EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

TOPIC 6

Sweetpotato Production and Management

Reaching Agents of Change Training of Trainers (ToT) manual

October 2018

Building Nutritious Food Baskets

Support Vitamin A Sweetpotato

CIP INTERNATIONAL POTATO CENTER
A CGIAR RESEARCH CENTER

UNIVERSITY of GREENWICH
NRI | Natural Resources Institute

Helen Keller INTERNATIONAL

Orange-Fleshed SWEETPOTATO
Rich in Energy & Natural Vitamin A

Everything You Ever Wanted to Know about Sweetpotato. Topic 6 - Sweetpotato Production and Management
Reaching Agents of Change ToT Training Manual

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Contents

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This manual was originally produced as part of the Reaching Agents of Change project in 2013 and updated by the Building Nutritious Food Baskets project in 2017/2018 – both projects funded by the Bill & Melinda Gates Foundation.

Acronyms and Abbreviations

AIs	Adequate Intakes
AVRDC	The World Vegetable Centre
BNFB	Building Nutritious Food Baskets
CBO	Community Based Organisation
CIP	International Potato
DAP	Days After Planting
DFE	Dietary Folate Equivalents
DONATA	Dissemination of New Agricultural Technologies in Africa
DVM	Decentralised Vine Multipliers
dwb	Dry Weight Basis
FAO	Food and Agriculture Organisation of the United Nations
FW	Fresh Weight
HH	Household
HKI	Helen Keller International
IBPGR	Bioversity International
IPM	Integrated Pest Management
IPPM	Integrated Pest & Production Management
K	Potassium
LGA	Local Government Areas
M&E	Monitoring and Evaluation
MAP	Months After Planting
m.a.s.l.	Metres Above Sea Level
Mm	Mass Multiplication
MSC	Most Significant Change
N	Nitrogen
NARO	National Agricultural Research Organisation
NGO	Non-Government Organisations
NHV	Negative Horizontal Ventilation
NRI	Natural Resources Institute
OFSP	Orange-fleshed Sweetpotato
P	Phosphorous
PMCA	Participatory Market Chain Approach
PMS	Primary Multiplication Site
PPP	Public Private Partnership
PVC	Polyvinyl Chloride
QDPM	Quality Declared Planting Material

QDS	Quality Declared Seed
RAC	Reaching Agents of Change
RAE	Retinol Activity Equivalents
RCT	Randomised Control Trial
RDA	Recommended Daily Allowances
RE	Retinol Equivalents
REU	Reaching End Users
RH	Relative Humidity
SASHA	Sweetpotato Action for Security and Health in Africa
SMS	Secondary Multiplication Site
SP	Sweetpotato
SPCSV	Sweetpotato Chlorotic Stunt Virus
SPFMV	Sweetpotato Feathery Mottle Virus
SPKP	Sweetpotato Knowledge Portal
SPVD	Sweetpotato Virus Disease
SSA	Sub-Saharan Africa
ToT	Training of Trainers
TMS	Tertiary Multiplication Site
Tshs.	Tanzanian Shillings
TSNI	Towards Sustainable Nutrition Improvement
UNICEF	United Nations Children's Fund
USD	United States Dollar
Ushs.	Ugandan Shillings
VAD	Vitamin A Deficiency
WAP	Weeks After Planting
WHO	World Health Organisation
WTP	Willingness to Pay

Foreword

During the past decade, interest in sweetpotato in Sub-Saharan Africa (SSA) has expanded, the number of projects utilizing sweetpotato has increased, and the demand for quality training resources, training development practitioners and farmers has subsequently risen. Sweetpotato scientists at the International Potato Center and national research centres often received these requests and frequently held 1-3 day training sessions, drawing on whatever training materials they had or could quickly pull together.

The Reaching Agents of Change (RAC) project in 2011 changed that situation. Jointly implemented by the International Potato Center (CIP) and Helen Keller International (HKI), RAC sought to empower advocates for orange-fleshed sweetpotato (OFSP) to successfully raise awareness about OFSP and mobilize resources for OFSP projects. RAC also sought to build the capacity of public sector extension and non-governmental organizational personnel to effectively implement those projects to promote the dissemination and appropriate use of vitamin A rich, orange-fleshed sweetpotato. The Building Nutritious Food Basket (BNFB) is a three-year project (November 2015 to October 2018) that followed on from the RAC project. The project is implemented in Nigeria and Tanzania and funded by the Bill & Melinda Gates Foundation. The goal of the project is to accelerate and support scaling up of biofortified crops for food and nutrition security and to help reduce hidden hunger by catalyzing sustainable investment for the utilization of biofortified crops (OFSP, PVA maize, high iron beans and vitamin A cassava) at scale. BNFB develops institutional, community and individual capacities to produce and consume biofortified crops. The objectives of the project are to strengthen the enabling environment for increased investments in biofortified crops and to develop institutional and individual capacities to produce and consume biofortified crops.

RAC/BNFB goal of developing and revising the Training of Trainers (ToT) manual on *Everything You Ever Wanted to Know about Sweetpotato* was 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 identified local institutions to work with in Mozambique, Tanzania, and Nigeria to host an annual course entitled: *Everything You Ever Wanted to Know about Sweetpotato.* The course has progressed from initially having CIP scientists working closely with national scientists to implement it, to national scientists and partners independently organising and conducting the course. In subsequent years, institutions in Burkina Faso, Ethiopia, Ghana, Malawi and others have been capacitated in conducting the course.

In developing the course content, a long-time collaborator of CIP, Tanya Stathers of the Natural Resources Institute (NRI), University of Greenwich, worked with CIP Scientists to review the existing training material, added in new knowledge from sweetpotato scientists and practitioners, and designed the course with a heavy emphasis on learning-by-doing. The CIP personnel who contributed to the development of the initial manual include, (Robert Mwanga, Ted Carey, Jan Low, Maria Andrade, Margaret McEwan, Jude Njoku, Sam Namanda, Sammy Agili, Jonathan Mkumbira, Joyce Malinga, Godfrey Mulongo), Adiel Mbabu and HKI nutritionists (Margaret Benjamin, Heather Katcher, Jessica Blankenship) and an HKI gender specialist (Sonii David) as well as NRI colleagues (Richard Gibson, Aurelie Bechoff, Keith Tomlins). Some of the materials were adapted from the DONATA project training materials, the Reaching End Users project and many others. After practitioners had used the course and the manual, a review was held in 2012 and the manual and course were subsequently updated, and a standard set of accompanying Power Point presentations created. In 2017-2018, the Building Nutritious Food Baskets project led a further review of the manual working closely with Tanya Stathers, the above mentioned CIP teams again plus Robert Ackatia-Armah, Kwame Ogera, Srini Rajendra, Julius Okello, Fred Grant, Joyce Maru, Hilda Munyua and Netsayi Mudege to update the content of topics 3, 4, 5, 12 and 13 which cover: sweetpotato varietal selection; nutrition; seed systems; monitoring, learning and evaluation; and using the 10 and 5 day ToT course.

This manual is designed to potentially serve a wide variety of audiences (nutritionists and agronomists, policymakers, extension workers, community development workers, leaders of farmer organizations, farmers etc.). Not all the materials will be relevant to all audiences, but facilitators can adapt the content to their audience and facilitation best practices. To ensure sustainability and wide reach; a cascading approach in the delivery of training is recommended; where key experts (agriculturalists, nutritionists, health workers, marketing and gender experts) will attend more detailed ToT workshops. The experts trained will then become primary facilitators and drive the agenda for OFSP. This group will in turn deliver shorter version courses and step-down the training to various levels of audiences (secondary and tertiary) – based on needs identified. This trend will continue until the training cascades down to "farmer trainers" who finally train the end users in their communities.

The original version of the manual has also been translated into Swahili, French, Portuguese, and Amharic are available online at https://www.sweetpotatoknowledge.org/learn-everything-you-ever-wanted-to-know-about-sweetpotato/ with the intension of translating the revised chapters as soon as resources permit. We envision the course to continue to be improved as new knowledge comes in. 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
October 2018, 2nd edition.

How to Use This Guide

This guide was designed to be used in two ways:

- As self-study material, or
- As a facilitator's guide for classroom training sessions

For each topic we have provided:

- A handbook (this volume)
- A PowerPoint presentation, and
- A handout for classroom training participants

If you plan to deliver this as classroom training, then we would encourage you to read the **Facilitator's Guide** (separate volume) prior to planning your lessons.

Introduction: Sweetpotato Production and Management

Topic Objectives

By working through this topic, participants will be able to:

- Describe the timing, social, soil, market, and climate conditions that sweetpotato advocates must be aware of.
- Explain the soil conservation and crop rotation practices that must be used to optimize sweetpotato production in the long term.
- Describe optimal techniques for sweetpotato planting in terms of drainage, timing, use of planting materials, and fertilizer.
- Create a staggered planting schedule tailored to an individual farm.
- Discuss the benefits and techniques of intercropping.
- List and describe the stages of the sweetpotato growth cycle.
- Distinguish symptoms of plant nutrient deficiencies from pest-borne and physiological disease symptoms.
- Begin a discussion of gender and diversity issues in sweetpotato farming.

Synopsis

Sweetpotato has the potential to produce remarkably high yields if given the right growing conditions. Sweetpotato can also yield more reliably under unfavourable conditions than many other crops, which is why it is so important for household food security in many places in Sub-Saharan Africa (SSA). Topic 6 deals with the environmental factors that influence sweetpotato production - soil and nutrients, water, light and temperature – with their management, and with production practices that can help to reliably produce good sweetpotato crops. Development workers should be aware that farmer knowledge of best management practices for sweetpotato may vary between farmers, genders and regions. In regions where sweetpotato is important, many farmers are likely to be highly skilled growers, managing the crop well within their farms and with available resources. In this manual we do not describe how sweetpotato must be grown, but rather try to help the reader (trainer) understand the principles and practices that can contribute to good sweetpotato production.

Unit 1 – Planning Sweetpotato Activities for the Farm Operation

Objectives

By the end of this unit, participants should be able to:

- Explain why timing of operations is critical to farm success.
- Name the regional social characteristics and climate conditions that promoters of Orange-Fleshed Sweetpotato (OFSP) must be aware of.

Key Points

- **Promoters of Orange-Fleshed Sweetpotato (OFSP) need detailed knowledge of the farming community's yearly schedule, the degree of commercialisation in the region, and the local gender dynamics.**
- **It is critical for sweetpotato farmers to have access to planting materials at the right time in order to take advantage of the onset of the rains.**
- **Different farming regions in SSA show different gender patterns, but sweetpotato farming is largely women-dominated.**

Planning Sweetpotato Activities for the Farm Operation

Completed sweetpotato activity calendar from Ukerewe, Tanzania

Timing of operations is critical to farm success. Having sufficient planting materials when needed, usually at the onset of the rains, is one of the biggest challenges to sweetpotato production in SSA. There are, of course, other challenges related to balancing the management of the sweetpotato crop with the other crops on the farm and activities in the household. This is particularly true for resource-poor households dependent on rainfed production, working with declining soil fertility, and facing increasing climatic uncertainty. It is important for the promoter of orange-fleshed sweetpotato (OFSP) to understand the agricultural calendar of the community they work with, and how orange-fleshed sweetpotato will fit into that calendar. Development workers need to know the degree of commercialisation of sweetpotato and understand gender roles and responsibilities along the sweetpotato value chain.

Male and female ownership/ management of sweetpotato fields in most parts of SSA can be grouped into three categories:

1. Sweetpotato is traditionally a female crop; few or no men grow it
2. Sweetpotato is traditionally a male crop; few or no women grow it
3. Sweetpotato is grown by both men and women on individually owned plots, family plots or leased plots

As discussed in Gender and Diversity Aspects, gender roles in sweetpotato production are dynamic, varying across regions of a country and changing over time. In many parts of SSA, sweetpotato is largely grown by women for subsistence purposes, with men becoming more involved in production as market demand increases. However, the reverse situation also occurs. In parts of northern Nigeria, where men are the major sweetpotato producers, women are increasingly growing the crop as it becomes more commercialized. Developing a cropping calendar with farmers, which explores who does each of the sweetpotato activities as well as the other activities which are competing for women's labour at those points in time can help explain the situation.

	Month												Who is involved?	Other activities/ crops competing for women's labour at this time
	J	F	M	A	M	Jn	Jy	Ag	S	O		D	Men, Women, Male children, female children, ~~Hired~~hired male labour, hired female labour	
RAINS														
Tasks														
Land preparation														
Land clearing														
Making mounds/ ridges														
Obtaining vines														
Transporting vines														
Planting														
Weeding														
Applying fertilizer														
Harvesting														
Transport to market														
Selling														
Processing roots														
Conserving vines														

While all the agricultural activities on the calendar will require some advanced planning, this is particularly true when sweetpotato planting materials need to be multiplied in order for there to be sufficient materials at the intended planting time.

Review Questions

1. What are the challenges with timing the operations?
2. Generally speaking, in many parts of SSA, what is the difference between why women and men grow sweetpotato?

Unit 2 – Selecting and Preparing Land

Objectives

By the end of this unit, participants should be able to:

- Describe the altitude and soil conditions that are best for growing sweetpotato.
- Tell why sweetpotatoes are typically grown on mounds, ridges, or beds. Explain how these beds can be constructed.
- Explain why crop rotation and plot separation are important.
- Explain why men in the community should be consulted, even when women are the main growers.

Key Points

- **Sea level up to 1,700 m above sea level are the best altitudes for sweetpotato plants.**
- **Sweetpotato can adapt to different soils, but deep, sandy, moderately fertile loam with a slightly acid pH is optimal.**
- **Sweetpotato plants like potassium, which can be obtained from ash.**
- **High nitrogen soils are not optimal.**
- **Fallow periods and crop rotation fight disease build-up. Using the same plot for sweetpotato only one year out of three is best.**

Selecting and Preparing Land

Altitude

Sweetpotato grows well from sea level up to 1,700 m above sea level (m.a.s.l.). Some varieties even grow up to 2,500 m.a.s.l. but have poorer taste and lower dry matter.

Soils

Sweetpotato can be grown on many types of soil but does best on deep, moderately fertile, sandy loam soils, which produce high quality storage roots with an attractive shape and appearance. Adequate drainage and soil aeration are important, which is one of the reasons the crop is usually grown on mounds, ridges or beds. Sweetpotato does best on slightly acid soils, with optimal pH 5.6-6.6, but can tolerate soils with higher and lower pH. Descriptions and quick field tests to determine your soil type are given in Appendix 6.1.

Sweetpotato, like other crops, obviously benefits from good soil fertility. As a root crop, sweetpotato has a high requirement for potassium. However, a high soil nitrogen content may lead to excess foliage growth and limited root production, particularly in humid environments. Farmers rarely add fertiliser to their sweetpotato crop, but the crop benefits from residual fertility when it follows or is intercropped with a fertilised crop such as maize. During land preparation, the mounds, beds or ridges may be constructed by heaping soil up and over the residues of previous crops or vegetation from fallow periods, to provide fertility for the sweetpotato crop and to loosen any compressed soil that might hinder root formation. Farmyard manure, compost, or green manures can be very beneficial, if available, but may be more likely to be applied in a kitchen/ backyard garden setting than in a large production field. Ash is rich in potassium and can be incorporated into soils to help boost sweetpotato root formation.

Crop Rotation and Plot Separation

As with any crop, it is advisable to rotate sweetpotato with other crops, or to have a fallow period between crops, in order to reduce the build-up of diseases, such as viruses, and pests such as

weevils and nematodes (though there are not many problems with the latter in SSA). Sweetpotato does well following cereals or legumes, but it is not recommended for it to follow other root and tuber crops, particularly cassava, due to their similar nutrient requirements. Sweetpotato has been reported to be a good first and last crop in the rotation following fallow. As the first crop, it leaves the soil easy to prepare for the next crop, although very fertile soils may produce lots of vines but few or no storage roots.

It is also advisable, though not always possible, to try to separate new sweetpotato fields from recently harvested or existing fields, particularly in environments where weevils and viruses are a problem. A barrier crop between old and new plantings, or a gap of >120 m can help prevent weevils from finding the new sweetpotato crop. If there is no choice but to re-use an old sweetpotato field, then complete incorporation or removal of the old storage roots and vines (which can be burnt or fed to livestock) may help reduce the spread of pests and diseases to the new crop. If possible sweetpotato should only be grown once every three years on the same soil, in order to limit pest and disease carry over problems. This is particularly important where a new variety is being introduced into an area.

Access to Land

In most parts of SSA, men are considered the owners of land and make all decisions regarding land allocation even when the crop such as sweetpotato is largely grown and controlled by women. It is critical for development workers to be sensitive to male control over land and ensure that men are consulted about project activities even where they are not directly involved.

Review Questions

1. What type of soil does sweetpotato grow best on?
2. Is potassium good for sweetpotato?
3. Does sweetpotato like high altitude locations?
4. Should sweetpotato be rotated with cassava?

Unit 3 – Planting Methods and When to Plant

Objectives

By the end of this unit, participants should be able to:

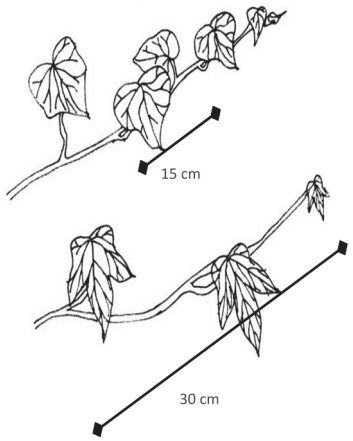
- Explain why soil aeration and drainage are important and how to achieve them.
- Describe the methods —of creating ridges, beds, and mounds for planting.
- Tell what part of the plant is used to create new planting materials.
- Explain how the cutting is prepared, planted, and spaced in the soil.

Key Points

- **Sweetpotato is usually planted in mounds or ridges for good drainage. Flat beds are possible where labour is scarce, but yields are lower.**
- **Land preparation is labour-intensive, and the form and size of the planting areas depends on whether tractors or oxen are available.**
- **Sweetpotato is often harvested piecemeal.**
- **Sprouts or vine cuttings are used to grow new sweetpotato plants. They are planted at a distance of 25-30 cm between plants and 60-100 cm between ridges.**
- **Tighter spacing creates smaller potatoes, which are preferred in some markets.**
- **Hoes or machetes are used to create depressions for planting.**

Planting Methods and When to Plant

Sweetpotato is planted on mounds, ridges or flat beds. Good soil aeration is needed for storage root initiation and growth, and hence, for higher yields, and so the height of the mound or ridge is important. Mounds and ridges ensure good drainage and make it easier to harvest the mature roots, especially when harvesting is done in a piecemeal fashion as is often the case with sweetpotato. Whether mounds or ridges or beds are used, their sizes vary among locations, usually based on what is most practical for farmers in that area. Where tractors or ox-ploughs are available, ridges are typically preferred, but ridges, mounds and beds may all be prepared manually. Land preparation for planting is the single most labour-intensive part of sweetpotato production. In households where there are labour shortages, sweetpotato may be planted in flat beds, although this typically results in lower yields than when ridges or mounds are used.



Internode lengths may differ between varieties, in some varieties 3 nodes = 15 cm, in others 3 nodes = 30 cm length

Sweetpotato vine cuttings or sprouts, at least 3 nodes (about 20-30 cm [see figure to the right]) long are usually planted at a spacing of 25-30 cm between plants and 60-100 cm between ridges, although farmers like to experiment with different spacings and will usually plant varieties with trailing vines wider apart than those with semi-erect or erect vines. Where sweetpotato is grown on mounds, farmers usually plant 3 vines per mound with some space between the vines. At a spacing of 1 m x 1 m between mounds, 30,000 cuttings are required per hectare if 3 cuttings per mound are used. While on ridges 33,333 cuttings are required to plant a hectare at a spacing of 30 cm between plants and 1 m between ridges. Adjustment of spacing can be used to control storage root size, with closer spacing producing a greater proportion of smaller sweetpotato roots, which are preferred by some markets.

To plant, a stick, machete or hoe is used to make a hole that most of the cutting (at least two nodes should be under the soil to enhance establishment and increase the number of roots that form) is placed into the soil, leaving only the tip exposed. The soil is firmed into place to ensure good contact between nodes and the soil. Sometimes lower leaves are removed before planting, but this is not necessary. Farmers sometimes hold cuttings for a day or two in a cool, shady place to encourage root initiation prior to planting. In many places farmers traditionally use two vine cuttings per planting hole, however this requires a lot of extra planting materials, and extensionists recommend using just one cutting per hole and then gap filling any plants that fail to establish. On mounds, the three cuttings are planted towards the top of the mound but equidistant from each other in a triangle configuration. On ridges, the cuttings are planted either vertically or at a slant along the top of the ridge at the required spacing.

Sweetpotato is often planted after the priority cereal crops and other important cash crops, and when sufficient planting materials have been generated by the rains. However, in areas with a short rainy season these delays in planting can end up exposing the sweetpotato crop to drought periods and weevil damage, significantly reducing potential yields.

Review Questions

1. Why is planting sweetpotato on mounds and ridges desirable?
2. How much spacing should there be between sweetpotato vine cuttings or sprouts when planted?
3. Is planting on flatbeds preferred?

Unit 4 – Staggered Planting to Get Yield Benefits and Smooth Supply

Objectives

By the end of this unit, participants should be able to:

- Name the generally optimal time to plant sweetpotato and tell why it is preferable.
- Define staggered planting and explain its benefits and drawbacks.
- Explain the benefits of a smooth supply of sweetpotato.

Key Points

- **Planting early in the rainy season maximizes the growing period but planting all at once creates a glut of sweetpotato.**
- **Staggered planting creates a smoother food supply for the household.**
- **Staggered planting reduces the effect of risks such as dry spells.**
- **Collecting cuttings from earlier plantings increases available planting material**
- **With staggered planting and piecemeal harvesting, farmers can wait till the market price goes up to collect crops for sale.**
- **Sweetpotatoes planted later in the season are more vulnerable, due to decreasing rains and risk of pests and theft.**

Staggered Planting to Get Yield Benefits and Smooth Supply

Planting sweetpotato as early as possible in the rainy season can be beneficial in terms of maximising the growing period and allowing early harvesting for household food consumption or early market sales. However, planting the whole sweetpotato crop at one time may lead to a glut at harvest; granted, there are differences between varieties in terms of their developmental times, and due to the piecemeal harvesting option for sweetpotato the root harvest can still be spread over some months.

Where the growing season permits, staggered planting, that is successive plantings made over a period of weeks or months can also have advantages. These include:

- Larger total area planted through ratoon harvesting of cuttings from multiplication plots;
- Spreading of risk of yield loss due to unreliable rainy season initiation and prolonged dry spells;
- Less likelihood of labour shortage bottlenecks as the labour requirements are spread across a longer period of time;
- A smoother supply of roots over a prolonged period as opposed to a glut of root production across all farms in that area at the same time. The smoother supply has positive market supply and household food security implications, particularly as orange-fleshed sweetpotato becomes important for meeting daily household vitamin A requirements.

However, by extending the planting period, those parts of the crop planted latest may well be exposed to very dry conditions after the end of the rains which may cause yield reductions, weevil infestation, more severe disease incidence and increased likelihood of theft.

Sweetpotato is already a fairly flexible crop, as storage roots can be harvested as soon as they are large enough to eat or market or can be left in the field to grow for an extended period if the market price is not favourable or the household already has enough food. Staggered planting will further increase this flexibility.

Review Questions

1. Why is planting sweetpotato as early as possible in the rainy season beneficial?
2. What are some of the advantages of staggered planting?

Unit 5 – Intercropping Sweetpotato

Objectives

By the end of this unit, participants should be able to:

- List the advantages of intercropping.
- Describe the conditions that favour intercropping and alley cropping.
- Point to studies showing the benefits of intercropping.
- List species that intercrop well with sweet potato.
- Describe the preferred intercropping techniques.

Key Points

- **Where there is pressure on land and labour, intercropping maximizes use of both.**
- **Intercropping increases dietary diversity, renews the soil, may fight weevils, and reduces weed growth.**
- **Intercropping is easiest when sweetpotatoes are planted on ridges, with other crops planted in a row alongside.**

Sweetpotato intercropped with soya beans and maize

Studies show the benefits of intercropping: One found yield and profit gains in intercropping sweetpotato with maize. Another found profit gains intercropping with sugar cane; another found that pigeon pea fixes nitrogen and does not compete with sweetpotato.

Intercropping Sweetpotato

In some areas sweetpotato is intercropped with other crops. This occurs particularly in areas where land pressure is high or labour for constructing ridges is limited.

Intercropping, in addition to improving crop and food diversity, can also: improve labour efficiency; increase soil fertility if nitrogen fixing intercrops are used; and reduce weed growth. Intercropping of sweetpotato is easier when it is grown on ridges. As with all intercropping, thecropping pattern should try and minimise the competition for light and nutrients between the two or more crops being intercropped. If intercropping sweetpotato with beans, soybeans or peas, sweetpotato can be planted along the ridge and a row of beans on either side of the ridge.

Sweetpotato intercropped with pigeon pea

Despite intercropping of sweetpotato being quite common in many situations, very few studies have actually analysed the impacts of intercropping sweetpotato from any perspective. A recent study in Malawi found that yield and profit gains could be obtained by strip intercropping orange-fleshed sweetpotato and maize. Farmer evaluators preferred a planting pattern of two rows of maize with one row of sweetpotato because of the importance of maize in their food culture, although the data suggested two rows of sweetpotato with one row of maize was a more economically profitable design. When intercropped with fertilised maize, sweetpotato can take advantage of the residual fertiliser and there is some evidence that sweetpotato when strip intercropped with maize has less weevil infestation.

Studies in East Africa showed that pigeon pea intercropped with sweetpotato increased productivity. Not only does pigeon pea fix nitrogen, it also initially grows slowly so does not compete strongly with sweetpotato. Pigeon pea has a very deep root system which continues to grow during the dry season after sweetpotato has been harvested, and when nothing else can be planted. In Costa Rica, intercropping two rows of sweetpotato between cassava rows planted simultaneously and continuously over four years was beneficial to both crops and showed no major increase in pests or diseases.

Sweetpotato in a mixed orchard

Intercropping of sweetpotato with sugar cane was found to be economically profitable in South Africa. Relay cropping of sweetpotato with maize, with sweetpotato planted as the maize is nearing harvest, has also been used successfully by some commercial producers in Ghana's Central Region.

Sweetpotato can also be alley cropped between lines of agroforestry trees or shrubs, preferably fast-growing leguminous species with open crowns that allow the sunshine through. These trees or shrubs are pruned regularly, and as the prunings decay they function as a green manure releasing nutrients and improving the physical properties of the soil. The local species of leguminous shrubs and trees will differ by site, however common species include: the river bean tree (Sesbania sesban); the ear leaf acacia (Acacia auriculiformis); the kassod tree (Cassia cajan); pigeon pea (Cajanus cajan); mother of cocoa or Nicaraguan cacao (Gliricidia sepium); and elephant ear tree (Enterolobium cyclocarpum). Farmers will want to experiment with different spacings, common spacings for the agroforestry species are 4-8 m between rows and 0.3 m within rows.

Review Questions

1. What are some of the advantages of intercropping?
2. What are some of the crops that could be intercropped with sweetpotato?

Unit 6 – Sweetpotato Requirements and Physiological Disorders

Objectives

By the end of this unit, participants should be able to:

- Describe the sweetpotato's required growth season and optimum conditions for growth and harvest.
- Discuss the structure and growth cycle of sweetpotato plants and roots.
- Analyse the effects of suboptimal weather conditions, pests, and physiological disorders.
- Identify which tasks farmers need to carry out at each stage of growth.
- Explain how to control weeds.
- List common physiological disorders and tell how to prevent them.

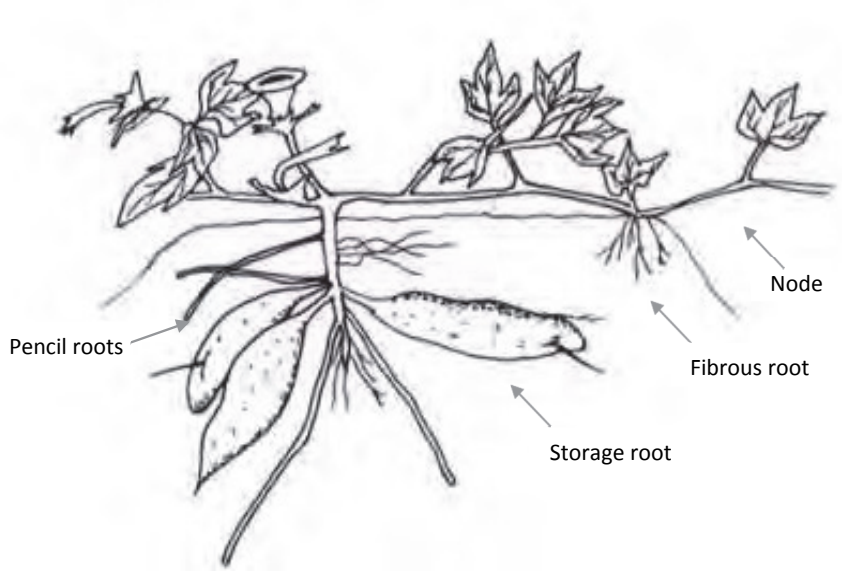
Key Points

- **Sweetpotato can grow at a fairly wide range of temperatures, although the temperature affects root yield.**
- **Low temperatures, lack of sunlight, and dry weather reduce yield and require an extended growing season.**
- **After planting, the root primordia in sweetpotato nodes produce adventitious roots that differentiate into storage roots under good conditions.**
- **The growth cycle includes three main phases, each of which requires farmers to perform specific tasks.**
- **In good growth conditions, normal levels of pests and disease will not greatly reduce the harvest.**
- **Irrigation is not always required, depending on the region, but drip irrigation is most efficient**

The Different Growth Stages of Sweetpotato

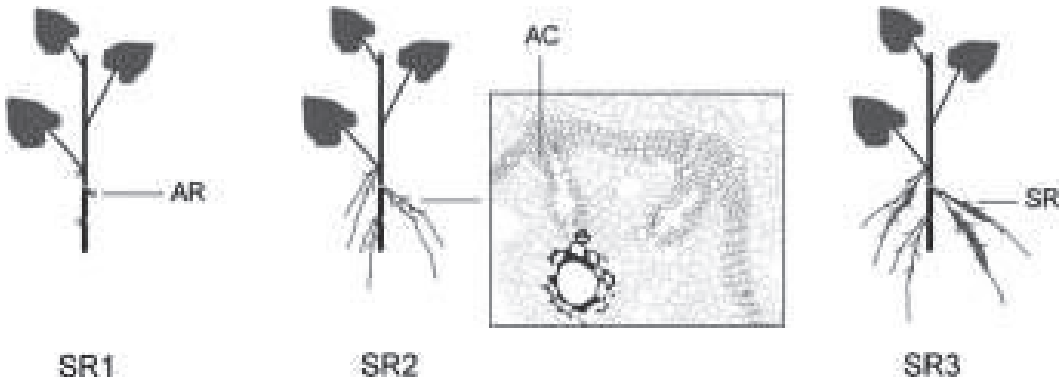
Sweetpotato generally requires a growth season of 4 to 5 months with optimum temperatures of 20°C - 25°C. It can, however, grow at a wide range of temperatures between 15°C and 35°C. Highest root yields are obtained during day time temperatures of 25 to 30^0C and night temperatures of 15 to 20^0C. Early maturing sweetpotato varieties can be harvested 3 to 4.5 months after planting, providing an important early source of food during the 'hunger season' in much of Sub-Saharan Africa [see photo to the right of a freshly harvested sweetpotato plant]. Temperature and the number of sunny days strongly affect sweetpotato yields. If temperatures are low the growing period has to be extended to 6-7 months, and if lots of overcast days occur the yield will be reduced, and root quality will be poorer. The length of growth period affects the size of roots: a short growth period will result in a high percentage of medium and small storage roots, while the average mass of the roots will be higher if they are harvested later.

The Sweetpotato Plant



After planting, adventitious roots emerge from pre-formed root primordia at the nodes and become fibrous roots, which under good water, air and mineral conditions have the potential to differentiate into storage roots, within the top 20-25 cm of the soil. Under unfavourable conditions roots may fail to differentiate into storage roots and become lignified pencil roots. Most of the storage roots develop from the initial adventitious root system of the plant, but in some varieties, or if hilling up is done, new adventitious roots (and storage roots) may develop, contributing to an extended piecemeal harvest. Storage root differentiation may begin as early as two to three weeks after planting, and on average between 4-6 weeks, depending on the variety and the environmental conditions. Therefore, favourable conditions during the first month after planting are of vital importance for storage root initiation and will strongly influence yield potential of a plant.

Early Stages of Root Formation in the Sweetpotato Plant



Key: AR = adventitious root, AC = anomalous cambium; SR = Storage root initiation phases 1 ,2, 3

Source: Villardon *et al*., 2009

This early phase of storage root formation can be divided into three critical stages: initial establishment (SR1) and presence of at least one adventitious root (AR), differentiation of storage roots with the development of anomalous cambium (AC) (SR2), and the initiation of storage root bulking (SR3).

Since temperatures influence rates of development, a measure of thermal time (growing degree days) is best used to describe how long it takes to get to each stage. In a field experiment with Beauregard, an early maturing US sweetpotato variety, SR1 was reached in 3 days, SR2 in 13 days and SR3 in 26 days. Stress, including excess heat, drought or flooding during these critical stages had the potential to severely reduce yield of this cultivar by resulting in lignified pencil roots, rather than storage roots.

By 8-12 weeks after planting all energy is devoted to the bulking of the storage roots. When many storage roots are formed on a plant, the weight per root is normally low, while few roots per plant normally results in big roots.

Depending on the variety, vine growth of a healthy sweetpotato crop, in which all requirements for maximum development are fulfilled, can be extremely abundant. Normal levels of pest and disease attack will neither result in much loss, nor will the crop suffer from nutrient deficiency symptoms. Although certain pests, such as leaf feeders, may eat parts of the leaves, a healthy plant is able to compensate for such damage. Vine length normally reaches a maximum half way through the final phase. At that stage the foliage of the crop looks most lush. After that, vine density decreases, because the plant uses more and more energy to fill the storage roots rather than to form and maintain the leaves. Sweetpotato has three main growth phases; the tasks which need to be done during each of these phases are described in the table below.

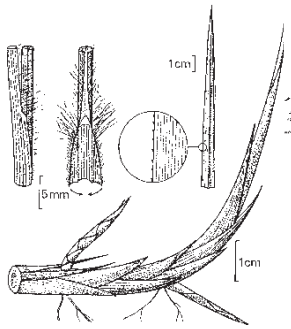
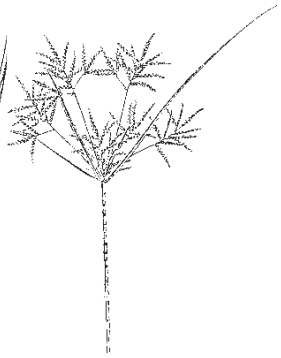
The Different Development Phases of the Sweetpotato Plant and Associated Tasks

Week	Development phase	Characteristics	Tasks
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 ↓ 52 	I. Establishment phase II. Intermediate phase (storage root initiation) III. Final phase (storage root bulking)	• Planting • Fast growth of young roots • Storage roots start to differentiate • Slow growth of vines • Initiation of storage roots • Fast growth of vines • Large increase in leaf area • Growth of vines ceases • Rapid bulking of storage roots • Reduction of leaf area due to yellowing and falling • Harvesting ↓	• Planting • Gap filling • Avoid stress • Weeding • Vine lifting • Hilling up • Harvesting

Weed Management

If weeds are not controlled during plant establishment and within the first two months after planting, they compete with the sweetpotato plants for nutrients and water and may harbour pests and diseases. The roots of certain spear grasses can even pierce and damage the sweetpotato roots. There are three main categories of weeds:

Examples of the Three Main Categories of Weeds

Grasses	Sedges	Broad leafed plants	
			
Imperata cylindrica	*Cyperus esculentus*	*Lantana camara*	*Solanum incanum*
Spear grass[Eng] Mtimbi[Ksw] Ebiat[At], Lalang, Lusanke[Lg] Tofa[Hau], Ata[Igb]	Nut grass[Eng] Ndaga[Ksw], Ayaya[Hau]	Sleeper weed, wild sage[Eng] Mtululu[Ksw] Akayuukiyuuki[Lg], Omuhuuki[An] Magwagwa[Lo], Mukenia[Ki],	Nightshade, Sodom's apple[Eng] Mtunguja mwitu[Ksw], Entengotengo[Lg], Mutongo[Ki], Ochok[Lo],

Key: Eng – English; Ksw=Kiswahili; Lg=Luganda; At=Ateso; An=Ankole; Ki=Kikuyu; Lo=Luo; Hau=Hausa; Igb=Igbo

Weeds can be useful. Some species can be harvested and fed to livestock, some can be slashed and used as a mulch on the soil surface, and some can be composted and then dug into the soil to supply soil nutrients and organic matter, thereby improving the soil structure.

Weeds are typically removed manually. Once the vines have grown together and covered the ridges, there is little need for further weeding. However, in very wet regions, further selective weeding may be required to remove stubborn or vigorous growing weeds. If these are few and scattered hand pulling can be practised otherwise a hoe is used gently ensuring that any storage roots remain covered by soil. Weeding is easiest when there is no crop to avoid. Removal of stubborn perennial weeds (such as, spear grass (*Imperata* spp.), star grass (*Cynodon* spp.), nut grass (*Cyperus* spp.) and couch grass (*Digitaria* spp.), and burial of annual weeds needs to be done during land preparation. During the making of ridges and mounds any new weeds should be buried under the soil, and then another weeding should be done during the first four to six weeks after planting before the vines cover the soil. Remember it is much easier to remove weeds before they have developed strong roots and stems, and much better to remove them before they disperse a new generation of seeds.

Mulching can reduce weed emergence significantly. Crop rotation also helps prevent the build-up of weed populations. Intercropping two plant types together can reduce weed problems due to the increased shade and crop competition with weeds through tighter crop spacing.

Commercial farmers might wish to use a herbicide such as Glyphosphate to control perennial weeds, this is best done at least two weeks before planting the crop. In Nigeria, Primextra Gold (active ingredients: atrazine and S-metolachlor) applied at 1.5 kg ai/ha 1 to 2 days after planting sweetpotato was found to be an effective herbicide for use in sweetpotato fields. Where the

stubborn spear grass weed (*Imperata cylindrica)* is predominant, a mixture of Glyphosate+Prometryn/S-metolachlor at the rate of 3.5+2.0 kg ai/ha was found to control it when applied at 4, 8, and 12 weeks after planting.

Basic safety precautions should be followed when using herbicides; follow the instructions on the label, use the specified application rate, use protective clothing, pregnant or lactating women should not spray herbicides or pesticides, do not spray in windy conditions or the herbicide will drift sideways away from the intended field and possibly onto other crops, rinse the spray equipment after use and pour away the rinsing water into a soak-away pit not into or near to a river. Small-scale farmers may find herbicides costly and have difficulties regarding their accurate and timely application.

Vine Lifting and Hilling-up

If the soil is moist and the stem of a vine touches it, roots will grow from the nodes. Some producers lift these vines to prevent these roots forming into small non-marketable storage roots. If this is done, care should be taken to just lift the vines and not to turn them over or the leaves may rot.

Hilling-up is done to ensure the developing storage roots are well covered and not exposed to sun or attack by weevils. Soil is hoed up around the base of the plant, closing cracks in the soil caused by expansion of storage roots, or erosion of the ridge or mound away from the crown of the plant.

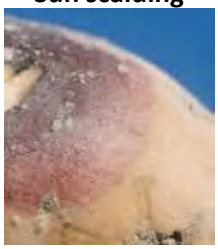
Physiological Disorders

Many factors affect the yield of a sweetpotato crop: quality of planting materials; soil type, land preparation and fertility management; variety; climate; spacing; planting and harvesting dates; virus and pest infestation levels; and irrigation or distribution of rains.

Physiological disorders of sweetpotato can be caused by a range of environmental, physiological and genetic factors, and are often misidentified as pathological diseases. Some common physiological disorders and their symptoms, causes and prevention strategies are highlighted in the table below.

Examples of Physiological Disorders of Sweetpotato and their Prevention Strategies

Physiological disorder	Symptoms	Causes	Prevention strategies
Mutations 	Roots have areas of different coloured flesh or skin	Sweetpotato has an unusually high natural rate of mutation	Use positive selection to avoid plants giving such roots, when selecting planting materials
Water blisters (edema) 	Small lumps (enlarged lenticels) on the outside of the roots.	Prolonged exposure of roots to very wet soils leading to lack of oxygen	Plant sweetpotato in well-drained soil. Ensure ridges or mounds are high in wetlands

Sun scalding 	Scalded areas are purplish-brown and prone to secondary infections	Exposure of roots to direct sun at high temperatures	Place sweetpotato roots in shade immediately after harvest
Growth cracks 	Cracks in root skin. More common on large roots. Nematode infested roots are more susceptible.	Cracks develop due to uneven growing conditions, especially uneven watering.	Cultivars differ in their susceptibility to this problem. Irrigation during dry spells.
Flattened stem (fasciation) 	Flattened stem with numerous leaves	Uncertain	Fasciated vines are usually rogued and should not be used as planting material.

Irrigation of Sweetpotato Crops

Irrigation is rarely used on sweetpotato crops in Sub-Saharan Africa with the exception of South Africa. Although sweetpotato is considered to be fairly drought tolerant, water is one of the most limiting factors for sweetpotato production and drought causes serious yield losses. The effect of drought conditions depends on when during the growth stage the water shortage occurs. The deep (0.75-0.9 m) and branching root system of sweetpotato enables the plant to absorb water in deeper soil layers than occurs in most vegetable crops. A well-distributed rainfall of 500 mm during the growth cycle is sufficient for high productivity. If necessary and available, irrigation can be used to ensure that the sweetpotato crop can be established in moist soil and has sufficient water throughout the growing season. Irrigation can also be used to reduce soil temperatures.

Most irrigation methods (e.g. furrow, drip, flood, and sprinkler) are suitable for sweetpotato. Furrow irrigation where alternative furrows are irrigated can be used when the crop is planted on ridges. Drip irrigation is currently practised under some research environments; it is the most water efficient method. In South Africa, drip irrigation has been found to be only suitable for well-drained soils with 10-15% clay content and high ambient temperatures. There is relatively limited information about the water requirements of sweetpotato, though it is recognized that adequate moisture is important during the first month of the crop, and it is generally agreed that the crop requires between 450 and 650 mm of water (which can be rain) well-distributed throughout the growing season. Once roots are established, they can survive reduced soil moisture regenerating once rains occur. Irrigation requirements are dependent on the soil type, the rainfall, the water quality and availability, the variety and the growth stage. In general irrigation twice a week is recommended up to 20 days after planting (DAP), once a week from 20 to 40 DAP, and once every two weeks from 40 DAP until harvesting. During irrigation the soil should only become wet to the

depth of the crop root zone, and not further. Overwatering or prolonged periods of heavy rain can also be problematic as sweetpotato does not tolerate extended periods of very wet soils; reduced storage root development, water blisters and root rot may occur.

In coastal Peru, sweetpotato is frequently irrigated. The irrigation commences before planting in order to loosen the soil for easy land preparation, a light irrigation is then given to help plant establishment, frequent irrigation is carried out in the first 5-6 weeks after planting, and after hilling-up (Pest and Disease Management) and prior to harvesting. A total of 2,000-3,000 m^3 of water per hectare per season is recommended, although this will vary by soil type and variety.

Review Questions

1. What are the three stages of OFSP growth?
2. Why is early stage important?
3. What is the optimal temperature for OFSP growth?
4. What are some of the ways of managing weeds?
5. What are some of the physiological disorders of OFSP?

Unit 7 – Nutrient Needs of Sweetpotato

Objectives

By the end of this unit, participants should be able to:

- Identify the nutrient needs of sweetpotato.
- Explain how farmers can best "feed" their plants.
- List the symptoms of plant nutrient deficiencies.
- Compare disease symptoms and nutrient deficiency symptoms.

Key Points

- **Sweetpotato needs a 1:3 ratio of potassium and nitrogen.**
- **Too much nitrogen causes poor root development, and too little creates low yield.**
- **Manure is more readily available than synthetic fertilizer, but manure must be applied a few weeks before planting to avoid weeds.**
- **All fields and fertilizers require experimentation or soil analysis to find ideal application rates.**
- **Sweetpotato likes alkaline soil; lime should be used on high Ph soils.**
- **Unusual colours, falling leaves, and stunting can indicate nutrient deficiency.**

Nutrient Needs of Sweetpotato

All crops absorb nutrients from the soil, and when the crop is harvested these nutrients are removed from the soil. In order to maintain the nutrient levels of the soil, nutrients must be returned to the soil. This can be partially done through ploughing crop residues back into the soil and letting the plant materials decompose and return their nutrients to the soil, or by adding fertilisers (which can be in the form of organic manures and composts or chemical fertilizers). In Asia, sweetpotato vines are typically used as green manure. Plants need nutrients not only for their growth, but also to enhance their resistance against diseases.
Sweetpotato, as with most root crops, absorbs more potassium (K) but less nitrogen (N) and phosphorous (P) than maize does.

Potassium is the most important element for storage root development, and so in many places sweetpotato will benefit from extra potassium. This can be provided using ash, as ash is rich in potassium. However, it is not only the amount of potassium that is important, but also the ratio between the potassium and nitrogen to be supplied. The best bulking of storage roots occurs when the nitrogen and potassium are present in the soil at a ratio of about 1:3. Applying potassium during the second half of the crop's growth cycle helps promote development of a strong skin.

Nitrogen (N) if present in too high concentrations can result in abundant vine growth but poor root development. This is particularly damaging if nitrogen is applied after the middle of the crop's growth period. Although sweetpotato does well even on very poor soils, if nitrogen levels are too low the plants have limited vine growth and low yields.

Nutrients can be added to the soil in several ways.

Farm yard manure can be used and is often more readily available than synthetic fertilizer. Rates of roughly 5 tons/hectare are recommended but rates this high are rarely applied. As the nutrient content of all manures differ it is difficult to recommend application rates, and it is more sensible for farmers to experiment with a range of different application rates to see which produces the best crop on their field. Manure needs to be added a few weeks in advance of the crop being planted to ensure that it has time to partially decompose before the crop is planted. Uncomposted manure introduces weeds to a field and should be avoided.

Fertiliser mixtures such as NPK are commercially available in different blends. Very general sweetpotato fertiliser recommendations suggest: N (34-45 kg/ha), P_20_2 (50-101 kg/ha), K_20 (84-169 kg/ha) or complete NPK 6:9:15 (560-1,120 kg/ha). In Nigeria, they use NPK 15:15:15 (400 kg/ha). However, as all soils differ it is best to experiment with different rates in your field or get a soil analysis done to obtain the fertilizer rate to apply.

Fertilisers (whether organic manures or industrial chemicals) can be applied by spreading the required quantity over the land, and then incorporating it into the soil prior to planting. The most efficient way of applying fertilizer, however, is to side dress in a furrow, applying and incorporating the required amount for each plant.

Research has found that if farmers have sufficient land to rotate their crops and keep some land fallow, the planting of *Mucuna* spp. (a nitrogen-fixing legume, commonly known as Velvet beans or Cowhage) in the field for two years before sweetpotato is grown can increase the storage root yield significantly. In trials this practice increased the root yield more than the addition of an NPK fertiliser, this was likely due to the *Mucuna* improving the soil structure as well as supplying macro and micro nutrients not contained in the NPK fertiliser.

The pH of the soil is also important as it affects the availability of the nutrients in the soil to the plant. Sweetpotato grows best in a slightly acidic to slightly alkaline soil with a pH between 5 and 7.5. If the soil's pH is more acidic (e.g. <5) then agricultural lime should be incorporated into the soil before planting, a soil analysis test will determine the pH and amount of lime required.

While soil analyses can be used to determine whether the soil the sweetpotato crop is to be grown in is deficient in any nutrients, in Sub-Saharan Africa it is not common for farmers to access soil testing services. Nutrient deficiency symptoms in the sweetpotato plant can be useful to the farmer and extension agent in helping to identify nutrient deficiencies. If a plant experiences a nutrient deficiency, it will show certain symptoms, mainly in its leaves but its whole growth pattern could be affected.

Typical symptoms of plant nutrient deficiencies include:

- Unusual colours of different plant parts:
  - Chlorosis: leaves turn to a light green, yellow colour
  - Necrotic spots: dry light brown spots on the leaves where tissue has died
  - Purple colouration of leaves
  - Browning
- Leaves drop unexpectedly
- Plants are shorter than normal (stunting)
- Deformation of plant parts: e.g. thin or spindly stems, and curling leaves
- Die-back of stem and root tips
- Similar symptoms on young and old leaves can indicate deficiencies of different elements.
- However, be careful not to confuse deficiency with virus symptoms or plant characteristics.

Specific symptoms of potassium, nitrogen and phosphorous nutrient deficiencies are shown in the following pictures. Information and photos of other nutrient disorders can be found on Sweetpotato DiagNotes http://keys.lucidcentral.org/keys/sweetpotato. Potassium deficiency is a common cause of low root yield. Root crops have a high requirement for potassium and several successive root crops may deplete the soil of potassium. Nitrogen deficiency is common on soils with low organic matter, or soils which have been cropped for some time without adequate fertilisation or manuring. Applying urea to a test area (e.g. one row within the crop) should make the test area visibly greener if there is a nitrogen deficiency. Volcanic and calcareous soils can bind phosphorous and make it unavailable to plant, and on acid soils aluminium toxicity can induce phosphorous deficiency.

Symptoms of Potassium (K) Deficiency on Sweetpotato

- Short vines with short internodes and small leaves are the first symptoms
- Leaves are of a darker colour (dark green), especially at the edges
- Short and pale petioles
- Small, shiny brown spots emerge on the leaves, first on the bottom of the leaves and on old leaves
- Old leaves become yellowish or reddish, starting at the top of the leaves and developing via the edges to the leaf base
- Plants wilt faster and leaves easily fall off
- When experiencing heavy deficiency, the whole leaf becomes yellow except the leaf base and the leaf tissue just next to the veins that become dark green
- Low number of storage roots
- Storage roots are long and thin
- Yellowing appears on the oldest leaves
- Storage roots are more easily infected by root rots and nematodes

Plants which received 100%, 14%, and 1.7% of optimum potassium supply

Small necrotic lesions following inter-veinal chlorosis on a mature leaf

Spread of chlorosis and necrosis on older leaves

Symptoms of Nitrogen (N) Deficiency on Sweetpotato

- Leaves become light green to yellowish and dull in appearance; reduced growth of the vine.
- Old leaves become reddish at the edges, yellowish in the middle, then reddish to brown all over.
- Stems of old plants become reddish.
- Short petioles
- Symptoms develop from the base of the plant to the top.

A nitrogen deficient plot (front) compared with a plot fertilized with nitrogen (back)

Healthy (L) and nitrogen deficient(R) plants

Nitrogen deficient crop exhibiting limp yellow older leaves and reddening of veins on lower surface of younger leaves

Red pigmentation of veins on lower surface of younger leaves

In addition to nutrient deficiencies, sweetpotato can also show symptoms of water deficiency, nutrient toxicity and diseases.

Water Deficiency

Sweetpotato is relatively tolerant to drought compared to other crops. However, water shortage, especially at the stage of storage root initiation and for prolonged periods of time, can strongly reduce the capacity of the plants to produce a good yield. The number of storage roots will decrease, and roots will be mostly small. Direct symptoms of water deficiency include wilting of the leaves and reduced growth. Drought stress can also make the plants more susceptible to viruses, insect pest attack, and to cracking of the storage roots.

Nutrient Toxicity

Most nutrients can cause toxicity in plants when applied in excessive amounts. Too much nitrogen fertiliser causes the vines to grow lushly, but initiation and development of storage roots is hampered. At excessive nitrogen applications, sweetpotato plants will not flower, although it should be remembered that not all sweetpotato varieties produce flowers. Potassium toxicity is seldom a problem. Sweetpotato is fairly tolerant of acid soils.

Symptoms of virus infection: Plants showing symptoms like stunted growth, curly leaves, and/or changed leaf or vein colour are likely to be infected by a virus disease [see the two lower plants in the picture to the right]. Viruses are usually transmitted by leaf-sucking insects, such as aphids and whiteflies (see Pest and Disease Management for full details). It can sometimes be difficult to differentiate between disease symptoms and nutrient deficiency or toxicity symptoms.

Common differences between nutrient deficiencies and disorders caused by disease, particularly viruses, are that diseases often occur in a patchy pattern across a field, with healthy and diseased plants mixed together, a disease may affect only one variety and a disease may strike suddenly. By contrast, nutrient deficiencies often affect large areas or whole fields from the start of growth.

Review Questions

1. What is the most important nutrient for storage root development?
2. What are some typical symptoms of plant nutrient deficiencies?
3. How are viruses usually transmitted to sweetpotato plants?

Unit 8 – Gender and Diversity Aspects of Sweetpotato Production and Management

Objectives

By the end of this unit, participants should be able to:

- Explain basic gender and diversity issues in sweetpotato production and management

Key Points

- **Different people bring different perspectives to sweetpotato farming.**
- **Facilitators and promoters of orange-fleshed sweetpotato (OFSP) must understand the roles of each person involved with sweetpotato production, from those who own the land to farm laborers.**
- **Facilitators and promoters must be culturally sensitive to male control of the land.**

Gender and Diversity Aspects of Sweetpotato Production and Management

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in Gender and Diversity Aspects Topic 11. Key gender and diversity issues relevant to sweetpotato production and management include:

Different people will have different understanding of management practices for sweetpotato, this may be due to experiences they have had while growing sweetpotato, the different roles they have in the production of sweetpotato, the resources they have access to, their information networks and access to training, and the importance of sweetpotato in their livelihoods.

It is important for development workers to understand who is typically involved in which aspects of sweetpotato production and management, when these activities are done, how they are done, what constraints are typically faced by those doing them, and what activities there are that compete for that labour or the land itself. The gender cropping calendar in Appendix 11.2 can be a useful tool in building this understanding.

In addition to understanding who is typically doing what (and it should be recognised that this may differ by household or based on whether the crop is intended for sale or home consumption), it is also important to understand who owns, controls access to and makes decisions regarding the resources required for sweetpotato production. This would include which area of land the sweetpotato is grown on, the order of priority in planting and caring for different crops, whether the sweetpotato can be intercropped, the labour available for activities such as land preparation, ridge or mound formation, planting, harvesting, transporting and processing, access to irrigation to preserve planting materials, access to manure or fertilisers, and who keeps or can decide on the use of any income generated from sweetpotato sales.

These factors are all relevant in deciding what type of information to share, who to share it with, which people to target and when. The perceived importance of the crop in local livelihoods (which may differ by household type and between men and women), will influence the investment levels farmers are prepared to make in terms or time and resources.

In most parts of SSA, men are considered the owners of land and make all decisions regarding land allocation even when the crop such as sweetpotato is largely grown and controlled by women. It is critical for development workers to be sensitive to male control over land and ensure that men are consulted about project activities even where they are not directly involved.

Activities

These learning-by-doing activities will provide hands-on discovery opportunities for participants.

Activity 6.1 Comparing Sweetpotato Varieties and Management Practices

Objectives

Participants will be able to help farmers set up a field experiment to compare different sweetpotato varieties or different sweetpotato management practices

Time

3 hours

Materials

- Flip charts
- Pens
- Rope
- Measuring tape
- Spades
- Labels
- Sticks
- Nearby field in which they can set up the experiment
- Topics 3, 6, and 7 of this manual
- Pages 20-22 in the handout booklet 'what is damaging my sweetpotato?'

Advanced Arrangements Required

Identify a nearby empty field with an area of about 30m * 30m, which participants can use for practising the designing and setting up of a field experiment.

Suggested Steps

1. Ask the participants to get into groups of 5 people. Explain that they are going to plan and design an experiment which they think would be useful to do with the farmers they provide services to. Remind them not to make the experiment too complex, one experiment should only test one topic at a time otherwise the results become too difficult tounderstand.
2. Ask them to discuss and agree on **the objective** of their experiment, and **what treatments** they will compare (too many or too few will not result in useful information, 3-5 treatments per experiment works well), make sure they remember they need to include a control treatment as well which could be the farmers' normal practice or the recommended practice. Remind them to think about:
    a) What they are trying to find out
    b) What treatments they are going to compare
    c) Which farmers they should involve in planning, managing and evaluating the experiment (recognizing that in this particular exercise farmers have not had a chance to participate as fully as would be the case in reality)
    d) How often they would need to visit their experiment and what they would observe or measure at each of those visits
    e) How they could be sure that the results of their experiment were reliable? (e.g., mention the concept of replication, and that they should replicate their treatments at least 3 times to increase their confidence that any differences in results between treatments are due to the treatments and not to the soil type in the corner of the

field where that treatment happened to be placed) *[Note: In a community it is also possible to replicate trials over farms. This is the way we do on-farm variety trials.]*

f) How large would each of their plot sizes be
g) How they would invite other farmers and extensionists to share the learning from the experiment, and how could they best present their experiment to these visitors (e.g. farmer to farmer explanations, clear labels, participatory evaluation by the visitors?)

Give each group a few empty flip chart pages to design their experiment, reminding them that they will need to present it to the rest of the participants

1. Ask each group to present their experiment's objectives, treatments, and design. Then ask the whole group to read through pages 20-22 on Experimenting in their handout booklet, 'What is damaging my sweetpotato?' Let the group discuss whether they need to make any further changes to their experiment
2. Move to the nearby field and ask each group to take one area of their field and set up as much as possible of their experiment, including the labels. Demonstrate to the participants how to lay out a right angle, to produce rectangular or square plots. [Note they will not have sweetpotato planting materials so will need to imagine these, they can lay out the different plots and make clear labels (including pictures) to show what is in each plot]. Explain that they have 1 hour to do this and then the whole group will tour each experiment. The facilitator will move around between groups ensuring they have thought carefully about the layout of the field e.g. any slopes, the size of their different plots, randomizing the treatments, and clear labelling. The facilitator can demonstrate simple field randomization.
3. As a whole group tour the field imagining that you are visitors to the experiments about 3 months after planting. Discuss:
    a) any aspects of the layout which do not work well and how you could improve them?
    b) when and how you would evaluate the trials with farmers?
    c) why it would help farmers to create, visit and evaluate an actual field experiment as opposed to just hearing a presentation about it?
    d) why labelling the different treatments is important?
    e) why it is important that women as well as men farmers are involved, and that farmers from different wealth groups are involved?
4. Ask the participants to copy the objectives and design of their own experiment, and any of the other experiments they thought might be useful into their notebooks and to highlight the key points they need to remember when setting up experiments with farmers.

Activity 6.2 Advanced Planning

Objectives

Participants will understand the different stages of the sweetpotato crop cycle and the management implications of each stage

Time

75 mins

Materials

- Flip chart sheets
- Marker pens
- Pencils
- Masking tape

Suggested Steps

1. Ask the participants to get themselves into groups of 10 people (preferably all working in the same geographical area so that the timing of their rainy seasons are similar). Ask them to identify two of them to act as facilitators to obtain as full a sweetpotato activity calendar as possible. Remind them:
    a) to mark the rainy seasons and months of the year on the calendar,
    b) to start by thinking carefully about all the activities they do related to sweetpotato production and postharvest aspects,
    c) to include a way of showing who in the household typically does the job, and if it is a combination of the wife and the husband what percentage of the task is done by each (the sweetpotato cropping calendar in Appendix 11.2 may be helpful),
    d) that they can use pictures and symbols as well as words in their calendar,
    e) that they will need to present their calendars to the rest of the participants, and
    f) to leave about 5 empty activity rows at the bottom of the calendar
2. Now ask the participants if they were to carefully conserve their healthy planting materials during the dry season, when they would need to select their planting materials and how they might conserve them during the dry season. Ask them to think about the process of multiplication of their planting materials in advance of the rains in order that they have sufficient planting materials for planting their whole field (they should specify the size of their field) at the start of the rains. They need to discuss and think about, and then add onto their calendar (in the empty rows at the bottom):
    a) when they would select their healthy clean planting materials from their previous crop
    b) how they would conserve those planting materials during the dry season, including their watering
    c) preparation of their multiplication nursery bed,
    d) taking of and planting of clean healthy cuttings from their conserved planting materials,
    e) maintenance of their multiplication plot,
    f) harvesting of their cuttings (note this may include ratoon harvesting, aka several subsequent harvests).
3. Now have all the participants move around each group's calendar one by one, as the owning group makes a brief presentation regards it. Encourage questions and discussions about:
    a) problems the participants foresee with the need for advanced planning and conservation of planting materials

b) gender aspects of the labour and market returns currently involved in sweetpotato production, and what these gender roles mean regards who they need to train on sweetpotato production
c) other activities for which it is crucial to plan in advance
d) other aspects of farm and household operations and labour availability, as a reality check

Answers to Review Questions

Unit 1

1. What are the challenges with timing the operations?
   - *Farmers ~~to have~~ access to planting materials, other players to understand and factor in agricultural calendar and gender roles.*
2. Generally speaking, in many parts of SSA, what is the difference between why women and men grow sweetpotato?
   - *It is largely grown by women for subsistence purposes, with men becoming more involved in production as market demand increases. There are exceptions where these roles a~~rend~~ reversed, e.g. Nigeria.*

Unit 2

1. What type of soil does sweetpotato grow best on?
   - *Deep, Moderately fertile, Sandy loam, Slightly acid soils (pH 5.6-6.6)*
2. Is potassium good for sweetpotato?
   - *Yes*
3. Does sweetpotato like high altitude locations?
   - *No*
4. Should sweetpotato be rotated with cassava?
   - *No, same nutrient requirements.*

Unit 3

1. Why is planting sweetpotato on mounds and ridges desirable?
   - *To ensure good drainage and make it easier to harvest the mature roots.*
2. How much spacing should there be between sweetpotato vine cuttings or sprouts when planted?
   - *About 25 to 30cm between plants, and 60 to 100cm between ridges.*
3. Is planting on flatbeds preferred?
   - *No, flatbeds have lower yields.*

Unit 4

1. Why is planting sweetpotato as early as possible in the rainy season beneficial?
   - *For maximising the growing period and allowing early harvesting (for household food consumption or early market sales).*
2. What are some advantages of staggered planting?
   - *Larger total area planted; Spreading of risk of yield loss; Less likelihood of labour shortage; A smoother supply of roots over a prolonged period.*

Unit 5

1. What are some of the advantages of intercropping?
   - *Maximises use of land and labour; Increases dietary diversity; Renews the soil; May fight weevils; Reduces weed growth; Increase soil fertility.*
2. What are some of the crops that could be intercropped with sweetpotato?
   - *Maize, pigeon pea, cassava*

Unit 6

1. What are the three stages of OFSP growth?
   - *1) Initial establishment; 2) Differentiation of storage roots; 3) Storage root bulking*

2. Why is early stage important?
    - *Affects yield size*
3. What is the optimal temperature for OFSP growth?
    - *20-25 degrees Celsius*
4. What are some of the ways of managing weed?
    - *Manual removal; Mulching; Crop rotation; Intercropping; Herbicides*
5. What are some of the physiological disorders of OFSP?
    - *Mutation, water blisters, sun scalding, growth cracks, flattened stem*

Unit 7

1. What is the most important nutrient for storage root development?
    - *Potassium.*
2. What are some typical symptoms of plant nutrient deficiencies?
    - *Unusual colouring of different plant parts; leaves drop unexpectedly; plants are shorter than normal; deformation of plant parts: (e.g. thin or spindly stems); and die-back of stem and root tips.*
3. How are viruses usually transmitted to sweetpotato plants?
    - *By insects such as aphids and whiteflies*

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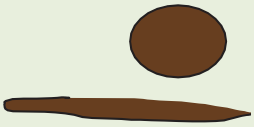
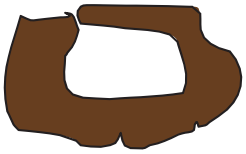
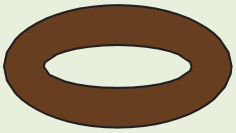
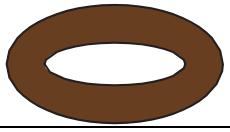
Appendix 6

Appendix 6.1 Determining Your Soil Type

Table 6A.1 Common soil types and features, and field tests to determine the soil type.

Soil type	Characteristics	Field test	Method for improvement
Sand	Will not aggregate, or will slightly aggregate. Will form a relatively stable ball if rolled carefully. Cannot be rolled into a sausage. Less than 10% clay.		Add organic matter (crop residues / compost / manure) and fertiliser regularly. Use green manure.
Sandy-loam	Forms a stable ball without difficulty. Will form a thick sausage if rolled carefully. The sausage will break if slight pressure is applied. Contains 15% to 20% clay.		Add organic matter and fertiliser. Use green manure.
Sandy-clay-loam	Can be rolled into a stable sausage. When bent into a U-form, it cracks in the centre. About 20% to 35% clay.		Organic matter is less important. Soil analysis will show which fertiliser programme is needed.
Clay-loam	Forms a stable sausage. Can form a stable U-form with careful handling. Contains 27% to 40% clay.		Organic matter is less important. Soil analysis will show which fertiliser programme is needed.
Sandy-clay	General characteristics of clay. Sausage tends to crack when formed into a circle. A definite grittiness when firmly pressed or rubbed between thumb and forefinger. Contains 35% to 55% clay.		Add organic matter.
Clay	Sausage forms a stable circle without cracking. Absence of grittiness. Plastic consistency. Good water-holding capacity. Some of the clay soils are very hard when dry and are difficult to roll (e.g. black turf). Contains more than 55% clay.		Add organic matter, such as compost and gypsum.
Silt	Poor structure, good fertility. Smooth and silky and slightly sticky. Generally behaves like clay. More than 80% clay.		Add loose organic matter. Use green manure.

Source: Faber et al., 2010

The International Potato Center (known by its Spanish acronym CIP) is a research-for-development organization with a focus on potato, sweetpotato, and Andean roots and tubers. CIP is dedicated to delivering sustainable science-based solutions to the pressing world issues of hunger, poverty, gender equity, climate change and the preservation of our Earth's fragile biodiversity and natural resources.
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