotato silage tube can be found on the Sweetpotato Knowledge Portal ([www.sweetpotatoknowledge.org](http://www.sweetpotatoknowledge.org)) and is described briefly in section 9.6.3. In order to prepare good quality silage from sweetpotato vines, the following principles should be considered.
  - An anaerobic condition should be maintained by compressing the forage material in silos to expel air.
  - Ensiled sweetpotato vines should be chopped into small pieces (2 – 5 cm).
  - Additives that supply carbohydrates such as sweetpotato roots, molasses or fresh sugar cane juice should be included. If making 100 kg of silage we need to add 2-5 kg of molasses or fresh sugar cane juice or 10–20% sweetpotato roots on fresh weight basis of ensiled forage material.
  - Trials in Vietnam looked at the nutritional value of different ensiled mixtures of sweetpotato vines, corn, cassava meal, rice-bran, sun-dried chicken manure and salt. Vines ensiled with chicken manure have higher protein, dry matter and ash contents and were nutritionally more cost effective.

Good quality sweetpotato vines silage will be brownish green in colour. It will have a pleasant aroma (fruit smell) and can be fed free of choice to the animals.

### 9.6.3 An improved method for making sweetpotato silage

Well-made sweetpotato silage is a wholesome and nutritious feed for all classes of cattle and pigs. Sweetpotato silage is made by anaerobic (in the absence of air) fermentation of chopped vines and roots of non-commercial value, and can be stored as a feed for up to a year. This can help to avoid periods of feed shortages, and to maintain good milk and meat production levels during the dry season.

Silage can be made with either just the chopped vines or a combination of chopped vines and roots, and is an excellent complement to grass feeds. Starter ingredients such as molasses can improve the fermentation process and nutrient content.

Use of sweetpotato silage can increase milk yields by 15-20%, as well as meat production, but amongst farmers in Sub-Saharan Africa there is limited knowledge or use of sweetpotato silage. The following information is taken from a new brochure on 'Making high quality sweetpotato silage'.

One of the challenges farmers face when making sweetpotato silage is that of excess water accumulating at the bottom of the silage container and resulting in spoilage. This challenge led to the development of the improved plastic tube silo.



## Making an improved plastic tube silo

### Materials:

1. A 95 cm length, 4 cm diameter plastic (PVC) pipe (the drainage pipe)
2. 2.5 m of 1,000 gauge silage tubing (made of polythene), sold in 1m diameter rolls
3. 230 cm of flexible rubber tubing, 2.75 cm in diameter
4. A 4 cm plastic tap, which should have the same diameter as the pipe or a piece of soft wood if a tap is unavailable
5. A metal rod of 0.9 cm in diameter for making holes in the PVC pipe
6. 7 meters of sisal twine
7. 3 wooden poles at least 1.2 m in length and 5 cm in diameter
8. 2 used 200 liter empty drums
9. 10 kg of molasses
10. 30 litres of water
11. Two 6cm long nails
12. 375 kg of fresh sweetpotato vines and 175 kg of fresh sweetpotato roots for 500 kg of silage.

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### Step A. Sealing the tube and making an internal drainage pipe

Open the silage tube up fully. At one end pleat the tubing, and twist together and tie firmly with rope. Turn the tubing inside out, so the tied end is on the inside.

Make 2 holes (2.75 diam.) on each side of the drainage pipe, one 4cm from the end A on both sides, and one 20cm from end B on one side and 22 cm on the other side.

Heat the nail and make small holes every 1cm along the PVC pipe (just between the larger holes), and the rubber tubing. Thread the rubber tube through the PVC pipe.



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### Step B. Fitting and fixing the drainage pipe

Make a 3.5cm diam. Hole at the side of the tube about 43cm from the tied knot.

Place the drainage pipe inside the base of the tube silo, so it protrudes ~ 20 cm out through the newly made hole in the tube. Tightly tie the plastic tube around the drainage pipe. Fit a tap or soft piece of wood at the end of the protruding drainage pipe.



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### Step C. Making a compacting drum

Remove the top and bottom of each drum to make it hollow. Then cut the oil drum longitudinally in half. Have a welder fix joints along each long edge and fit a long rod through them to hold the two sides together. He/she will need to cut out a place on one side for the drainage pipe to protrude through.

Find a shady place to make and store the silage. Move the drum there and place the tubing inside it letting the excess tube length fold over the sides of the drum.



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#### Step D. Preparing, filling and managing the silo

Chop the sweetpotato vines and roots into pieces not more than 2.5cm long. Mix the 10kg of molasses with 2 to 3 times as much water until the mixture flows easily.

Fill the tubing by adding alternate layers of chopped vines and roots (~20cm deep) and the molasses/water mix (sprinkle until thoroughly wet on top). Compact each layer before adding the next layer. When full, bunch tubing together and remove all excess air, tie the plastic tubing, and place heavy stones on top. Remove the compacting drum. Anchor filled tube with 3 poles with ropes between them to prevent collapse. Open drainage tap daily for 5 days, then every 4-5 days.

Fermentation is usually complete after 30 days.



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#### Step E. High quality silage

Well prepared silage is bright or light yellow-green in colour, has a strong smell similar to that of fermented milk and a firm texture. Poor quality silage smells like rancid butter or ammonia.

The tube silo should be in the shade and protected from rodents.

After removing some silage for feeding animals, make sure you re-tie the tube tightly without trapping air inside.



Source: Lukuyu et al., 2012

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## 9.7 Gender and diversity aspects of sweetpotato processing and utilisation

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in Topic 11. Key gender and diversity issues relevant to sweetpotato processing and utilisation include:



- Nutritional requirements including vitamin A requirements and dietary preferences vary by age, sex and workloads. Some recipes will be more appealing to certain groups, it is important to find out about the local food culture and see how new nutritious recipes could be combined with it.
- Attention needs to be given 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 and who influence consumption patterns (grandmothers, husbands, wives, 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.
- Attention needs to be paid to postharvest gender roles and how processing may impact on them, including appropriateness of equipment and whether the introduction of machines affect gender roles and income benefits in any way.

## 9.8 Ideas for processing and utilisation learning-by-doing activities

These learning by doing activities have been designed to provide hands-on discovery learning opportunities for the participants of the 10 day ToT course on '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. The following activities occur on day 8 of the ToT course, an overview of the suggested day 8 programme is given below. However, we hope these activities will also be used by trainers as stand-alone learning activities and as part of other training courses. Please note the programme for day 8 combines the topics of harvesting, post-harvest management, and processing and utilisation.

Day	Topics	Intended Learning Outcomes	Activities
8	Harvesting, post-harvest management, and processing	<p><i>Participants will:</i></p> <ul style="list-style-type: none"> <li>- Know about the main aspects of sweetpotato harvesting, post-harvest management and processing.</li> <li>- Understand how the processing and storage of OFSP affects its beta-carotene content</li> <li>- Understand the importance of involving different groups in processing training and awareness</li> </ul>	<ul style="list-style-type: none"> <li>- <i>Activity 8.9.1: Increasing profits through storing fresh sweetpotato roots.</i> Field exercise to harvest roots, separate out damaged roots; set up a protected fresh root pit store (NB grass, bamboo pool and wood for cover need to be arranged in advance and hole dug in advance) (see Activity 8.9.1) [2hrs]</li> <li>- <i>Activity 8.9.2: Effect of sun-drying and storage on beta-carotene content of OFSP.</i> Participants observe the differences between samples of OFSP chips which have been sun-dried for 7, 5, or 2 days. Beta-carotene content estimates are provided to illustrate how the beta-carotene content declines over time during storage. (see Activity 8.9.2) [30 mins]</li> <li>- <i>Presentation 8.</i> Piecemeal harvesting, chip drying and curing for improved shelf-life; including gender aspects. Post-harvest management of fresh roots and dried chips; storage containers, protection from pests and monitoring over time. Discuss who in the household is responsible for storage, and how to ensure information reaches them? [45 mins]</li> <li>- <i>Activity 9.8.1: Substituting sweetpotato flour for wheat flour in a chapati recipe AND Activity 9.8.2 Making sweetpotato juice AND Activity 9.8.3 Making sweetpotato flossis.</i> Split the group into halves and in small groups have them follow either Activity 9.8.1 or (9.8.2 &amp; 9.8.3). [2hrs 30 mins]</li> <li>- <i>Presentation 9.</i> Processing and discussion on who to target for processing training, such as people who are already micro-food processors and might incorporate OFSP, discussion regards the importance of involving men even though women do the food preparation usually, but men are still influential in deciding what foods to plant or purchase. [45 mins]</li> </ul>

### 9.8.1 Substituting sweetpotato for wheat flour in chapati recipes

*Intended Learning Outcome:* Participants will know how to incorporate sweetpotato (particularly the vitamin A rich OFSP) into popular recipes that normally only use wheat flour

*Timing:* ~2 hours 5 mins

*Materials:* Per small group: sauce pan; charcoal or gas stove; frying pan; cutting board; 1 litre luke warm boiled water; rolling pin; grater; fruit squeezer; food containers; bowls; plates; knives; flip chart; marker pens; masking tape

2 kg wheat flour;  
 ½ kg OFSP;  
 ½ kg boiled OFSP;  
 ½ kg OFSP flour;  
 1 cup of vegetable oil;  
 some salt;

*Advanced preparations:* Obtain sufficient OFSP for each small group to have ½ kg of it. If you will be short of time the OFSP for the boiled & mashed recipe could be pre-boiled so that the participants just mash them and then incorporate them into the recipe.

*Suggested steps:*

1. If equipment allows break the participants into groups of 5 people. Explain to them that they are going to prepare chapatis using a range of different recipes that incorporate sweetpotato. First each group will prepare a typical chapati using just wheat flour. Then they will make chapatis using orange-fleshed sweetpotato flour, they can decide whether to use: raw and grated OFSP; or boiled and mashed OFSP; or OFSP flour in their recipe. Ask the group what benefits there might be from using OFSP as a substitute for wheat flour in recipes (e.g. cost, nutritional, taste, ease of access etc.)? [5 mins]
2. The different options are written up on a flip chart so that the groups can decide which they will make. The facilitator must ensure that there is a good spread of the different recipes, and that not all groups are using OFSP, as the aim is to get them to practice and compare the different chapati recipes. If there is time, each group could test 2 or 3 of the different sweetpotato chapati recipes. Remind them that they must wash their hands before preparing or eating any food. [5 mins]

Wheat flour chapati	Orange-fleshed sweetpotato chapati options		
	OFSP raw & grated	OFSP boiled & mashed	OFSP flour
100% wheat flour	50% raw&grated OFSP /50% wheat flour	50% boiled&mashed OFSP /50% wheat flour	30% OFSP flour/70% wheat flour
500 g wheat flour	250g grated OFSP 250g wheat flour	250g boiled & mashed OFSP 250g wheat flour	150g OFSP flour 350g wheat flour

3. Procedure:

1. First mix dry ingredients together in a bowl, then add any grated or mashed sweetpotato (depending on which recipe you are using), and mix. (500g of flour makes ~5 large chapatis).
2. Add 1 tablespoon of oil and mix well.
3. Add the lukewarm water little by little to the mixture in the bowl and knead till a stiff smooth paste is formed.
4. Divide the dough into 5 equal sized balls.
5. On a floured surface roll one ball at a time.

6. Put aside for 20 minutes
  6. Fold each ball at a time to form a strip.
  7. Coil each strip to form a circle
  8. On a floured surface, roll out each coil into a thin circular sheet.
  9. Grease a shallow frying pan.
  10. Fry each circular sheet on both sides till golden brown, make sure both sides are greased.
  11. Taste. [1.5 hours]
4. Ask them to individually rank the products by preference (4=most preferred, 1=least preferred). [5 mins]
  5. Discuss the different products: cross-compare the chapatis made with OFSP flour; raw&grated OFSP and boiled&mashed OFSP and the chapatis made from 100% wheat flour. Ask them to explain why they chose their preferred product, (probe if necessary with questions about colour, taste, texture, nutritional aspect, easiness to make, cost etc...). [10 mins]
  6. In their small groups ask them to discuss the marketing issues associated with the different products? Quality and storage issues of these products? Any ideas for new OFSP products that they could develop? Then bring these points into a short whole group discussion. [10 mins]

### 9.8.2 Making sweetpotato juice

*Intended Learning Outcome:* Participants will know how to process sweetpotato into juice

*Timing:* 45 mins

*Materials:*

4 cups of sugar;  
 8 medium sized boiled peeled sweetpotato roots;  
 3 teaspoons of citric acid OR juice from fruits like oranges or pineapples;  
 5 litres of cooled boiled water;  
 flavouring add tamarind, passion, pineapple or orange juice;  
 sieve; pans; fruit squeezer; wooden spoon; jug; 5 \* 1 litre clean empty bottles; fridge to chill the juice in.

*Advanced preparations:* Organise cooking ingredients, equipment and facilities. Obtain sufficient OFSP. If you will be short of time the OFSP can be pre-boiled so that the participants just mash them and then incorporate them into the recipe.

*Suggested steps:*

1. Work in small groups, as long as you have sufficient equipment for each group to use eg pans. Note the above quantities of ingredients will produce about 5 litres of juice.
2. Boil water and sugar and then leave to cool.
3. Mash boiled sweetpotato or blend, mix the product with the boiled water and then sieve/ filter.
4. Add citric acid/ lemon juice and fruit flavour if desired and mix well.
5. Pour into a jug, chill if possible and serve cold as fresh juice.

### 9.8.3 Making sweetpotato fiosis

*Intended Learning Outcome:* Participants will know how to process sweetpotato into fiosis

*Timing:* 45 mins

*Materials:*

300g (2-2 ½ cups) wheat flour  
50g margarine  
200g (1 – 1 ½ cups) sweetpotato puree  
65g (¼ cup) sugar  
2 eggs  
Oil for frying  
2 teaspoons baking powder

*Advanced preparations:* Organise cooking ingredients, equipment and facilities. Obtain sufficient OFSP, and pre-boil them so that the participants just mash them and then incorporate them into the recipe.



*Sweetpotato fiosis*

*Suggested steps:*

1. Work in small groups, as long as you have sufficient equipment for each group to use.
2. Beat the margarine and sugar together.
3. Add the eggs and then the sweetpotato puree, keep mixing.
4. Gradually add the flour and baking powder, keep mixing.
5. Knead the dough well until it stops sticking to your hands.
6. Roll small pieces of the dough into little sausage shapes and then tie each in a loose knot or bow.
7. Fry in oil (not too hot).
8. Share with the rest of the group.

## 9.9 References used to inform this topic

The many recipes in this topic have been collected from a wide range of people and places – thank you for sharing them with us all.

- Bechoff, A. Poulaert, M., Tomlins, K.I., Westby, A., Menya, G., Young S., Dhuique-Mayer, C. (2011). Retention and bioaccessibility of  $\beta$ -carotene in blended food from sub-Saharan Africa containing orange-fleshed sweet potato. *Journal of Agricultural & Food Chemistry*, 59: 10373-10380.
- Bechoff, A., Tomlins, K.I., Dhuique-Mayer, C., Dove, R., Westby, A., (2011). On-farm evaluation of the impact of drying and subsequent storage on the carotenoid content of orange-fleshed sweet potato. *International Journal of Food Science & Technology*, 46: 52-60.
- Etela, I., (2010). Chapter 8: Sweetpotato in animal nutrition. *In: Sweetpotato: Post Harvest Aspects in Food, Feed and Industry*. R.C. Ray, K.I. Tomlins (Eds.). Nova Science Publishers, New York. pp. 225-244.
- Gakonyo, N., (1992). Processed sweetpotato: responding to Kenya's urban food needs. *In: Product Development for Root and Tuber Crops Vol III-Africa. Proceedings of the Workshop on Processing, Marketing and Utilisation of Root and Tuber Crops in Africa, 26 October-2 November 1991 at the International Institute for Tropical Agriculture (IITA) Scott, G.J., Ferguson, P.I. and Herrera, J.E. (Eds.) International Potato Centre. Ibadan, Nigeria. pp337-357*
- Hagenimana, V., Carey, E., Gichuki, S.T., Oyunga, M.A., Imungi, J.K., (1999). Carotenoid contents in fresh, dried and processed sweetpotato products. *Ecology in Food and Nutrition* 37: 455-473.

- Hall, A., Bockett, G., Nahdy, S., (1998). Sweetpotato postharvest systems in Uganda: strategies, constraints, and potentials. International Potato Center Social Science Department Working Paper No. 1998-7. 81pp.
- Harrington, R., (2009). Baking a cake over a campfire. <http://www.helium.com/items/1400417-make-a-cake-over-a-campfire>
- Katongole, C.B., Bareeba, F.B., Sabiiti, E.N., Ledin, I., (2008). Nutritional characterisation of some tropical urban market crop wastes. *Animal Feed Science and Technology*, 142: 275-291.
- Kósambo, L. (2004) Effect of storage and processing on all-trans- $\beta$ -carotene content in fresh sweetpotato (*Ipomoea batatas* (L.) Lam) roots and its products. CIP Funded Research Project: Annual Report (July 2003 – June 2004). Kenya Industrial Research and Development Institute. Nairobi. 11pp.
- Li, L. (1974) Variation in protein content and its relation to other characters in sweetpotatoes. *Journal of the Agricultural Association of China*, 88: 17-22.
- Lukuyu, B., Gachuri, C.K., Agili, S., Leon-Velarde, C., Kirui, J. (2012) Making high quality sweetpotato silage: an improved tube silage making method. CIP, Nairobi. 12pp. <http://sweetpotatoknowledge.org/adding-value/use-as-animal-feed/IMPROVED%20SILAGE%20TUBE%20BROCHURE%20201209.pdf>
- Odaga, A., Wanzie, R., (1991). The use of sweetpotato in bakery products in Cameroon. *In: Product Development for Root and Tuber Crops Vol III-Africa. Proceedings of the Workshop on Processing, Marketing and Utilisation of Root and Tuber Crops in Africa, 26 October –2 November 1991 at the International Institute for Tropical Agriculture (IITA) Scott, G.J., Freguson, P.I. and Herrera, J.E. (Eds.). International Potato Centre. Lima, Peru. pp 377-384*
- Owori, C., Hagenimana V., (1995). Assessment of the potential for sweetpotato processed product (doughnuts) for diversified utilisation of sweetpotatoes in Uganda. *In: Root Crops and Poverty Alleviation. Proceedings of the Sixth Triennial Symposium of the International Society for Tropical Root Crops-Africa Branch. Akoroda, M.O. and Ekanayake, I.J., (Eds.). Lilongwe, Malawi. pp450-453.*
- Owori, C., Karuri, E., Mbugua, S., Hagenimana, V., Ragama P., (2001). Importance of “kabakalaga” processing to the sweetpotato product development needs in Uganda. *In: Root Crops: the Small Processor and Development of Local Food Industries for Market Economy. Proceedings of the Eight Triennial Symposium of the International Society for Tropical Root Crops-Africa Branch. 12-16 November 2001. M.O. Akoroda (Ed.). Ibadan, Nigeria. pp150-156.*
- Owori, C., Agona, A. (2003) Assessment of sweetpotato cultivars for suitability for different forms of processing. *In: Sweetpotato Post-Harvest Assessment. Experiences from Tanzania. D., Rees, Q., van Oirschot, and R., Kapinga (Eds.). Natural Resources Institute, University of Greenwich.*
- Owori, C. B., Lemaga, R.O.M., Mwanga, A., Namutebi, Kapinga, R., (2007). Sweetpotato recipe book: sweetpotato processed products from Eastern and Central Africa. African Crop Science Society, Kampala, Uganda. 93pp.
- Peters, D., (2010). Chapter 9: Sweetpotato and Pigs: Traditional Relationships, Current Practices and Future Prospects. *In: Sweetpotato: Post Harvest Aspects in Food, Feed and Industry. R.C. Ray, K.I. Tomlins (Eds.). Nova Science Publishers, New York. pp245-270. ISBN: 978-1-60876-343-6.*
- Stathers, T.E., Namanda, S., Olupot, M., Nungo, R., Owori, C., Kavana, P., Mwanga, R.O.M., Khisa, G., Julianus, T., Ndamugoba, D., Kapinga, R., (2006). Sweetpotato processing and recipes. A farmer guide to sweetpotato processing and recipes. International Potato Centre, Kampala, Uganda. pp24.
- Sweet Potato (1990) Leaflet No. 13. *In: South Pacific Commission - Community Health Services – South Pacific Food. <http://www.fao.org/WAIRdocs/x5425e/x5425e0d.htm>*
- van Hal, M., (2000). Quality of sweetpotato flour during processing and storage. *Food Review International* 16, 1-37.
- Woolfe, J. A., (1992). Post harvest procedures: Sweet Potato an untapped Untapped Food Source. Cambridge, UK: Cambridge University Press. 643pp.
- Zou, C.Y., (2002.) Sweetpotato utilisation in Sichuan pig production systems. Powerpoint presentation, Sichuan Academy of Animal Sciences, Chengdu, Republic of China.

*Notes on: **Sweetpotato Processing and Utilisation***



# TOPIC 10: MARKETING AND ENTREPRENEURSHIP

## IN

### EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

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## Topic 10: Marketing and Entrepreneurship

### 10.1 Marketing of fresh sweetpotato roots in Sub-Saharan Africa

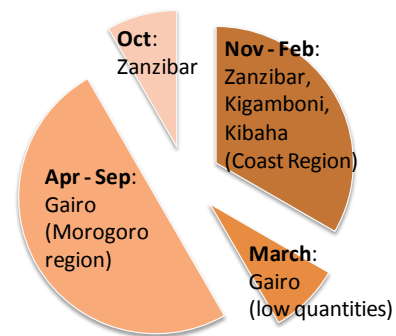
Within Southern and Eastern Africa fresh sweetpotato roots are widely traded and usually available in urban markets throughout much of the year. Numerous small-producers from different geographical areas sequentially provide the roots creating a fairly continuous year round supply in large urban centres (see Figure 10.1). Sweetpotato marketing investments typically occur in areas where sweetpotato is consumed as a primary staple food as opposed to areas where it is a secondary staple.

Sweetpotato supply chains tend to be short (both intermediary wise and distance wise) because of the bulkiness of the crop, its short shelf-life and its relatively low value/ profitability. Traders, who sell produce in markets to consumers, often travel to rural areas by bicycle or to other markets by road transport to source produce. Small-scale traders sell only a few sacks a week. Additionally, farmers may take their produce to sell to market traders. Bicycle traders may take their own produce or that purchased from other farmers to sell to retailers. Large-scale wholesale traders move sweetpotato in trucks, and often there are agents in the field who locate the sweetpotato and make sure it is bulked up in a convenient location before the truck arrives. In many Sub-Saharan African countries, in non-Muslim areas, the actual retailing of the sweetpotato roots in the markets and interaction with customers is mainly done by women, while men are the ones who travel to rural areas to source the roots.

Studies in Kenya, suggest that rural consumers use the sweetpotato roots size, colour, taste, texture of the skin, price, shape, fibre content, health and freshness as the main selection criteria before they buy sweetpotato roots. Size being their most important factor: as an indicator of whether the root is immature or not, and because medium sized roots are easier to cook and package, while larger roots have to be cut up before cooking. Roots are mainly consumed after boiling or steaming without peeling, making them a fast and easy to prepare food, they may also be mashed and mixed with beans. Small and medium roots can also be more easily shared e.g. one root per household member. Urban consumers were more likely to choose sweetpotato roots based on the skin colour and area or region where root was grown, then size (preferring medium size), then damage, especially weevil damage (consumers fear damaged roots as they may taste bad, and there are concerns that unclean water may have been used for washing the produce and may have entered the root through the damage sites), then shape and freshness. Boiled roots are often taken with a cup of tea in the morning, especially when they are cheaper than bread. Wealthier households in urban areas also prepare chips and doughnuts from sweetpotato.

However, from the perspective of farmers in less favoured locations (with limited road and market linkages), marketing fresh sweetpotato roots is problematic. Markets are often located far away resulting in high transport costs or farmers having to take whatever farm-gate price the sole trader buying from their area offers. Local rural markets are typically oversupplied during the harvest season.

Due to sweetpotato production being so seasonal, the quantity and quality of supply is not smooth throughout the year. This results in large price variations. In Kenya and Tanzania, the commercial value of sweetpotato is highest during the month of Ramadan as sweetpotato roots are often used to break the fast.



**Figure 10.1** Calendar of sweetpotato sources at Mabibo market, Dar es Salaam

To date, there is little commercial processing of sweetpotato into chips or flour, which would have a longer shelf-life and could help encourage year round consumption of sweetpotato in stiff porridges, bread or other products. In order to try and supply sweetpotato roots for a longer period of the year, farmers practice staggered planting, as most are unaware of or inexperienced in the use of fresh root pit stores (see section 8.5).

Marketing costs of sweetpotato are high due to its bulkiness, perishability, discontinuous and geographically fragmented supply. The high transport costs and tax structure of urban markets in East Africa have resulted in sweetpotato being jammed into large extended bags, which are difficult to carry and therefore result in the bruising and damage of many of the roots inside them. This practice lowers the quality of the roots and shortens their shelf-life. These varied market problems highlight the need for improvements to be made across the value chain.

Farmers usually rely on traders or neighbours for market price information, although the use of mobile phones for checking prices is increasing. Sweetpotato prices are rarely available at the national level.

Although usually not recorded, sweetpotato plays a major role in informal, cross-border trade and ensuing food security within Africa. Examples include trade from: Uganda to Kenya (via the Busia border) and to Sudan via the north; and from Mozambique to Malawi via the Mulanje border.

Transformation of the value chain could be brought about through successful promotion of the nutritional benefits of consuming orange-fleshed sweetpotato, or use of products from processed orange-fleshed sweetpotato, or sweetpotato as animal feed. Extending the period of the year when fresh sweetpotato roots are available is another option. Given the very different natures of markets across Sub-Saharan Africa (SSA), there is unlikely to be a simple solution, and any strategies will need to be adapted to the specific conditions.

**Involving traders:** The positive role played by traders in the value chain is sometimes downplayed by organisations purporting to assist farmers. However, traders can be used to help develop the orange-fleshed sweetpotato market; traders need to be trained so they have the necessary understanding regards its nutritional benefits in order to be able to help promote and drive market demand for it. In a project in Zambézia province in Mozambique, a market development strategy was developed to:

- inform retail sweetpotato traders of the health benefits of consuming orange fleshed sweetpotato (OFSP) (creating a willingness-to-buy from farmers),
- train farmers and traders on appropriate postharvest handling and transport of roots,
- tell the traders where they would find sources of supply and help facilitate the initial linkages between traders and farmers,
- explain how traders could make a higher margin from trading OFSP, even if they had to pay farmers more for it (OFSP, when available, retailed for a higher price),
- raise urban consumers' awareness through radio advertising and promotional signs in markets, about the advantages of eating orange-fleshed sweetpotato—particularly due to its pro-vitamin A content and its sweet taste—over other types of sweetpotato,
- inform consumers of where orange-fleshed sweetpotato was being sold,
- provide farmers with simple marketing training, and
- link farmer groups to traders.

This approach led to a rapid growth in the commercialisation of orange-fleshed sweetpotato.



*Poor packaging of sweetpotato roots in overfilled sacks and rough handling causes losses*

**Export of sweetpotato from Africa:** Very small amounts of sweetpotato are exported from Africa. In 2010, Africa exported 14,785 tonnes of sweetpotato with a value of USD\$ 9.7 million. This is ~7% of the global total sweetpotato exported, which is estimated to be 205,845 tonnes with a value of USD\$ 149.5 million.



*Sweetpotato ready for export*

Egypt and South Africa are the main African sweetpotato exporting countries, exporting 11,725 tonnes and 2,603 tonnes respectively in 2010. Small amounts (65-225 tonnes) were also exported in 2010 from Cameroon, Madagascar and Rwanda, and even smaller amounts (1-28 tonnes) from Nigeria, Kenya, Senegal, Swaziland, Ethiopia, Zimbabwe, Niger and Cote d'Ivoire. Globally the USA, China, Egypt, Syria, Slovakia, the Netherlands, Indonesia, Dominican Republic and Italy export the largest amounts of sweetpotato.

## 10.2 Marketing and market orientation



*Make sure your business is market orientated and meeting consumers' needs and wants*

Marketing is about meeting the needs and wants of customers, it is about understanding customers and finding ways to provide products or services which customers demand. Marketing is a business-wide function, not something that operates separately from other business activities.

There are many different definitions of marketing, including:

*"The all-embracing function that links the business with the customer needs and wants, in order to get the right product to the right place at the right time."*

*"The achievement of corporate goals through meeting and exceeding customer needs better than the competition."*

*"The management process that identifies, anticipates and supplies customer requirements efficiently and profitably."*

*"Marketing may be defined as a set of human activities directed at facilitating and accomplishing exchanges."*

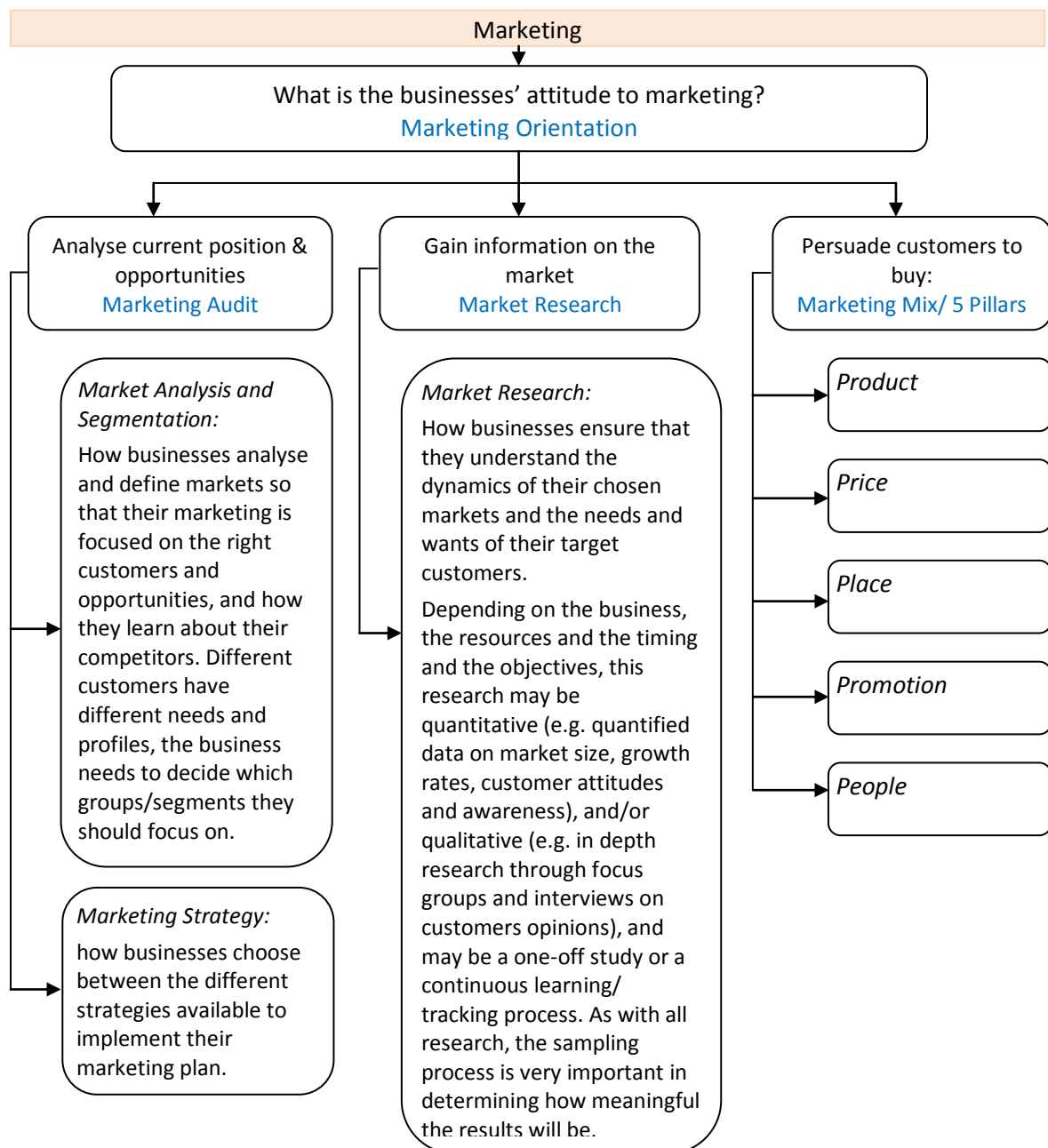
*"Marketing is a social and administrative process through which people and groups obtain what they need and want, creating products and values and exchanging them with third parties."*

It is a fundamental idea of marketing that organisations survive and prosper through meeting the needs and wants of customers. This important perspective is commonly known as the marketing concept. Market orientation is generally regarded as the implementation of the marketing concept (see Figure 10.2). The 5 Pillars (5Ps) of marketing often known as the marketing mix, which represent choices the business has to make in order to implement its marketing strategy, are discussed in section 10.4.

A business that is market oriented, produces goods and services that are carefully researched and designed to attract the clients in the market. The customer’s needs drive the process, the business must develop the skills to identify the needs and decide which ones it will try to satisfy.

Social marketing is a form of marketing which aims to improve the well-being of consumers and of society. Businesses engaged in social marketing determine the needs, wants and interests of their target markets, and have to operate with greater effectiveness and efficiency than their competitors.

**Figure 10.2 Key elements of marketing**



The alternatives to a marketing orientation are a sales orientation (as shown in Table 10.1), production orientation and product orientation.

**Table 10.1 Contrasting aspects of sales and marketing orientation**

Sales orientation				versus	Marketing orientation			
Starting point	Focus	Means	Goal		Starting point	Focus	Means	Goal
Factory/ product	Existing products	Sales and promotion	Profits due to volume		Market	Client needs	Integrated marketing	Profits due to client satisfaction
<ul style="list-style-type: none"> <li>• Products are emphasized</li> <li>• Company first makes product and then tries to sell it</li> <li>• Management focuses on sales volume</li> <li>• Planning is short-term according to current products and markets</li> </ul>					<ul style="list-style-type: none"> <li>• Clients desires are emphasized</li> <li>• Products are made according to market needs</li> <li>• Management focuses on profits</li> <li>• Planning is long-term in terms of new products and markets</li> </ul>			

The sales-oriented business pays little attention to customer needs and wants, and does not try particularly hard to create suitable products or services.

A production-orientated business is mainly concerned with making as many units as possible. By concentrating on producing maximum volumes, such a business aims to maximise profitability by exploiting economies of scale. In a production orientated business, the needs of customers are secondary compared with the need to increase output. Such an approach is probably most effective when a business operates in very high growth markets or where the potential for economies of scale is significant.

A product –orientated business is “obsessed” with its own products. Their products may start out as fully up-to-date and technical leaders. However, by failing to consider changing technological developments or subtle changes in consumer tastes, a product-orientated business may find that its products start to lose ground to competitors.

*Managing* a market-orientated business consists of five key tasks:

Identifying target markets – which customers does the business want to trade with.

Market research - collection of information on the current and potential needs of customers in their target markets, including how customers buy and what competitors are offering

Product development – develop products which meet needs and wants sufficiently to attract target customers to buy

Marketing mix/ 5Ps – after identifying the target markets, and developing the relevant products and developing relationships along the value chain, the price, promotion and distribution methods must be determined. To offer value to the customer, to communicate the offer and to make it accessible and convenient.

Market monitoring – In addition to attracting customers businesses need to retain them, in order to do this and to develop new products it is important to obtain customer feedback over time, and to recognise that the competitive environment can change very rapidly.

*Long-term focus:* businesses need to regularly look for new products and markets for future growth, there are four main ways in which growth can be achieved.

Market penetration – increase sales of an existing product in an existing market

Product development – improve present products and/or develop new products for the current market

Market development – sell existing products into new markets (e.g. developing export sales)

Diversification – develop new products for new markets

### 10.3 Entrepreneurship

Entrepreneurship is the process of creating something new with a value by devoting the necessary time and effort, assuming the accompanying risks, and receiving the resulting rewards.

Entrepreneurs are innovators or developers who recognise and seize opportunities; convert those opportunities to marketable ideas (products or services that can be sold); add value through effort and skills; assume the risks of the competitive marketplace; and realise the rewards or losses. Entrepreneurs can be people who enter new or established markets, and through their ingenuity find creative ways to add to their own wealth, power and prestige. Entrepreneurs vary widely, however most of them have the following behavioural characteristics: initiative taking; assertive; organising and re-organising/ adaptive strengths which enable them to turn opportunities into practice and to learn; committed; an acceptance of risk and failure. More traits are described in Table 10.2.

**Table 10.2 Traits of successful entrepreneurs**

Traits	Comments
Self-motivated	<ul style="list-style-type: none"> <li>No-one will be breathing down your neck to check you are working, you will need to motivate yourself to work</li> <li>Owning a business requires you to do tasks you may not like, you need to find strategies for organising and motivating yourself to ensure they get done</li> </ul>
Hunger	<ul style="list-style-type: none"> <li>Hunger pangs help create the drive necessary to get your business off the ground and growing</li> <li>Many of the great business success stories come from disastrous circumstances</li> </ul>
Decision-making ability	<ul style="list-style-type: none"> <li>You will need the ability to make decisions intelligently after carefully weighing up several options or alternatives, including those that involve risks</li> <li>You may have the drive, and remarkable ideas in your head, but if you cannot make sound decisions these will be wasted</li> <li>When starting-up you need to be aware that despite all your planning there is a great deal of risk inherent in your venture, you will need to make decisions almost daily that involve some gamble. As your business grows so will the impact of your decisions</li> <li>Your decision-making will need to balance present and future aspects. Monitor your businesses performance accurately so you can base present performance and projections on reality and valid assumptions</li> <li>Intelligent decisions involve understanding: the context, your objectives, the alternatives and your criteria</li> </ul>
Resourceful	<ul style="list-style-type: none"> <li>When you start-up there will not be enough funding to pay for all the things the business needs</li> <li>Stepping out of your comfort zone to enlist friends and family to help market your business can cut costs</li> </ul>
Personable	<ul style="list-style-type: none"> <li>In most businesses you deal with people on a regular basis</li> <li>Customers will not return if they had an awkward interaction with you</li> <li>Customers will pay more or even accept lower quality if they trust you</li> </ul>
Adaptable	<ul style="list-style-type: none"> <li>A positive attitude and willingness to roll with the punches will take you far</li> <li>When faced with a problem, look for a solution not who to blame</li> </ul>
Persuasive	<ul style="list-style-type: none"> <li>You will need to be able to influence other people's buying decisions</li> <li>It is much easier to be persuasive about something you truly believe in</li> </ul>

Entrepreneurs may start their entrepreneurial activities for different reasons. It could happen out of necessity, e.g. if they have been made redundant they need to find a new livelihood. It could happen

through someone identifying an opportunity, e.g. the possibility of using locally produced sweetpotato flour to replace imported wheat flour. Part-time activities or hobbies may become successful enterprises, new opportunities may be seen for doing business through mobile phones or the internet. Tips on how to be an entrepreneur are given in Table 10.3.

Entrepreneurship comes with challenges and risks, including: an often uncertain income, risk of losing the entire investment; long working hours; hard work; lower quality of life until the business gets established; complete responsibility; discouragement, disillusion and difficulties; family, social, career and psychological risks.

Entrepreneurship is a major mechanism of economic growth. Countries with higher levels of entrepreneurial activity are showing greater economic growth. Various factors can contribute to making the environment enabling or disabling for entrepreneurship, these include: culture, education and societal history; finance availability; location; government policies; institutions (NGOs, labour market, openness etc.).

**Table 10.3 How to be an entrepreneur**

Instructions	Comments
Do what you love	<ul style="list-style-type: none"> <li>Most successful businesses have one factor in common. Their owners love what they do – so choose a business idea that aligns with your interests, no matter what they are.</li> </ul>
Know what you want	<ul style="list-style-type: none"> <li>Are you willing to leave your job if your business takes off? Or do you envision your business as a side project?</li> <li>Answering these questions will help you organise your time and priorities.</li> </ul>
Be radical	<ul style="list-style-type: none"> <li>Do not be afraid to try something that no one else has ever done. Create an off-the-wall product or shake up an existing market by changing factors such as a service or delivery model that established companies take for granted. E.g. Jollyken Ltd in the Kenyan flower industry, OFSP based biscuits in Rwanda.</li> </ul>
But follow the rules	<ul style="list-style-type: none"> <li>Make sure you register your business, keep records, pay taxes and health requirements to save problems later.</li> </ul>
Manage your time	<ul style="list-style-type: none"> <li>Understand what is required of you in your separate roles as an employer and a business owner.</li> <li>Use planning and organisational tools, e.g. a well-maintained appointment book, Microsoft outlook calendars and contacts, filing systems.</li> </ul>
Find a mentor	<ul style="list-style-type: none"> <li>Befriend a local entrepreneur or business leader with a record of achievement to be your business mentor.</li> <li>They can help you understand the risks and challenges of business, provide a sounding board for your ideas, help you find investors/ financial support for your company.</li> </ul>
Exploit online resources	<ul style="list-style-type: none"> <li>You can access hundreds of <a href="#">online resources</a> for entrepreneurs. Use them to help inspire, direct and motivate you.</li> </ul>
Be good to yourself	<ul style="list-style-type: none"> <li>You will get overwhelmed at times. If this happens step back from your work and do whatever relaxes you.</li> <li>Stay healthy – eat, sleep and exercise well - it will help you maximise your performance.</li> <li>Keep a check on the state of your mental health, remind yourself you are not competing against anyone but yourself, and that life is a journey.</li> </ul>
Use team work	<ul style="list-style-type: none"> <li>Learn to delegate, but delegate in a managed way by giving clear instructions and taking time to train and check on those you are delegating to. This will free-up time for you to create new opportunities.</li> </ul>



## 10.4 Understanding the five pillars (5P's) of marketing: Product, Price, Place, Promotion, People

Planning how you will market your product is crucial. Marketing is not just about selling, it consists of various issues. It involves determining what the customer wants and developing that product, working out a price that is profitable and attractive, delivering the product to a place where the customer will see it in order to purchase it. Additionally it involves informing the customer about the product and identifying who will be involved in the transactions during the sale of the product, and what knowledge they need to have.

People talk about the 5 pillars of marketing, and how these 5 pillars need to work together in order to found a strong foundation for marketing efforts. So what are these 5 pillars of marketing?

### Product

What to sell? The product can be either a tangible product (a sweetpotato root, or a packet of sweetpotato flour, for example), or an intangible service (such as agricultural extension advice, nutritional information, weeding), or a mixture of the two. Decisions regards what product or service to sell must be based on meeting the customers' needs, at the quality, quantity and value that customers demand (for sweetpotato this includes the size, colour, variety, taste, freshness of roots). It should be noted that sometimes customers are not always aware of their needs, for example many people are not aware they are deficient in vitamin A. Competing crops and products must also be taken into consideration, to understand the market context and competition. For example, is it cost-effective to substitute some wheat flour with sweetpotato flour or sweetpotato puree? Can farmers with access to water earn more from horticultural crops than sweetpotato vine production? Are people willing to pay more for undamaged roots than slightly damaged ones? Are OFSP preferred to white sweetpotato roots?



### Price

How much to sell at? The price needs to be right, good products at the wrong price will struggle to achieve success. The price has to be both profitable and attractive, and should be set and adjusted based on: production and marketing costs; the profit margin over costs; and prices of competing products. Understanding seasonal supply and demand changes and determining which criteria (e.g. root size, shape, variety, geographical source, skin colour, quality, price, convenience) most influence customer purchases is important. It is important to set a price that buyers can realistically afford. It is important to know the competitors' prices. In markets where there is limited purchasing power (poor consumers only have a small amount of money to spend), sweetpotato sellers often keep the same price and adjust the quantity sold in heaps when there are real changes in the price.



## Place

Where to sell? Includes both the physical location (e.g. home, farm, local market, under a tree stand, urban market, as well as how to display it on perhaps on a raised platform, middle of the shelf etc., how to make sure the place is clean to encourage buyers to visit) and customer's access to information about the product, e.g. how easy is it for a customer to contact the producer or sales person to find out the necessary details about the product. Will you work with middlemen? Consider the transport costs, methods and duration of journeys and storage. Decide on whether to work with farmer groups or form a farmers' association to bulk sales and provide a more continuous supply. Often sweetpotato is found in the least desirable parts of the market and part of changing its image is to negotiate with the traders and the market managers to change its location.



## Promotion

How to draw attention or create interest in the product and build demand for it? Advertising/ promotion is important in order to tell consumers about the availability of products or services, their benefits and why customers should make a purchase decision. Promotion strategies need not be expensive, but if well thought out will attract consumers to your product. To be effective, promotion has to reach the customers you want to target at the right place and time, through a combination of media channels, and to convey information that is compelling enough to persuade them to act. Advertising could include cardboard signposts, product labels with descriptions, attractive packaging, radio spots, posters, flyers, loud speaker messages at markets, painted market booths, signposts about orange fleshed sweet potato availability and price. Other forms of promotion could include: giving out samples of orange-fleshed sweetpotato roots together with nutritional information, adding a free sweetpotato root when someone purchases a different product, training market traders on the benefits of consuming orange-fleshed sweetpotato, exhibiting at field days or special occasions, and creating a brand or positive image about orange-fleshed sweetpotato. Remember consumers are not a bland homogenous group, there are lots of differences amongst them, such as: age, wealth, gender, cultures, formal and non-formal education levels. You may need to use different promotion approaches to reach different consumer groups. We have found that after consumers learn of orange-fleshed sweetpotato's nutritional value and its importance, they are willing to pay a slightly higher price for orange-fleshed roots over white.



## People

Who are the people involved in the producing, selling and buying of your product? They are our market value chain actors (e.g. farmers, extensionists, brokers, retailers, wholesalers, processors and consumers (e.g. individuals, schools, factories and barracks)). The actions, attitudes and knowledge of those involved in the selling of the product (e.g. traders, farmers, vine multipliers) can be influential in whether the consumer has a positive purchase experience that they would wish to repeat or share with other people or not. Being responsive to feedback and evaluating and then making the necessary changes is important.

In service organisations, people are part of the product itself, e.g. health care.



## 10.5 Exploring your sweetpotato market value chain

The sweetpotato farm-to-market value chain is the chain of connections that sweetpotato roots move along from the point of production to the point of consumption, from the farmers to the consumers.

The people involved in the different parts of the value chain are often referred to as the value chain actors. They include farmers/ producers, agricultural service providers, traders, processors/ millers, transporters and consumers. The different levels of traders are typically defined as follows: those who buy in small volumes (retailers); those who buy in large volumes (wholesalers); those who play a linking/ negotiating role in return for a fee or commission (brokers). The actors in the value chain need to work together to survive in business, they each have an important role to play and are interdependent. The roles of the different actors in the value chain are shown in Figure 10.3.



Projects involved in working with value chains need to be careful that they play a facilitative role in helping to better link the different actors, as opposed to themselves getting involved in the value chain as a bulking or selling actor. The aim should be to help develop a more sustainable system, by empowering the different actors as opposed to taking on the role of any of the actors, this fact should be made clear to the farmers involved right from the start of the project. That being said, at the beginning of a project, it is often necessary to facilitate the first links to bring the actors together because often traders are risk averse regards getting involved in a new value chain or financially subsidizing a new concept, like grading roots and getting a higher price for quality roots.

By exploring and analysing the sweetpotato value chain in your target areas we can identify the weak links in the chains, and opportunities for strengthening them. The analysis typically involves analysing prices, volume data and operations at each point on the value chain taking into account relevant cost factors (labour, inputs, transportation, taxes etc.) and returns on produce marketed. This information is then used in scenarios of increased volumes sold and prices realised from improvements in production yields, product quality, postharvest improvements, processing, market

diversification etc. Following this the opportunities for upgrading activities and improving returns at different points along the chain are studied. For example:

**Production:** Enabling farmers to respond to market demand by improving quality, supply dependability, increasing volumes sold, or diversifying their product offerings, while simultaneously lowering unit production costs and boosting revenues through the introduction of improved, low-cost technologies and sustainable farming practices.

**Postharvest improvements:** Reducing product losses after harvest by understanding the importance of careful harvesting and avoidance of wounds, curing (wound healing), careful packing and transport at all levels to maintain root quality, temporary and longer term storage practices, and potential benefits of working in groups. By implementing other improved postharvest practices such as sorting and grading, packaging, and possible value adding and transformation into new products.

**Marketing and logistics:** Facilitating marketing arrangements between smallholder groups and private partners such as traders, institutional customers, wholesalers and processors, which lead to increases in volumes sold. Such arrangements often involve the provision by these partners of market information, technical assistance and inputs to their farmer suppliers, in return for the assurance of receiving consistent quality and supply. The result is the increased integration of smallholder suppliers into the farm-to-market value chain. Training traders about orange-fleshed sweetpotato so they can promote it knowledgeably to their customers often provides a fairly simple opportunity. Trader training materials are available at <http://sweetpotatoknowledge.org/adding-value/training-communication>. In Mozambique, the training for traders constituted one model that incorporated seven main messages:

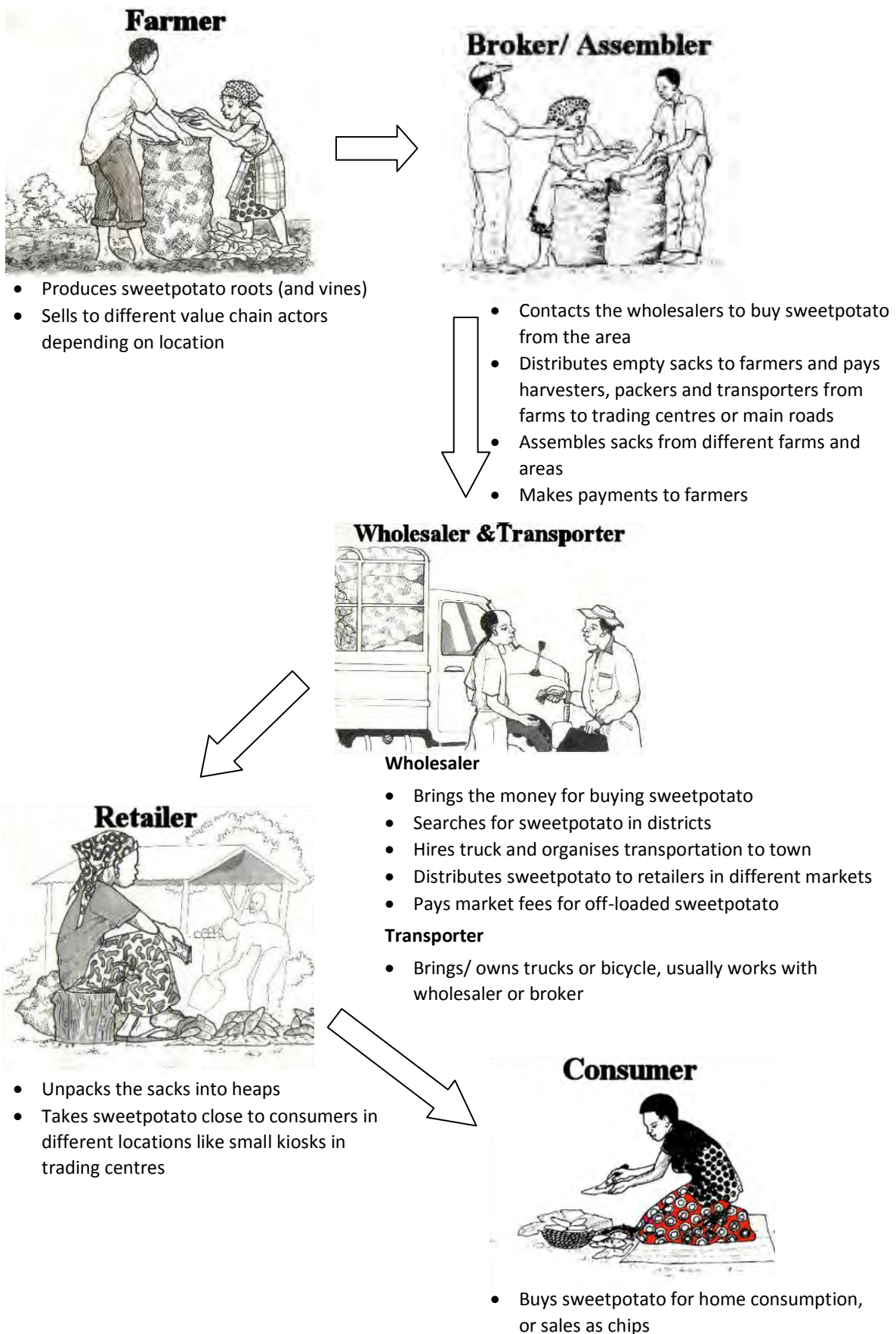
- (1) the importance of traders in marketing OFSP;
- (2) how OFSP is different from white and yellow sweetpotato;
- (3) why vitamin A is important;
- (4) how a trader can increase consumption of OFSP (promotion);
- (5) different ways to cook and prepare OFSP;
- (6) retail selling (grading, sorting, treating as a high-value product); and
- (7) marketing costs and margins.

**Agribusiness service providers:** Availability and quality of services (e.g. extension advice, credit and savings organisations and market information) and inputs (e.g. planting materials) in the target production areas.

Market linkage is the process of bringing together different actors in the sweetpotato value chain in order to improve their business. Farmers may be linked directly to retailers, or to wholesalers and brokers, or just to brokers, or to all of them. Subsidised or free inputs such as planting materials can be important initial market drivers. But care should be taken to prevent farmers assuming that those who provide inputs will also purchase the products, as is often done with cotton, tobacco and soya.

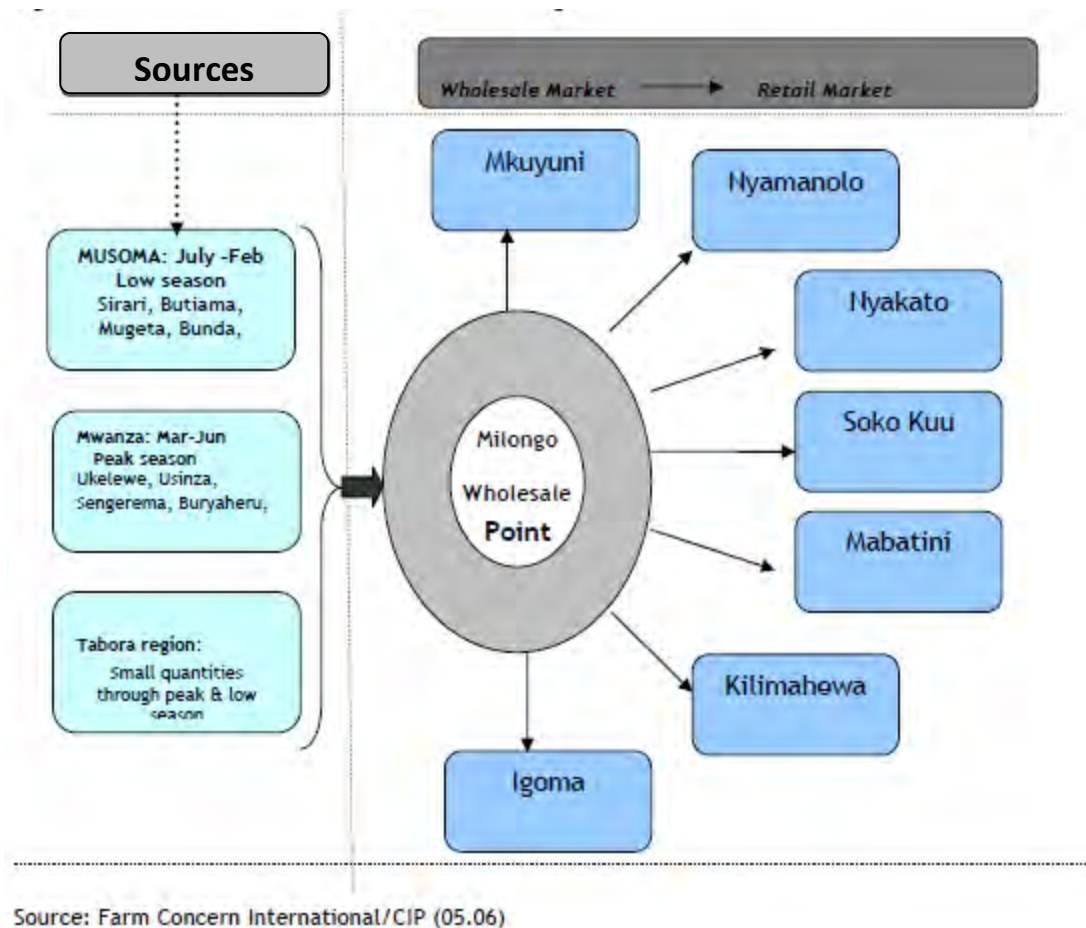
In Mozambique, once traders started to ask farmers for orange-fleshed sweetpotato and started to visit rural areas looking specifically for it and offering higher prices for it, farmers realised they could earn additional income by growing it. Farmers began to replace their white-fleshed varieties with orange-fleshed varieties and to take better care of their crop, and paid more attention to vine conservation. Most farmers planned to increase their orange-fleshed sweetpotato production because of the market demand. In Uganda, in addition to the good market demand for both the roots and vines of orange-fleshed sweetpotato, the fact that children and grandchildren expressed a strong preference for orange-fleshed sweetpotato was an important driver of adoption. Barriers to marketing included lower yields, which affects profitability, and the fact that some orange-fleshed sweetpotato varieties cannot be stored as long in the ground and do not lend themselves to piecemeal harvesting.

**Figure 10.3 Roles of different actors in the sweetpotato value chain**



A study of sweetpotato value chains in Tanzania in 2006, investigated the sweetpotato market networks of the different regions. The following example is from Mwanza, Lake Zone (Figure 10.4).

**Figure 10.4 Sweetpotato sources and market networks in Mwanza Region, Tanzania**



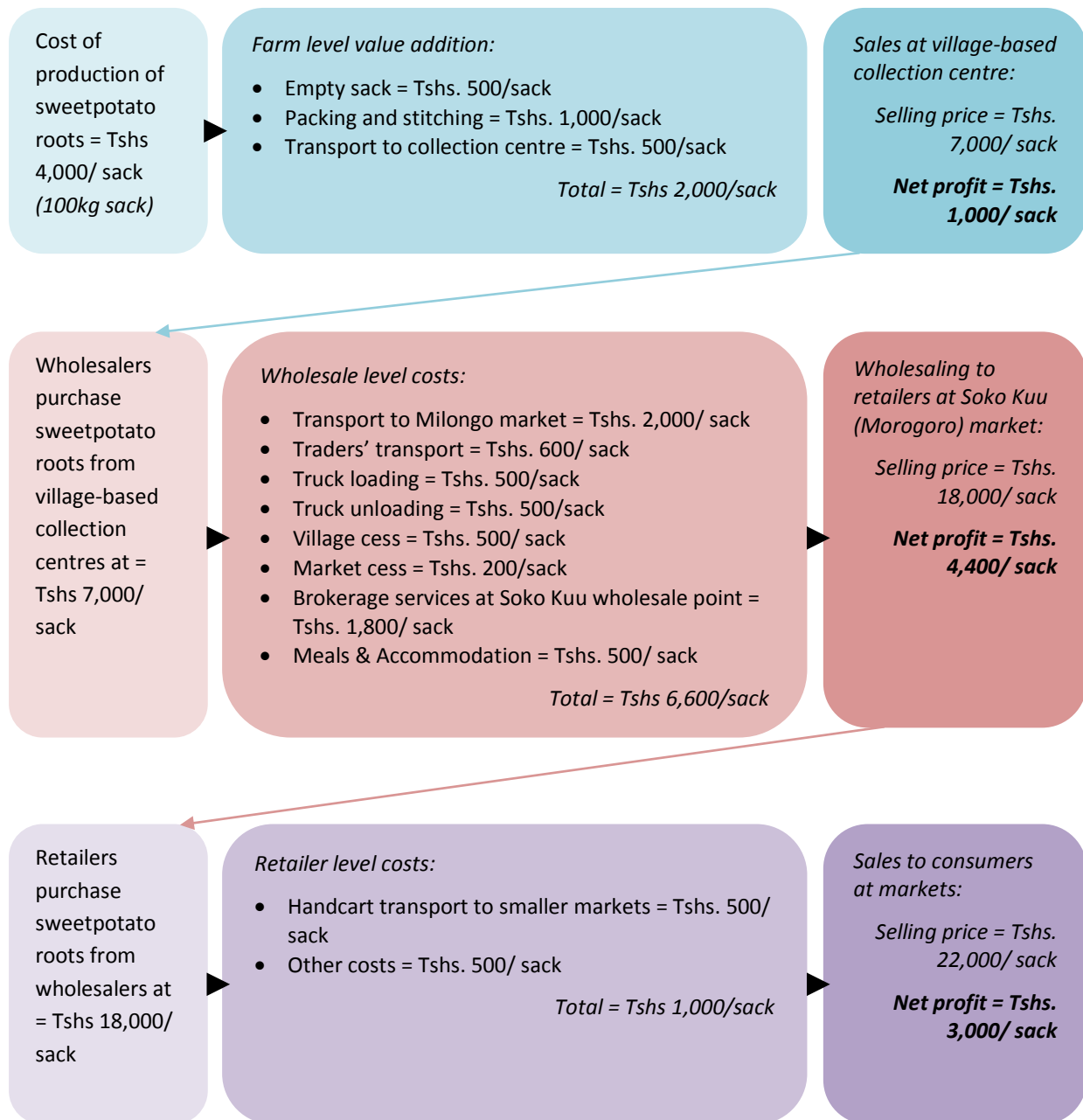
The study mapped the costs associated with sweetpotato roots at each stage of the value chain, and these are detailed in Figure 10.5.

The average cost of production of sweetpotato roots was estimated at Tshs. 4,000/ sack. Farm level value addition, including packaging materials, weaving and transportation was estimated at Tshs. 2,000/ sack. Selling price at village-based collection centre was Tshs. 7,000/ sack, generating a net profit of Tsh1,000/ sack. The estimated weight of the sack was 100kg.

Wholesalers typically purchase sweetpotato at Tshs. 7,000/ sack from farmers' collection points or road side points. They then offload the sack and sell to retailers at Tshs. 18,000/ sack, making a net profit of Tshs. 4,400/ sack after having deducted the costs of transport, loading and unloading, cesses, brokerage, meals and accommodation. Retailers pay Tshs. 18,000/ sack and incur Tshs. 1,000 for business development services such as transport and market fees and sell the roots from each sack at Tshs. 22,000 generating net profits of Tshs. 3,000.

At retail level, the roots are arranged in piles of 4-7 fresh roots, with prices ranging from Tshs. 200 to 1,000 depending on the size of the pile. During the high supply season the amount of roots per pile increase but the price levels remain the same. For example, a Tshs. 200 pile would have 3 roots during the low supply season and 6 roots during the high supply season. During the low supply season most of the sweetpotato retailers diversify into selling cassava which is available all year round.

**Figure 10.5 Costs along the Mwanza sweetpotato value chain (2006)**



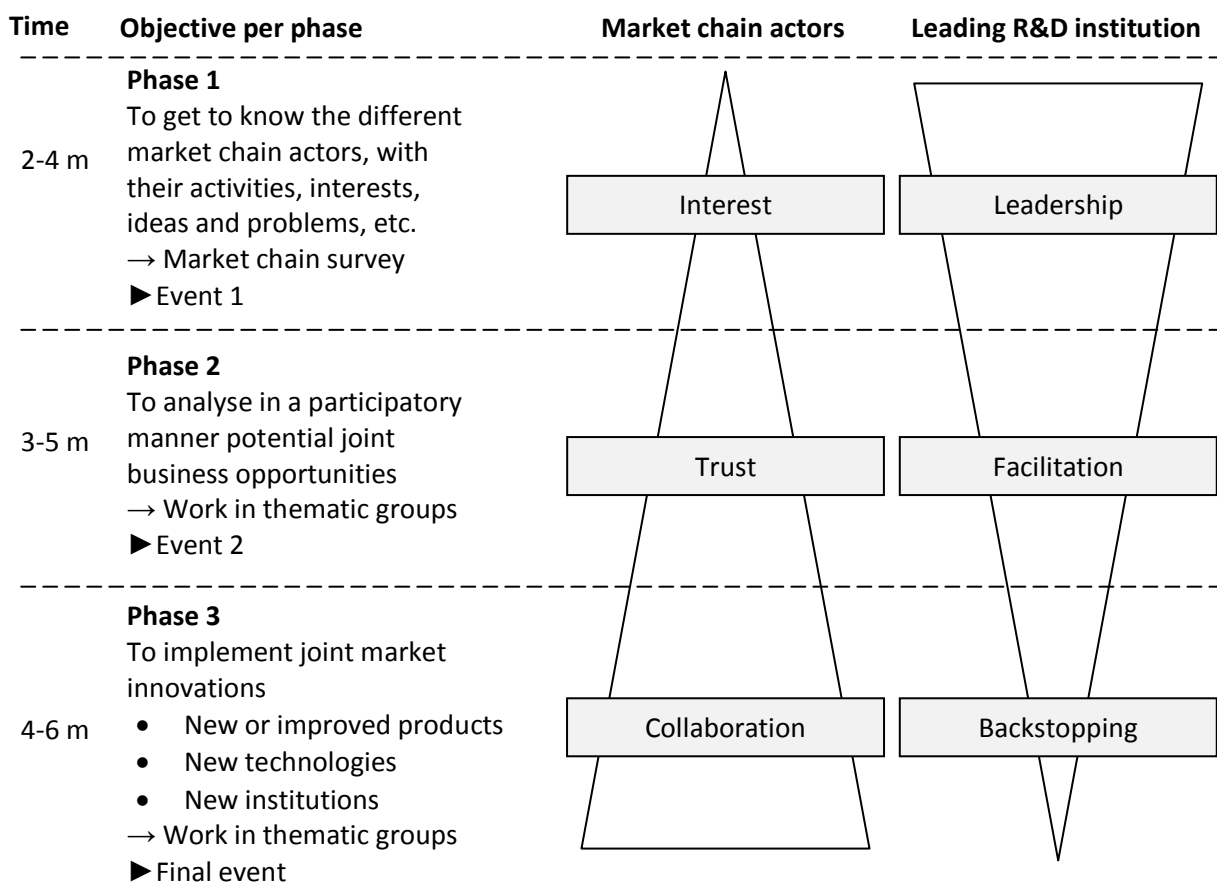
Source: Adapted from Farm Concern International and CIP (2006)

Commercial relationships exist between the different stakeholders/actors in the value chain. Commercial relations typically fall into three categories: Agreement – an informal type of relationship in which the exchange is conducted if the terms of sale are acceptable to both parties. Alliance – a more formal type of relationship in which there is a certain level of commitment between both parties. Contract – a formal relationship in which a legal document has been signed by both parties.

To improve how the market chain functions, consider using the Participatory Market Chain Approach (PMCA) (see Figure 10.6). PMCA brings the different market chain actors together, using facilitation techniques to build trust between the actors so that they begin working together to improve the product they have selected to market. Improving the product could involve all kinds of changes, for example: more continuous supply, grading and sorting the product based on quality standards,

better packaging, increased advertising, lengthened shelf-life. Refer to the PMCA manual for details on how to implement the method.

**Figure 10.6 Overview of the participatory market chain approach**



## 10.6 Why work as a group to market your sweetpotato?

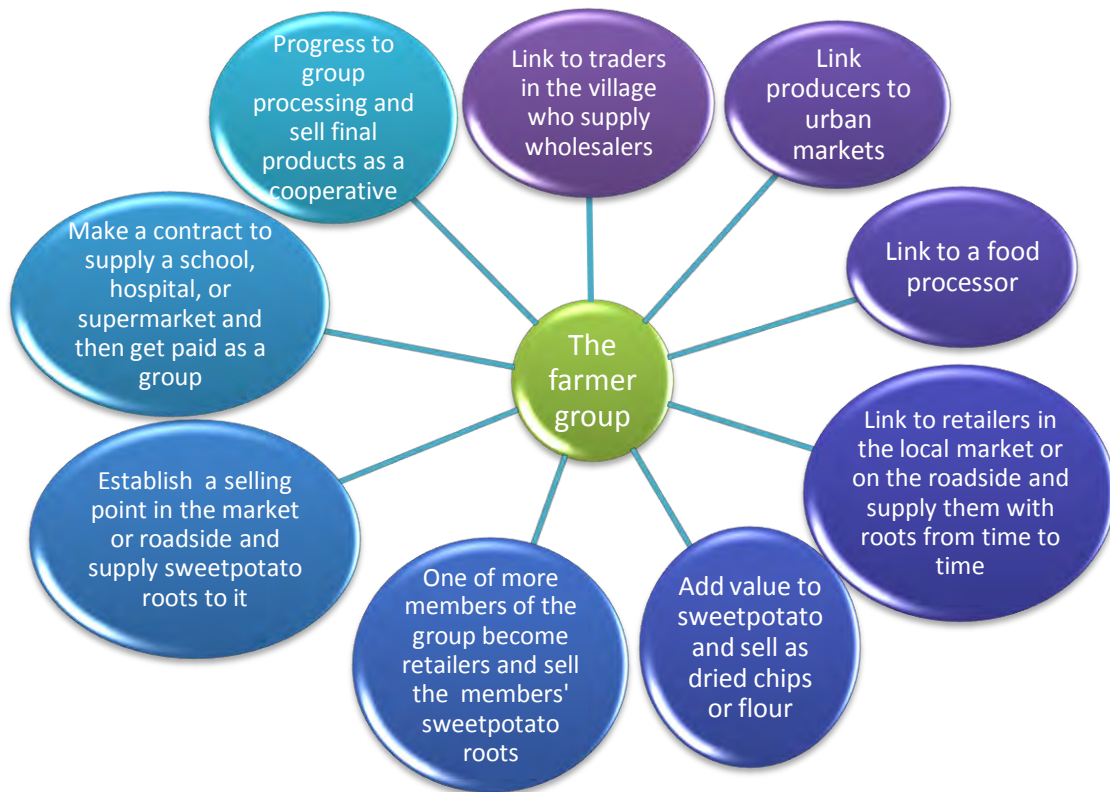
There are several reasons why a farmer might work in a group with other farmers to market their sweetpotato. These include:

- Being able to supply a larger volume. Traders do not want to spend their time and money collecting small volumes of sweetpotato from lots of different locations.
- Being able to supply sweetpotato consistently. If many farmers are involved and some stagger their planting dates, some irrigate, and some store, seasonality in supply can be significantly reduced. Organized groups often come up with production calendars among their members to help stagger their planting and harvesting dates.
- To gain a better bargaining position. If farmers work as a group they can negotiate with the trader so that they get a good set price for all members, which would not be possible if farmers were selling individually.
- To help build a good relationship with traders so that they will continue to buy from the group.
- To improve the quality of their products. The group will have to work at having a uniform quality of product from all members in order to keep their relationship with their trader.
- To take advantage of extension services who typically work only with groups so that they can reach more clients per extension agent. Focus on learning how to engage with sweetpotato as a business.



Whether marketing individually or as a farmer group, the 5 pillars of marketing can be used to help in planning. Group marketing systems can operate in many different ways, some examples are given in Figure 10.7.

**Figure 10.7 A selection of group marketing functions**



*Linking to institutional buyers:* Linking farmers to institutions as long-term assured outlets for sweetpotato has obvious advantages. However, the idea also comes with some large caveats, as procedures such as supplier registration and payment can be extremely slow. In helping to facilitate contracts between buyers and farmers, it is important to remember that in Sub-Saharan Africa it is difficult to enforce a contract if one of the parties chooses not to honour it. Hence, buyers need to be willing to pay slightly higher than the local market price if they want farmers to honour the contract over time. When they do not, the practice of *side-selling* emerges, whereby farmers often claim they have lost part or all of their crop, when they really have just sold it elsewhere. A good approach to keep farmers loyal is to offer additional services such as loans on anticipated sweetpotato yield, which is then repaid when the farmer harvests his crop. Processors can offer farmers, who supply roots or dried chips to them, technical support services or inputs which are properly monitored to help maintain loyalty.

Another model to consider is a lead outgrower model. In this model, there is a large farmer who is not interested in being part of a group, but he or she is willing to buy roots from surrounding farmer groups or neighbours and re-sell to his/her regular buyers or market directly. Sometimes such farmers are willing to serve as quality vine multipliers and/or demonstration sites for their area.

## 10.7 Can you make a profit from selling fresh sweetpotato roots?

To negotiate effectively, commercially oriented farmers need to understand their costs of production. Encourage farmers to keep a notebook with 4-6 pages reserved for each field to record all associated cost and sales incomes. You may need to support the farmers in their record keeping during the first season to help them understand how important it can be for them and their families (see Box 10.1). Many farmers have no experience of keeping records.

### Box 10.1 Calculating sweetpotato costs of production and returns

Farmers should record:

1. What they pay for inputs: such as purchased vines, chemicals, sacks, land hire, and especially what they pay for hired labour for each task (clearing, ridging, planting, weeding, hilling-up, harvesting, packing, carrying).
2. What they pay for transport, this includes tips given to those assisting to move bags, or help in hiring transport.
3. What they pay for marketing fees and staying over in the market, if they sell the crop themselves.
4. How much they harvested in kgs, and what amount can be taken to the market (marketable roots) and what was left at home as it could not be sold (unmarketable roots). If they harvest in sacks or other standard unit, they should know the weight of that sack or standard unit when it is filled with sweetpotato. Estimate the area of the field (10,000 square meters equals 1 hectare) and determine yield (1,000 kgs = 1 ton) in tons per hectare. If they are growing more than one variety, they should grow each variety on a separate ridge so that results for each variety can be easily recorded separately.
5. How much they sold in kgs, when they sold it, where/to whom they sold it and the price they sold it for.
6. Keep track of the amount of sweetpotato that is lost (number of roots or kgs) - either at harvest time (poor quality) or during storage. Estimate that 4 medium size roots are approximately 1 kg.
7. Then they should calculate their gross revenue: (total amount harvested (kgs) minus total amount lost (kgs)) X average sale price of their sweetpotato. They can also just calculate the value of the amount sold.
8. Then they should add up all of their costs and calculate their net return to their family labor: Total revenue minus total cost. If the area of the field is known, this can be done on a per hectare basis as well. Net returns per hectare can be compared to those for other crops.

Encourage farmers to note any problems they encountered during the season and what they did to solve them. Then they can begin to see how their business management ability grows over time.

Calculating whether you can make a profit from sweetpotato is not just about knowing the difference between your sales price and your production, marketing and transaction costs. You also need to know that there is sufficient demand for your product, and in some cases being involved in helping to increase demand through awareness creation strategies. The case study below (Box 10.2) provides some examples for raising awareness regards marketing orange-fleshed sweetpotato roots.

### **Box 10.2 Mozambique, Zambézia Province case study**

Sweetpotato roots are typically consumed as a secondary staple for breakfast, and as a snack food. The sweetpotato marketing system is well developed, particularly in the south for supply to Quelimane and cross-border to Malawi.

To create a self-sustaining market the project used a strategy of informing retail sweetpotato **traders** of:

- the advantages of consuming orange-fleshed sweetpotato (to create a willingness-to-buy from farmers)
- where they would find sources of supply
- how they could make a higher profit margin from trading orange-fleshed sweetpotato, even if they had to pay farmers more for it

And simultaneously raising **urban consumers'** awareness through radio advertising of:

- the advantages of eating orange-fleshed sweetpotato – particularly its pro-vitamin A content and its sweet taste.
- where orange-fleshed sweetpotato was being sold.

And supporting sweetpotato farmers with marketing training and on how to form marketing committees and establish links with traders. Families need to be encouraged to produce enough to eat (so the family gets the vitamin A and food security benefit) and a surplus to sell. The project held events to promote orange-fleshed sweetpotato to consumers and local leaders where nutrition extensionists explained the nutritional benefits and demonstrated different ways orange-fleshed sweetpotato could be prepared and gave out samples for consumers to taste.

The active promotion of the product, led to rapid organisation of orange-fleshed sweetpotato marketing in Gurue town markets within just one season. Most orange-fleshed sweetpotato was sold where there were existing marketing channels and where it could be easily substituted for other varieties. Additionally, many innovative farmers became involved in finding and creating new markets. Building trust with the traders is key for a project aiming to create demand for a new product.

In the four main markets in Zambézia, orange-fleshed sweetpotato commanded a 15% premium in the sales price compared with white fleshed varieties. However, this price increase was not always passed onto the farmers. In all urban markets, traders reported that orange-fleshed sweetpotato sold faster than white or yellow fleshed varieties. Traders would break off the tip of the root to indicate the 'orangeness'.

## 10.8 When does it make sense to develop a processed product?

Few processed sweetpotato products are currently marketed in Sub-Saharan Africa.

Key supply issues limiting processing include unreliability of supply, poor quality of chips due to poor drying techniques and high labour inputs required to wash, peel and chip. Farmers complain about the low price of sweetpotato chips compared to the price of fresh roots. In addition to the technical aspects, there are also organisational and market development constraints.

Some drying and storage techniques reduce the beta carotene content, which then limits the nutritional value of orange-fleshed sweetpotato as a processed product (see section 4.3.1 and Handout 8.9.2). Low-cost, direct sun drying on a raised tray or platform can result in beta-carotene losses of 20% if you do not overdry. Make sure the drying process is relatively fast, not more than two days in order to maintain the drying quality. Insufficient drying may lead to poor quality flour that becomes mouldy when stored, check the moisture content of the chips before milling. If you leave the orange-fleshed sweetpotato to dry for too long (over-drying), you can lose a lot of the beta-carotene and the dried chips will hardly look orange at all.

However, storage *after drying* can lead to even higher losses of beta-carotene content in orange-fleshed sweetpotato chips. It is therefore recommended that orange-fleshed sweetpotato chips are only stored for a maximum of 2 months, otherwise the beta-carotene content is greatly reduced (e.g. by more than 70%).

Food preparation methods can also reduce the beta-carotene levels. But in most cases, if 25% or greater of the wheat flour is replaced with a medium to dark-intensity orange-fleshed sweetpotato in puree or flour form, there are significant amounts of pro-vitamin A in the product.

While there is a huge range of delicious processed products that can be made from sweetpotato, how many of these products make commercial sense? Before spending lots of time making a wide range of products, figure out which ones are likely to be attractive to consumers and profitable. Below we use the development of *Golden Bread* in Zambézia Province in Central Mozambique as an example.

### 10.8.1 How to select the best product to try

The first step is to understand which consumers you are targeting. Is it the poorer consumer that is likely to be more at risk of vitamin A deficiency (VAD), or the middle-to-upper class consumer more able to purchase more expensive products? In Zambézia Province, the majority of the population was poor and at risk of VAD and that was the targeted group.

Once you have decided on your target consumer group, find out what products (bakery, fried, juices) they are already consuming and what they are paying for those products. Then investigate what it costs the agro-processor to make those products and identify the ingredients that could be substituted by sweetpotato. In the major urban market in Zambézia, it was found that most products were produced by a single individual who made a batch and sold it before making the next batch. The majority of processed products on the market had wheat flour as an ingredient. Wheat flour was expensive, particularly because it was imported into the Province from the coast over 500 kms away. The major constraint faced by product makers was the low purchasing power of consumers. No unit price of a product sold exceeded US\$ 0.04 (in 2003). Net returns to labour were calculated for all products and bread and fried doughnuts had the highest net returns per unit sold. The project focused on bread, because fried doughnuts required oil as well as wheat flour.

### 10.8.2 How to develop the sweetpotato product

One of the first questions that normally arises when developing a sweetpotato processed product is should one use flour or puree (boiled and mashed sweetpotato). Flour is convenient to store, but requires drying and milling. Puree is easy to prepare, but more difficult to store once made. It often requires a processor to have a refrigerator or freezer or alternatively, to store the fresh roots and prepare when needed. The major consideration in making this choice is purely economic. One must also consider access to electricity, in many areas of rural Africa this is not available, meaning that whatever product you select must be able to be made with an alternative electricity source and still give quality products. It takes 4-5 kgs of fresh roots to make one kilogram of sweetpotato flour. It takes 1.25 kgs of fresh roots to make one kilogram of sweetpotato puree. In most Sub-Saharan African countries with sweetpotato yields ranging from 5-15 tons/ha on farmer's fields, sweetpotato flour is usually more expensive than wheat flour. That means, for most products where you are going to use sweetpotato to partially substitute for wheat flour, puree makes economic sense. Sweetpotato flour can usually only be considered if you are targeting a food or feed processor or wealthier, health conscious consumers or if you are sourcing your sweetpotato from highly productive commercial operations producing 40-60 tons/ha.

In Zambézia Province, the project started with the recipe that the bakers were already using and tested the substitution of different amounts of orange-fleshed sweetpotato puree for wheat flour. They also increased the amount of yeast. Products were tested with consumers in different forms (round, elongated) as well as with different levels of sweetpotato substitution, with the idea of maximizing the amount of sweetpotato so that the pro-vitamin A content could be pushed as high as possible. They found that consumers liked Golden Bread in which 38% of the wheat flour by weight had been substituted with puree. The other major modification made to the baker's recipe was to reduce the number of risings of the dough from two to one. Further research established that it is also important not to add too much salt, because salt reduces the final volume of the bread. Consumer studies found that the consumers preferred Golden Bread over white wheat bread because of its heavier texture (*"it fills the stomach"*), superior taste, and attractive golden appearance.

The Golden Bread was analysed for beta-carotene content. According to United States Food and Drug Administration guidelines, a product can be considered an excellent source of vitamin A if it contains 20% or more of a daily value of a reference amount. It can be considered a good source if it contains 10 to 19%. A 110 gm bun of Golden Bread was found to be an excellent source of vitamin A for children and non-pregnant women and a good source for all other adults.

Equally important, was that bakers in Zambézia saw profit increases from 54% to 92% by substituting 38% of wheat flour with orange-fleshed sweetpotato puree. As a rule of thumb, the price of wheat flour must be at least 1.5 times greater than the price of fresh sweetpotato roots to consider substituting sweetpotato puree for wheat flour in bread.

The challenge in developing any processed product is to ensure continuous supplies of roots to the processor. In countries with two or more sweetpotato growing seasons per year, the continuity of root supply will usually be better than in places with only one main growing season. Although, if farmers all plant and harvest their crop at the same time, there will still be supply continuity problems. Staggered planting and fresh root storage can help to avoid this problem, but processors may need to work with growers on planning of timing and inputs to help ensure they can access the continuous supply they require. In countries with only one major growing season, investments need to be made in fresh root storage or off-season irrigated sweetpotato production. One must always be aware that if fresh root market prices are high, agro-processors will be less inclined to use sweetpotato roots in their products.

### 10.8.3 Sweetpotato products with commercial value

Currently, the orange-fleshed sweetpotato products with the most commercial potential being produced in Sub-Saharan Africa are:

1. Fried products, such as chips, crisps, chapatis, and doughnuts
2. Baked products, such as breads and biscuits
3. Juice

Recipes for these products are provided in Topic 9. However, it should be remembered that the healthiest way to eat your orange-fleshed sweetpotato is to boil and mash it and add just a teaspoon of oil to increase vitamin A absorption. Deep fat fried products (chips, crisps) are much less healthy than boiled or baked products. When making the juice, the key is to use clean, boiled water.



The Zambia project's experience suggests product training efforts should focus on people already engaged in selling products or in businesses like restaurants that serve products. They are more likely to make the products on a regular basis than farmers, unless the latter are already making chapatis or other products in their households. Women's groups looking for an enterprise may also adopt these products.



In Rwanda, the sweetpotato Superfoods project is working with large-scale processors to produce orange-fleshed sweetpotato biscuits and mandazi, and improved packaging.



*Sweetpotato biscuits and mandazi being produced in a factory in Rwanda, and nicely packaged sweetpotato products being promoted at a trade fair.*

In China there are many commercially sold sweetpotato products, see Topic 9 for more examples.



*Cornflake breakfast cereal made from sweetpotato and corn flakes, sweetpotato snacks and crackers*

## 10.9 Gender and diversity aspects of sweetpotato marketing and entrepreneurship

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in Topic 11. Key gender and diversity issues relevant to sweetpotato marketing and entrepreneurship include:



- It is important for development workers to understand who is typically involved in which aspects of the sweetpotato value chain, as well as what these players do, when and how, and what constraints they typically face. In addition to understanding who does which tasks it is also important to understand who makes the decisions, and who reaps what benefits at each stage of the value chain. A gender sensitive value chain analysis can be a useful tool in building this understanding.
- If particular groups of the community (e.g. a particular religious or ethnic groups, poorer people or women) are under-represented in the value chain it is worth probing to find out why this is, and what the constraints to their involvement are. For example a participatory exercise on the benefits and challenges of women playing the different roles in the sweetpotato value chain could be very enlightening for all involved. The project may be able to develop innovative ways of working which help widen access to the different roles in the value chain.
- Attention needs to be paid to postharvest gender roles and how processing may impact on them, including appropriateness of equipment and in what ways the introduction of machines or new products will affect gender roles and income benefits.
- The above factors are all relevant for a project in deciding what type of information to share, who to share it with and when. The perceived importance of the sweetpotato value chain crop in the different stakeholders' activities will influence the investment levels in terms of the time and resources that they are prepared to make.
- As with all training, attention needs to be given not only to imparting appropriate and practical information to the target beneficiaries, but also to those who make decisions and control access to the raw materials. Timing, duration, location, delivery language, approach and participant composition of training events need to be considered to ensure certain groups are not unintentionally prevented from accessing training.
- In most parts of Sub-Saharan Africa, men are considered the owners of assets such as land and buildings and make decisions regarding their use. It is critical for development workers to be sensitive to male control over resources and ensure that men are consulted about project activities even where they are not directly involved.

## 10.10 Ideas for sweetpotato marketing and entrepreneurship learning-by-doing activities

These learning by doing activities have been designed to provide hands-on discovery learning opportunities for the participants of the 10 day 'Everything you ever wanted to know about sweetpotato' ToT course. 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. The following activities occur on day 9 of the 10 day ToT course, an overview of day 9 is given below. However, we hope these activities will also be used by trainers as stand-alone learning activities and as part of other training courses.



Day	Topics	Intended Learning Outcomes	Activities
9	Marketing and entrepreneurship	<p><i>Participants will:</i></p> <ul style="list-style-type: none"> <li>- Be familiar with the concepts of marketing and market orientation</li> <li>- Understand the 5 pillars of marketing</li> <li>- Understand the opportunities and challenges in sweetpotato fresh root and processed product marketing</li> <li>- Explore gender issues along the value chain</li> <li>- Understand the importance of trader training</li> <li>- Be aware of how to select an appropriate processed product</li> <li>- Know how to calculate marketing margins for fresh root trading</li> <li>- Know how to calculate marketing margins of processed products from flour or puree</li> </ul>	<ul style="list-style-type: none"> <li>- <i>Activity 10.10.1: Market trip.</i> Research visit to a market with half the group working on fresh root marketing margins and issues and the other half on processed products, find out about characteristics and constraints of each including any gender issues. Back at training centre groups summarise findings into a presentation followed by discussion (see section 10.10.1 below). [4.5hrs]</li> <li>- <i>Presentation 10a.</i> Marketing and entrepreneurship and relevant gender aspects. Group marketing. [20 mins]</li> <li>- <i>Activity 10.10.2: Calculating your profit margins.</i> Using a farmer case study, participants will work out the profit margins at each stage of the value chain (see section 10.10.2 below). [45 mins]</li> <li>- <i>Activity 10.10.3: The 5 Pillars of Marketing.</i> Role play to get participants to explore marketing issues (see section 10.10.3 below). [55 mins]</li> <li>- <i>Presentation 10b.</i> The 5 pillars of marketing, and how to select your product. [20 mins]</li> </ul>



### 10.10.1 Market trip

*Intended Learning Outcome:* Participants will

- understand the opportunities and challenges in sweetpotato fresh root marketing
- understand the opportunities and challenges in sweetpotato processed product marketing
- be aware of how to select an appropriate process product

*Timing:* 4.5 hours plus travel time

*Materials:* nearby market, transport, 5 measuring cups, 5 plastic containers (~2kg root capacity), notebooks and pens, flip charts and markers.

*Advanced arrangements:* organise transport, facilitator should make a pre-visit to the market to find out where the sweetpotato root traders are and whether any sweetpotato processed products are being traded, and if not to look at which processed products the participants could study.

*Suggested steps:*

1. Split the participants into 2 main groups and then into sub-groups of 4 persons each. Each sub-group should have one person assigned to ask the principal questions. All other participants should take notes. One group will be tasked with learning about fresh sweetpotato root marketing, and the other group about processed products. [30 mins]
- *Fresh root group:* Brief the 'fresh root group' on the fact that they will be visiting the market, and will have 1.5 hours to find out everything they can from small-scale and larger scale sweetpotato traders regards their activities. In the market they will probably want to work in pairs or fours, and they should write down what they learn as they will then make a presentation about it to share with the other group. This should include:
    - a) how they got into sweetpotato trading, what factors influenced their decisions?
    - b) an understanding of the different places they source sweetpotato from during the year and whether this is due to production seasonality or other factors?
    - c) when the low season and high season are, and what the traders do during the low season e.g. do they diversify into different products?
    - d) their view of who the different actors in the value chain are from producers to consumers?
    - e) the typical quantities of sweetpotato that the traders sell each day and week?
    - f) the size of the sack they buy, and the size of the heaps they sell?
    - g) observe their sales 'place' and style what do you notice about it, is it clean and encouraging to customers, which section of the market is it in, how could it be improved?
    - h) do they do any 'promotion' of their roots, if so, how?
    - i) do they sell a range of different varieties, and why or why not? Do they sell other crops or products alongside sweetpotato?
    - j) do they sort or grade the roots they sell in anyway, if so, in what ways?
    - k) the price that they buy a sack of sweetpotato for, what costs do they then have to pay, what sales income do they earn, what their profits are?
    - l) how they manage risks?
    - m) how their profits from sweetpotato compare to those earned for selling other crops?
    - n) observe which type of people are selling sweetpotato, e.g. is it only women or only men, do they also grow sweetpotato, are they typically young or middle aged, or is it a wide range? Why does it tend to be these people?
    - o) what do they know about orange-fleshed sweetpotato?
    - p) what the main problems and constraints they face are (this should include probing on quality aspects of sweetpotato roots as well as other constraints)?
    - q) what information they would like to learn related to sweetpotato trading?
    - r) ask a few consumers what the main factors are that they use when deciding whether or not to purchase sweetpotato, and which sweetpotato roots to purchase?

- *Processed product group*: Brief the 'processed product group' on the fact that they will be visiting the market, and will need to find out everything they can from traders selling either a sweetpotato processed product (if there are any), or a product that might be able to use sweetpotato as a major ingredient, e.g. bread rolls, mandazi (doughnuts), chapati, juice, chips made with Irish potato or compete with sweetpotato products, e.g. a coconut sugar bar. The group might want to work in pairs and thus be able to cover several products. The group should carry a measuring cup, to help the product makers estimate actual amounts of ingredients used in case they can't remember. Remind them that they should write down what they learn as they will then make a presentation about it to share with the other group. This should include:
    - a) how they got into trading this product, what factors influenced their decisions?
    - b) how do they make their product, step by step including
      - i. the amount of each ingredient they use
      - ii. how much they pay for each ingredient and where they buy it from
      - iii. how many units do they make at a time (batch)
      - iv. whether they hire any labour to help and what that costs
      - v. any other expenses they may have associated with making the product
    - c) how much they sell the product for and why don't they sell it for a higher price?
    - d) how many customers do they get in a day and how long does it take to sell a batch?  
How many batches do they make and sell in a week?
    - e) do they or members of the family eat a part of the batch?
    - f) what do they see as their profit margin per batch?
    - g) observe their sales 'place' and style what do you notice about it, is it clean and encouraging to customers, which part of the market is it in, how could it be improved?
    - h) do they do any 'promotion' of their products, if so, how?
    - i) if they sell other products, how their profits from different products compare?
    - j) observe which type of people are selling these products? e.g. is it only women or only men, are they typically young or middle aged, or is it a wide range?
    - k) what the main problems and constraints they face are (this should include probing on quality aspects of raw ingredients as well as other constraints)?
    - l) what do they know about orange-fleshed sweetpotato?
    - m) have they ever considered using any kind of sweetpotato as an ingredient in their product?
    - n) ask a few of their clients what the main factors are that they use when deciding whether or not to purchase the processed product, and which processed product to purchase?
2. Travel to the market, preferably by foot if it is nearby. [X mins (travel/transition time)]
  3. Visit the market, the fresh root group and the processed product group will speak with different traders about all the issues listed above as bullets. [1.5 hours]
  4. Return to the training centre [X mins (travel/ transition time)]
  5. Each group makes a chart comparing what they have learned from different interviews [1 hr]
  6. Ask the two groups (fresh root and processed products) to each spend 45 mins discussing what they learnt and preparing a presentation (which could involve role play) about the trading activity they focused on (including gender aspects), which they will share. [45 mins]
  7. Presentation [10 mins per group = 20 mins]
  8. Discussion: following both the presentations facilitate a discussion on the trading activities observed, differences between fresh root and processed product trading and key characteristics and constraints of each (including gender aspects). Ask the participants to think about how they might involve traders in a sweetpotato project, and what opportunities they saw for improving different aspects of the value chain. [25 mins]

### 10.10.2 Calculating your profit margin

*Intended Learning Outcome:* Participants will know how to calculate marketing margins for fresh root trading

*Timing:* 45 mins

*Materials:* Enough photocopies of the Case Study on Esther (Box 10.3 below) for each person to have a copy

*Suggested steps:*

1. In pairs participants are given a written case study describing farmer Esther's costs of producing and marketing sweetpotato roots at each stage of the value chain. Note there are different options described. They need to work out how to present the information in a visual way that they can then use to calculate the costs and profit margins at each stage of the value chain. Highlighting any risks or opportunities they have noticed. [45 mins]
2. Ask each pair to join another pair, and to explain to each other their value chain calculations using the visual diagram they have prepared. [15 mins]
3. In a whole group discussion, ask them to discuss any difficulties they had in interpreting and presenting the case study, any differences between their understanding of the value chain and its costs and profits and that of the pair they joined with, and brilliant ideas they saw or had for presenting the information visually. [15 mins]

### 10.10.3 The five pillars of marketing

*Intended Learning Outcome:* Participants will understand the five pillars of marketing

*Timing:* 55 mins

*Materials:* 20 orange-fleshed sweetpotato roots, stickers/ post-its, marker pens, flip charts, masking tape, Presentation 10b on the 5 pillars of marketing

*Suggested steps:*

1. In order to explore their existing knowledge of the 5 pillars of marketing, organise a brainstorming followed by group discussion on the key aspects of marketing. [20 mins]
2. Ask for 6 volunteers to create a role play using the orange-fleshed sweetpotato roots to depict a typical market scene with people buying and selling sweetpotato roots. Give them 5 minutes to plan a 5 minute performance. The other participants will be observers. [10 mins]
3. At the end of the role play, ask the participants who were observing to comment on key marketing issues they saw. Note down key observations on a flip chart as the discussion continues. If necessary the facilitator should subtly probe to get the participants to mention aspects related to all the 5 pillars of marketing, and to bring out gender and diversity aspects. [10 mins]
4. The facilitator should then make a presentation about the 5 pillars of marketing, using questions to involve the participants and get them to share their experiences of the different pillars, and the importance of all the pillars. [15 mins]

### Box 10.3 Case study: Esther's sweetpotato costs and returns

Esther wanted to prepare her sweetpotato field and hired men to help (Ushs40,000), she then ploughed the field twice at a cost of Ushs30,000 per ploughing, and then hired women to help make the mounds to plant her sweetpotato on. They made 10,000 mounds which cost a total of Ushs 200,000. Esther didn't have enough planting materials so she went to the swamp to buy some from Josfat, she bought 10 bags of vines at a cost of Ushs15,000/ bag. She hired bicycle transport to take them to her field at a total cost of Ushs 3,000. She hired labourers to help her plant, this cost a further Ushs 30,000. Fortunately the rains were good and her crops grew well, but so did the weeds, so she twice had to hire labourers to help her weed, each weeding cost her Ushs60,000. Soon it was time to harvest, the yield was good so she hired labourers to help her harvest. They harvested a total of 60 bags of roots, and she paid the labourers Ushs1,500 per bag for the harvesting, and the empty bags cost her Ushs800/bag.

Esther was planning to sell her roots, and she knew in order to sell them she needed to grade and sort them, which cost Ushs500/bag, and package them @ Ushs1,000/bag.

She couldn't decide whether to take them to the market and sell them at Ush20,000/bag or sell them from her home at Ush15,000/bag.

If she took them to the market she would incur additional costs, such as transport @Ushs5,000/bag, loading and off-loading @Ushs1,000/bag, market fees @ Ushs500/bag, agents commission @Ushs600/bag. She would also end up having to stay over at the market and this typically cost Ushs20,000.

Help Esther work out:

- 1) What her production costs per bag of sweetpotato roots are?
- 2) What her marketing costs per bag of sweetpotato roots if sold at home are?
- 3) What her marketing costs per bag of sweetpotato roots if sold at the market are?
- 4) What her minimum per bag selling price if sold at home should be?
- 5) What her minimum per bag selling price if sold at the market should be?
- 6) What her profit margin would be per bag of sweetpotato roots if sold at home?
- 7) What her profit margin would be per bag of sweetpotato roots if sold at the market?

Discuss:

- What risks she might face by selling from home, and what risks she might face selling at the market?
- What the impact of grading and sorting the roots might be? Could she bargain for a higher sales price?

## 10.11 References used

- Ameu, M., Carey, E., (2011). TOT training manual on sweetpotato vine multiplication.
- Farm Concern International, (2004). Orange fleshed sweetpotato promotional research: creating a suitable market environment for orange-fleshed sweetpotato and nutrient-rich baby foods. Farm Concern International, Nairobi. pp38.
- Farm Concern International, CIP, (2006). Value networks assessment of the sweetpotato: Tanzania Central Corridor (Shinyanga, Singida, Morogoro, Dar es Salaam, Arusha). Rural Livelihoods Development Company, Tanzania. pp98.
- Harvest Plus, (2010). Reaching and Engaging End Users (REU) with orange fleshed sweetpotato (OFSP) in East and Southern Africa. Final report submitted to the Bill and Melinda Gates Foundation, July 9, 2010. Washington DC: Harvest Plus. 477pp.
- Isubikaul, P., Magezi, S., Musoke, C., Nsubuga, H., Namanda, S., Ball, A., and Harvest Plus, (2009). Promoting production, consumption and marketing of the orange sweet potato: trainer's guide. Harvest Plus Reaching End Users –OSP Uganda Project. pp 59.
- Kaguongo, W., (2007). Rapid appraisal for the impact-at-scale through nutrition-focused marketing of African indigenous vegetables (AIVs) and Orange-Fleshed Sweet Potatoes (OFSP) project. Project report, International Potato Center, 41 p.
- Low, J., Lynam, J., Lemaga, B., Crissman, C., Barker, I., Thiele, G., Namanda, S., Wheatley, C., Andrade, M., (2009). Chapter 16 Sweetpotato in sub-Saharan Africa. In: The Sweetpotato. Loebenstein, G., Thottappilly, G., (Eds.). Springer. pp359-390.
- Low, J.W., van Jaarsveld, P.J., (2008). The potential contribution of bread buns fortified with beta-carotene-rich sweetpotato in Central Mozambique. *Food and Nutrition Bulletin*, 29(2): 98-107.
- Nsubuga, H. and Harvest Plus, (2007). Training manual on market and product development for traders and processors. Harvest Plus, Uganda. 12pp.
- Riley, J., (2012). What is marketing? Tutor2u. [http://www.tutor2u.net/business/marketing/what\\_is\\_marketing.asp](http://www.tutor2u.net/business/marketing/what_is_marketing.asp)
- Tomlins, K., Rees, D., Coote, C., Bechoff, A., Okwadi, J., Massingue, J., Ray, R., Westby, A., (2010). Chapter 10 Sweet potato utilization, storage, small-scale processing and marketing in Africa. In: Sweet Potato: Post Harvest Aspects in Food, Feed and Industry. R.C. Ray, K.I. Tomlins (Eds.). Nova Science Publishers, New York. pp. 271-293. ISBN: 978-1-60876-343-6.
- USAID, (2009). The farm to market value chain approach: linking smallholders to Wal-Mart in Honduras. Best Practices in Implementation Paper Series, MicroReport 139. pp8.
- Wheatley, C., Loechl, C., (2008). A critical review of sweetpotato processing research conducted by CIP and partners in sub-Saharan Africa. CIP, Lima, Peru. Social Sciences Working Paper 2008-3. 48pp.

Notes on: **Marketing and Entrepreneurship**

