

EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO



TOPIC 5

Sweetpotato Seed Systems

Reaching Agents of Change Training of Trainers (ToT) manual

October 2018



Everything You Ever Wanted to Know about Sweetpotato. Topic 5 - Sweetpotato Seed Systems

Reaching Agents of Change ToT Training Manual

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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.

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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

Als	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, Srinji 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 Seed Systems

Objectives

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

- Discuss what is meant by seed in the context of vegetatively propagated crops.
- Explain the differences between farmer-based, commercially-oriented, and formal seed systems.
- Discuss how agro-climatic conditions influence the seed system.
- Explain the importance of starting with clean (pathogen tested, weevil-free) planting materials from a known source and describe the role tissue culture can play in this.
- Describe two methods farmers can use to preserve sweetpotato planting materials during the dry season.
- Identify whether a centralised or decentralised planting material multiplication and dissemination strategy would work best in your project.
- Describe at least 10 criteria which are important when selecting decentralised vine multipliers (DVMs).
- Explain how vouchers can be used as part of a planting material dissemination strategy.
- Calculate how many cuttings of each variety need to be planted how many months in advance to obtain the targeted amount of planting material at the start of the rains.
- Discuss key considerations for scaling seed systems.
- Describe some of the gender and diversity dimensions of the existing seed system and be aware of how seed system interventions may impact differently on men and women.



If you have participated in the ToT course, you will also be able to:

- Identify, select, conserve and multiply clean sweetpotato vine planting materials, and understand how multiplication rates of varieties differ.
- Set-up a triple s (storage in sand and sprouting) root-based seed system.
- Design a dissemination program for two different scenarios to reach 5,000 households with clean planting material of known origin.
- Understand the benefits of and training requirements for a successful DVM strategy.

Synopsis

Topic 5 focuses on sweetpotato seed systems, exploring different types of seed systems in terms of the seed production systems and different actors involved. It explains the laboratory process used to produce clean versions of virus-infected planting materials, and how these delicate plantlets are then reintroduced to the field conditions. It describes how planting materials can be multiplied and disseminated to provide thousands of households with cuttings of virus-free and/or new varieties. Step-by-step instructions for designing and costing a planting material multiplication and distribution system are presented.

Unit 1 – What Do We Mean by The Term “Seed”?

Objectives

By working through this section, you will be able to:

- Discuss what is meant by seed in the context of vegetatively propagated crops.
- Explain the methods African farmers use to obtain their sweetpotato planting materials from the vines of a growing crop or from vines from the sprouts of storage roots.
- List the different classes of sweetpotato seed in your country.

Key Points

- Sweetpotato seed or planting materials are cuttings from vines; they can be planted and are genetically identical to the mother plant.
- Plant breeders can also produce ‘true seed’ by fertilising a sweetpotato flower with pollen from another sweetpotato plant. When planted, this ‘true seed’ will produce a genetically unique sweetpotato plant.
- Vines can be harvested more than once from a plant; this repeat harvesting is called ratooning.

What Do We Mean by the Term “Seed”?



There is often confusion about how different people use the term ‘seed’. Throughout this manual, when we refer to sweetpotato seed, we are referring to cuttings from vines (also referred to as planting material¹), which are used vegetatively (or clonally) to produce (or propagate) another sweetpotato plant. Any cuttings taken from the same mother plant, will be genetically identical. Cuttings are the term used for the pieces of vine that are planted; one vine may be cut into more than one cutting. The size of cuttings used varies. Shorter cuttings (3-4 nodes (10-15 cm) are used for further multiplication using rapid multiplication techniques. Longer cuttings (25 – 30 cm) are used as planting material for root production. Vines can be harvested from the same plant several times over a period of months, after the first vine harvest, the subsequent harvests are called ratoons.

Many countries are now starting to use the same terminology for sweetpotato seed as is used for the seed of grain crops, e.g. pre-basic, basic, certified seed classes and quality declared seed (QDS).

Seed from Vine Cuttings and from Sprouted Roots

Currently there are two main methods used for obtaining planting materials. One is to obtain vines from growing plants, for example, from an existing field crop or a crop grown specially



Sweetpotato vines

¹ The term “slips” is used in the USA and refers to sprouts growing from the eyes in the sweetpotato root.

to produce planting materials/ vines. The other is to obtain them from the sprouts that grow from storage roots; these vines that grown from the sprouts are then used as planting material.



Sweetpotato planting materials can be obtained from vines of growing plants



Sweetpotato planting materials can also be obtained from the sprouts that develop on storage roots

Vine cuttings obtained from existing field crops are typically the cheapest source of seed supply. In Africa, farmers may be able to maintain a small area of sweetpotato crop over the long dry season to supply cuttings at the start of the rains. Alternatively, roots left over in the field after the previous harvest sprout and can provide a late crop of cuttings some weeks after the rains begin. More than 95% of planting material is obtained from farmer's own or their neighbours' fields, or local markets (i.e. from the farmer-based system). However, increasingly farmers are purchasing planting material, especially in drought prone areas, when there is a market for roots, when farmers want new varieties, or when they have seen the benefits of using fresh, clean planting materials to obtain higher root yields.

True Seed

Plant breeders also produce botanical or 'true seed', by fertilising the flower of a sweetpotato plant, usually with pollen from another plant. A sweetpotato plant grown from true seed will be genetically different from any other sweetpotato plant. The true sweetpotato seed is hard, dark brown to black, sometimes speckled or tan, and has prolonged dormancy. They are typically 3-5mm in diameter and are flat on two sides and round on the other. 100 seeds together weigh about 2g.



*Clipped flower to prevent
pollination (in circle)*



Hand pollination



*Botanical or 'true seeds' of the
sweetpotato plant*

Review Questions

1. What is a 'seed'?
2. What is a 'true seed'?

Unit 2 – Seed Systems: Description and Diagnosis

Objectives

By working through this section, you will be able to:

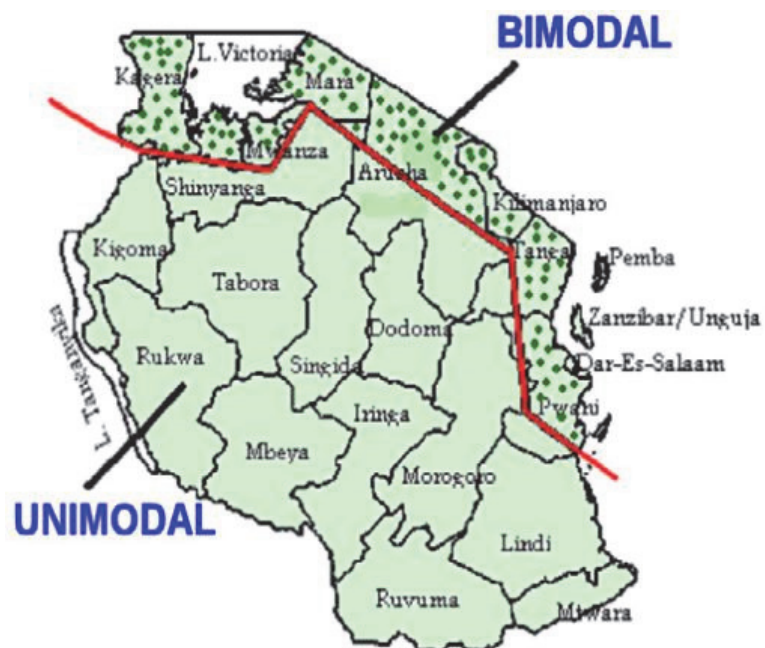
- Explain the differences between farmer-based and formal seed systems.
- Discuss how agro-climatic conditions influence the seed system.
- Describe and provide examples of why it is important to analyse the existing seed system from different user perspectives, before intervening in it.

Key Points

- Sustainable seed systems are able to provide sufficient and well-timed planting materials for all growers in the region.
- Seed systems exist from the scale of individual farmers managing their own yearly planting to national companies or systems.
- Bimodal climate areas enjoy two rainy seasons per year, unimodal, as along the Tropics of Cancer and Capricorn, only one. Planting materials in unimodal systems can be lost during the long dry period.
- Women who lose seed find more difficulty replacing seed or planting material than men.
- A “Multi-stakeholder framework for intervening in RTB seed systems” tool is available to help with seed management monitoring.

Seed Systems: Description and Diagnosis

A sustainable seed system ensures that high quality seeds of a range of varieties are produced, available at the right times and places, and affordable to farmers and other stakeholders. A seed system encompasses the integrated series of activities, the different actors and their interactions, and the enabling environment all of which need to function together to enable farmers to access good quality seed. There needs to be capacity within the seed system to: breed new varieties with attractive characteristics for different end users; securely maintain pure disease-free seed; multiply seed using good agronomic practices and disease and pest management; and distribute seed.



Bimodal and unimodal rainfall areas of Tanzania

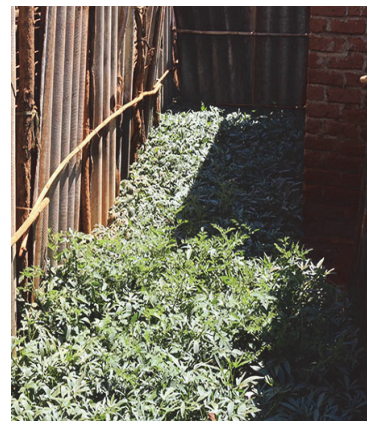
Seed systems can range from those managed by farmers for their own use, those where some of the seed is bartered or traded with nearby farmers, to those where the seed is produced by national organisations or private companies following strict regulations and at large scale. These different

seed systems can co-exist. Whatever the type of seed system, it should ensure that farmers are able to access affordable, quality seed of preferred varieties, for timely planting to obtain improved yields. In many societies' women are the custodians of seed management practices and knowledge. The gender context and dynamics of existing seed practices need to be understood to determine who we work with and how. The organisation of a seed system will depend on its role in relation to national development objectives and agro-ecological context.

Sweetpotato root production in Africa, like that of most other field crops, is typically rainfed. In bimodal areas where there are two rain seasons per year farmers can usually access sweetpotato planting materials from the previous field crop. However, in unimodal areas where there is just one rainy season per year and a prolonged and hot dry season, planting materials can easily be lost if care is not taken to preserve them during the dry season. Rainfall is mainly bimodal along the equator and increasingly tends towards unimodal as one moves north or south of the equator. Along the tropics of Cancer and Capricorn, rainfall is unimodal. Climate change projections suggest these unimodal regions of Africa are likely to experience even longer dry seasons and more erratic rains in the future. Highest root yields are obtained when day time temperatures are 25°C to 30°C and night temperatures are 15°C to 20°C. Temperature can also be important in the production of planting materials, with optimum growth between 20°C and 25°C. It is not productive below 10°C. Warm temperatures combined with good soil moisture encourage vine growth.

In areas with prolonged dry seasons, farmers are unable to access sweetpotato planting material from their previous field crop, and so methods of preserving planting materials during the prolonged dry season and accessing them in time for the new season have developed. Methods include the preservation of planting materials in swamps, shady areas of the household yard such as underneath banana plants, around the washroom drainage area. In some area's farmers purchase planting material from those male and female farmers who have good access to water during the dry season to conserve vines and so have planting material available to sell at the start of the rains. Many farmers just wait for the new rains to cause the few sweetpotato storage roots which were left behind in the field at the last harvest (either purposefully or accidentally) to sprout and to then produce vines for planting.

Where farmers are not able to access planting materials from their previous field crop, it is women who often face gender-related constraints in accessing seed from elsewhere. In comparison to men, women farmers tend to have more limited time, less access to labour and cash which influences their vine sourcing strategies. Women are also often less mobile than men and tend to have to rely on their husbands or other male family members to fetch vines from more distant locations, which may have negative implications for the quality of the vines they plant. Scarcity of vines from nearby locations, lack of cash and time often means that women farmers may reduce their planned field size and to plant planting materials which they consider sub-standard. Therefore, timely access to planting material by male and female farmers and distribution of improved varieties are major constraints to sweetpotato productivity in Sub-Saharan Africa.



Dry season preservation of planting materials

There is the need to understand and build on or improve current practices in farmer-based seed systems and strengthen linkages to sources of new varieties, disease-free planting material, knowledge and skills on agronomic practices. The multi-stakeholder framework for intervening in roots, tubers and banana seed systems is a tool which can be used to describe and analyse the existing seed system from the perspective of different stakeholders. It allows a systematic assessment of the seed system functions to ensure availability, access and quality of seed to identify priority constraints, and potential interventions.

The use of the framework ensures that interventions are based on a holistic understanding of existing seed systems. Interventions may then be prioritised to address key constraints related to the availability, access or quality of seed. These may include a combination of strengthening farmer seed management practices, introducing varieties with specific traits, and ensuring a flow of clean, disease free seed.

Improve Farmer-Based Sweetpotato Seed Systems By

1. Identifying, sensitising and training existing multipliers;
2. In areas where there are no existing multipliers: identifying and training entrepreneurial individuals or farmer groups, who have access to land, water and other resources to multiply and locally disseminate planting materials to their surrounding community; these are often called decentralized multipliers (DVMs)
3. In some contexts, centralised, mass multiplication sites for mass dissemination may be appropriate.

A range of different multiplication and dissemination strategies with various degrees of commercialisation and decentralisation are discussed in detail in Unit 7. The choice of which strategy to use will be dependent on the specific aims of your intervention and the associated agro-ecological, varietal, socio-economic, and institutional factors. For example, interventions could range from those trying to: promote a new highly nutritious variety to vulnerable households; clean-up the planting material of popular local varieties to improve food security; provide sufficient planting materials to a community returning to their land after civil war.

Seed systems multi-stakeholder framework tool

A “Multi-stakeholder framework for intervening in RTB seed systems” tool to support the systematic analysis of seed availability, access, and quality from the perspectives of different seed system stakeholders from farmers to policy makers, was developed by the CGIAR Research Program on Roots, Tubers and Bananas (RTB).

The framework can be used to plan a future intervention or to analyse the recent history of one. When used pre-intervention, the framework may guide a study of the existing seed system and identify bottlenecks and key actions for the upcoming intervention. When used to monitor an on-going intervention, the framework can help to plan the evolution of activities, scope, theory of change (including assumptions about farmers and seed), objectives, and impacts. The framework helps stakeholders to think about RTB seed systems in a holistic way and to account for differences—even contradictions—in the perspectives of some of the people and organizations who are stakeholders in these crops.

A user’s guide is available at: <https://cgspace.cgiar.org/handle/10568/81049> . The user’s guide explains how to apply the multi-stakeholder framework. This is a table with rows for the different stakeholders (e.g., policymakers, researchers, and seed producers) and columns of characteristics: availability of seed, access, and quality. Access includes delivery channels, affordability, and awareness. Seed quality includes crop variety and other issues (i.e. health, genetic purity, physiological age, and physical quality). A gender lens is also integrated.

In bi-modal rainfall areas, where the crop can be grown throughout the year and planting material obtained readily from the mature crops, seed systems could be improved through strengthening farmer seed management practices: ensuring that cuttings are obtained from disease-free plants and any clearly virus infected plants are rogued out (pulled out) of the supply materials; cuttings are only taken from the apical (tip end) of the vines to avoid the chances of them containing weevil eggs; or working with breeders and multipliers so that varieties are available that meet farmers' and consumers' needs;

In uni-modal rainfall areas, most of which have a prolonged dry season, in addition to the above improvements the seed systems should address the main constraint of the scarcity of planting materials when the rainy season starts. Planting sweetpotato at the beginning of the rainy season as opposed to a couple of months later can double the root yield obtained. However, it must be remembered that most male and female farmers are not only planting sweetpotato on their farms and (depending on their internal household decision-making) may prioritise the planting of their cereal crops and lack sufficient labour to be simultaneously planting sweetpotato.

Whilst interventions to improve seed systems have frequently been achieved at pilot level, the challenge is much greater when it comes to working at the scale of impact required to bring the benefits of clean planting material and/ or improved varieties to a wider geographical and higher population coverage. Approaches to scaling of sweetpotato seed systems activities are discussed later in the topic.

Review Questions

1. What are some of the characteristics of Effective Seed Systems?
2. What is the purpose of "Multi-stakeholder framework for intervening in RTB seed systems" tool?

Unit 3 – Where to Source Healthy Planting Materials

Objectives

By working through this section, you will be able to:

- Explain the importance of starting with clean (pathogen-tested, weevil-free) planting materials from a known source.
- Describe how laboratory and tissue culture techniques can produce cleaned-up virus-free plantlets, and how these plantlets are hardened off before they are planted out.
- Discuss the advantages and disadvantages of different sources of planting material.

Key Points

- **Virus infection can decrease the yield of popular sweetpotato varieties.**
- **Tissue culture techniques can be used to remove viruses and produce ‘cleaned-up’ planting materials.**
- **Tissue culturing is a specialised technique requiring highly trained staff and well-equipped facilities. The plantlets are thus expensive and fragile.**

Where to Source Healthy Planting Materials

Unlike the true seeds of cereals or pulses, sweetpotato planting materials are green, fresh plants, of high moisture content, bulky to transport, and with a relatively short shelf-life. Additionally, sweetpotato planting materials are often exchanged directly from farmer-to-farmer, may be infected with viruses or infested with pests and seldom subject to any formal quality standard checks. However, as both sweetpotato roots and planting materials become increasingly commercialised, sweetpotato planting material will become subject to higher quality standards.

As discussed in *Topics 2 and 7*, sweetpotato plants in Sub-Saharan Africa may be infected by virus diseases which can seriously reduce their root yields. When planting a field of sweetpotato the root producer should start with clean healthy planting material, this will give the sweetpotato crop the best chance of remaining healthy and producing a high yielding crop of sweetpotato roots and leaves. Therefore, sweetpotato seed producers (e.g. DVMs) need to ensure that they are producing seed of the highest quality for farmers to benefit. This means sourcing starter seed from known sources of pathogen-tested material.

Tissue Culture Based Methods

One of the main challenges sweetpotato farmers face, is that of accessing sufficient disease-free (particularly virus-free) planting materials at the start of the rainy season. If high yielding, nutritious varieties of sweetpotato become infected by viruses their yields can rapidly decline, and farmers may stop using the variety. Tissue culture techniques (e.g. meristem culture) combined with thermotherapy (using high temperatures) are used to remove sweetpotato viruses (this is often called “clean up”). The plant is then tested using two different methods to determine if any viruses can be detected. This is called virus indexing. The two methods are: grafting a part of the plant onto an indicator plant such as *Ipomoea setosa* to observe any virus symptoms; and then testing a sample from the grafted plant using NCM ELISA, which uses anti-bodies to determine the presence and type of viruses.



Once the plant has tested negative for known and detectable viruses, tissue culture methods can be used for micro-propagation. Under sterile conditions, each plantlet is divided into small pieces of 1-2 nodes (called sub-culturing) to produce new plantlets which are grown in test tubes with nutrient media. Each plantlet can produce 3-4 other plantlets every six weeks.

After four weeks of growth, each plantlet is hardened. This involves gradually acclimatising the plantlet as it is taken from laboratory test tube conditions (*in vitro*) to screen-house conditions with ambient temperatures and soil media. The process of hardening a plantlet into a sweetpotato plant in a pot, polytube or bed, takes around four to six weeks. Details of the hardening-off process for tissue-cultured sweetpotato plantlets are given in Appendix 5.1. When the plant is well established, and growing, (~four to six weeks after hardening) cuttings can be harvested as pre-basic seed.



Sweetpotato plantlets starting hardening-off at receiving point



Planting sweetpotato plantlets into polytubes



Planting materials produced from tissue cultured plantlets

Tissue culture is beginning to be widely used for large-scale plant multiplication. In addition to its important ability to rapidly produce large quantities of clean planting materials, the yields and maturity periods among tissue cultured plants are typically very uniform. However, tissue cultured plantlets can be expensive and risky for farmers to directly access as they require the careful hardening-off process to enable them to adjust to and survive ambient field conditions. It can therefore be advisable that NARIs and private sector tissue culture laboratories manage the hardening-off process and subsequently produce pre-basic cuttings under screen-house conditions.

Sources of Healthy Seed for Sweetpotato Seed Producers

Sweetpotato seed producers should obtain their starter material from a known source, e.g. a National Agricultural Research Institute (NARI) or a private sector seed enterprise producing pathogen tested pre-basic or basic seed. Pre-basic seed (cuttings) are produced from pathogen tested tissue culture plantlets and multiplied under screen house (protected) conditions. Depending on the variety, virus pressure and management conditions, seed producers should replenish their starter material every two to three years. Advice should be sought from your nearest agricultural research station.

Seed producers should practice negative selection routinely in their vine multiplication plots by roguing out (removing) plants that are not true-to-type, and plants showing virus symptoms to leave only healthy, vigorous plants. Roguing of virus-infected plants helps prevent the virus disease from spreading to the other plants. (Note: details of how to recognize virus and pest infected plants are given in *Topic 7*).

Sources of Healthy Seed for Root Producers

Root producers should identify their nearest source of quality planting material and new varieties. This may be a trained multiplier or farmer group (e.g. DVMs) who have obtained their starter material from a NARI or private seed enterprise. This will ensure that the root producer has access to

improved varieties, healthy seed and other agronomic information. The number of seasons that a root producer can re-cycle their material will vary depending on the variety, the disease pressure and management practices. Root producers should avoid re-cycling their vines if they see a reduction in root yield, or the plants look tired (unhealthy).

Review Questions

1. Why does exchanging planting materials from farmer to farmer helps spread viruses?
2. What is tissue-based culture method?
3. What are the recommended sources of healthy seeds?

Unit 4 – How to Identify and Multiply Your Clean Planting Materials

Objectives

By working through this section, you will be able to:

- Describe the characteristics of healthy planting materials.
- Explain why and how to use the rapid multiplication technique.
- Describe how planting materials should be handled after harvest.
- Explain where, when, how and why rapid multiplication technique (RMT) should be used

Key Points

- **Planting materials which contain pests and diseases such as, virus or weevils will produce low-yielding plants and act as a source of contamination to other healthy plants.**
- **Only use vine cuttings that are from vigorous virus-free plants.**
- **Use the top/apical portion of the vine for planting materials, each cutting should be at least 3-4 nodes long (~20-30 cm).**
- **In areas with a long dry season, healthy roots can be stored in sand, and then planted out and watered prior to the rains – this system is known as Triple S.**
- **If the market for healthy planting material is minimal, farmers can use a dual-purpose system to ensure they have planting materials.**
- **RMT can be used to speed up and increase the quantity of planting materials produced**
- **It can be done during the dry season, if there is a reliable source of water, adequate fertilizer, and good pest and disease management.**
- **It uses shorter cuttings (3 nodes (~10-20 cm long)) and closer spacing than normal vine multiplication practices.**
- **Farmer multipliers have found that cuttings of at least 3-4 nodes (~20cm length) with the leaves left on, survive better than short ones and sprout faster.**
- **A dual-purpose planting material multiplication system can be used to produce both planting material and storage roots, this can be helpful for food production reasons and if the market for quality planting material is unpredictable.**
- **A dual-purpose system should: use wider spacing than 15 cm between plants, rogue regularly; and only harvest $\frac{1}{3}$ of the vines from each plant.**



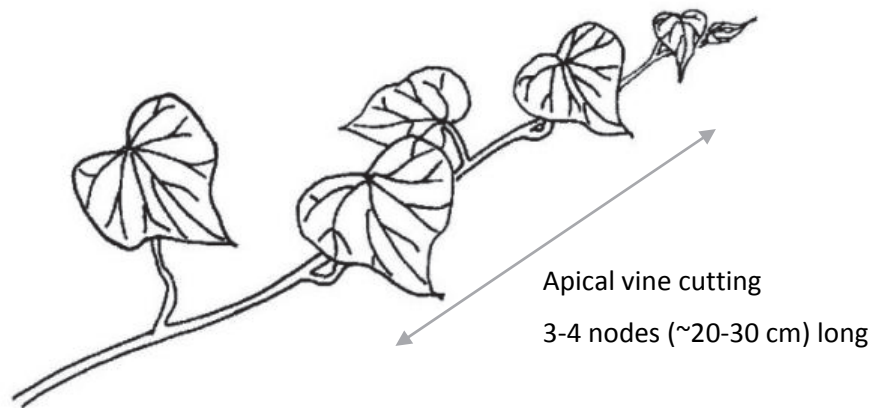
Seed producers can use rapid multiplication techniques (RMT) to produce cuttings for their whole field and to supply cuttings of new sweetpotato varieties to several hundred other farming households.

Vine cuttings from vigorous looking plants which are free of virus disease symptoms, should be selected. This limits the chances of virus infection being transmitted to the next generation through planting materials.

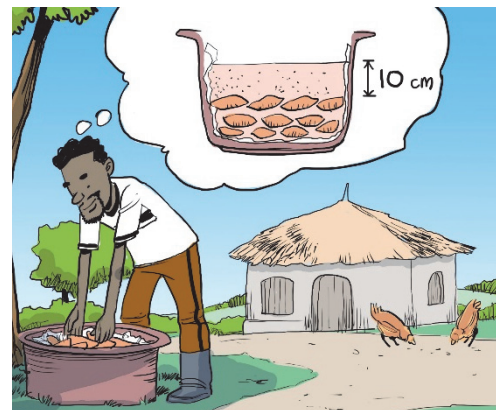


Use the top/apical 3-4 node long (~20-30 cm, depending on the variety) portion of vines of healthy-looking plants as planting material

When selecting the planting materials, use the top/ apical 3-4 node long (~20-30 cm) portion of the vine. This part most easily recovers from cutting and planting shock and establishes faster than the lower parts of the vine. In addition, the tip of the vine is more likely to be free of sweetpotato weevil pupae, larvae or eggs, or stemborer eggs. If the vine is long enough to take several cuttings, this may be done but it is important to ensure that the vine portion remaining on the plant is at least 15 cm above soil level, to avoid the part of the vine which may contain eggs.



While in many bi-modal areas the selection of planting materials from the growing crop is the most common method used; in areas with a long dry season, there may be no standing crop, or it may be too old and dried out to use. Instead, another method known as Triple S (Storage in Sand and Sprouting) can be used (see unit 6 for full details).



Rapid Multiplication of Planting Materials

Once a seed producer has a source of pathogen tested cuttings, a rapid multiplication technique (RMT) can be used. When a DVM uses RMT, s/he must plan well, so that the harvest of the planting materials is timed to coincide with the peak period of demand from root producers. If a DVM plans to sell planting materials at the start of the rainy season, the number of rapid multiplication beds will depend on the quantities of planting materials required from the DVM's customers.

Root producers undertaking their own vine conservation and multiplication, can also use RMT to rapidly increase their amount of planting materials to ensure sufficient availability and timely planting in the field.



Preparing and Managing A Rapid Multiplication Nursery

Site Selection and Preparation

Choose a site for the rapid multiplication plot that is close to a water source to make the irrigation easier. Sandy loam soils are generally good for vine multiplication. The site should not have been used for sweetpotato root production for at least two seasons. This is to avoid fields infested with sweetpotato weevil and millipedes. The site should not be close to other sweetpotato root production fields. Avoid sites which are windy as there is more risk of insects which are disease vectors being blown from longer distances. Avoid sites with steep slopes, where there may be run-off from neighbouring fields, and erosion. The size of the plot depends on the estimated total number of beds required. Avoid sites which may be at risk of flooding as sweetpotato does not

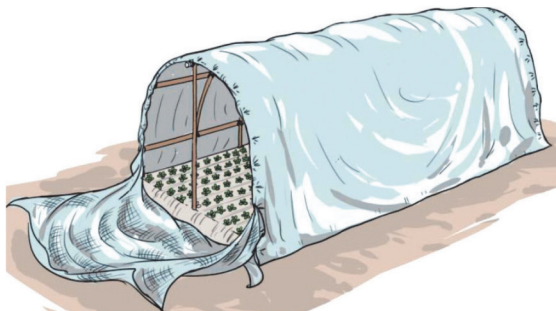
tolerate sustained period of waterlogging. Sustained humidity increases the risk of *Alternaria* leaf spot disease.

If the farmer multiplier is registered as a seed producer and will be selling planting material, the site should meet the national sweetpotato seed standards for rotation practice, and isolation distance. The use of barrier crops should be considered to reduce risk of transmission of diseases by pests, (e.g. maize and onion can be planted since these crops can help reduce the weevil problem). The site should be accessible for seed inspectors and customers.

Equipment

In addition to the usual agricultural tools such as hoes, rakes, measuring tape; irrigation equipment is needed. The most basic types are watering cans or buckets. However, if the vine multiplier has a medium-scale enterprise, water lifting equipment (diesel/petrol/solar pump, treadle pump, depending on local availability and cost effectiveness) plus water storage capacity (raised tanks) should be considered together with drip lines, or use of furrows.

Net tunnels may also be used in high virus pressure areas, they prevent the insect vectors (such as whiteflies and aphids) from reaching the sweetpotato plants helping to keep planting materials clean of virus. Detailed information on the use and construction of net tunnels is presented in Appendix 5.2.



Net tunnels can be used for protecting planting materials from virus infection

Bed Size and Preparation

A standard rapid multiplication bed is 1 m wide by 5 m long, with 50 cm space between beds. Long, narrow beds of 1 m width allow for easy management. Only one variety should be planted in each bed. Depending on soil type and topography, the bed should be raised about 20 cm above ground level (e.g. black cotton, clay) or beds should be sunken (sandy soils) for higher soil moisture retention. Beds should be sited at right angles to the field slope to reduce effect of run-off and soil erosion.

Fertility Management

Prepare a rapid multiplication bed using loose soil mixed with fertiliser, compost or manure (see Fertiliser recommendations in Box 5.1 below for details). If you are using mature farmyard manure, make sure that you prepare the nursery bed at least a week in advance of planting so that there is time for the organic matter to decompose before you plant the cuttings.

Box 5.1 Fertiliser Recommendations for Rapid Vine Production

Vine production requires nitrogen, so any nitrogen-containing fertiliser if applied correctly will increase vine production. Choose an area with good soil fertility. Employ manure or top soil to enrich the organic matter of the soil for this nursery.

All soils differ, and therefore the standard recommendations below will not be applicable to all fields. Consult local expertise on this, and you can also experiment with different rates and types of fertiliser to see what suits your specific plot and situation best. It is always worth experimenting with different application rates.

Make sure the soil is wet before applying any fertiliser.

Pre-planting fertiliser application

NPK

Some of the pre-planting rates of NPK and/or manure which have been used successfully for rapid multiplication are shown in Figure 5.1 below. Efficiency wise it is best to apply the NPK in a furrow about 10 cm away from the cuttings as described above. However, even when it is mixed into the plot's soil pre-planting it will still increase vine production.

Well Decomposed Manure or Compost

Pre-planting incorporation of an organic manure or compost can also be effective in increasing vine production. If NPK 25:5:5 is available, then a small amount (0.5 kg NPK per bed (1 m x 5 m) can be mixed in with the manure at pre-planting. This helps to balance the nutrient composition).

Top dressing after first harvest is very important since we need to boost the crop to produce good quality of vines in a short period of time. We use N-fertilizer for it.

Urea

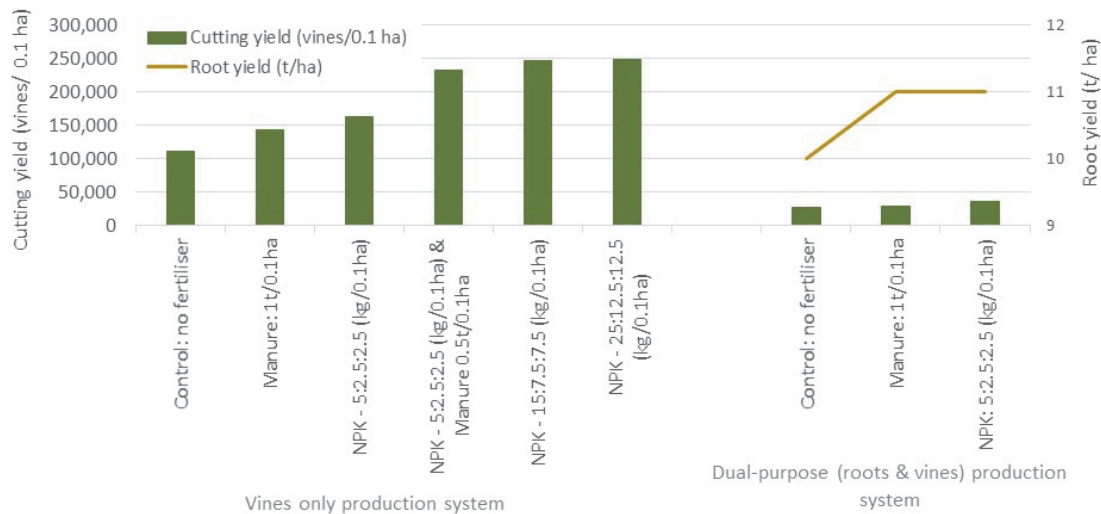
Always make sure that the soil is already wet. Apply urea at a rate of 13-50g per square metre after each harvest of cuttings. Apply it by opening a small furrow in the soil at least 10 cm away from the side of the cutting and sprinkle urea (using a soda bottle lid as a container) into the furrow. Then cover the furrow over with soil. Do not let the urea touch your cuttings as it will burn and kill them. (Note: urea is not suitable for pre-planting application because it dissolves very fast, and the nutrients are lost quickly if there is much rain)

NPK and Urea

A pre-planting application of NPK, can be followed by an application of urea at 13g per square metre in a furrow 10 cm away from the plants at the time of the first ratoon harvest.

Depending on site specific characteristics (i.e. soil type and fertility), adding a nitrogen containing fertiliser such as NPK, urea or mature manure or compost to your vine multiplication plot can greatly increase your vine productivity seek local advice and see the figure and table below for examples.

Comparison of Different Fertiliser Application Rates on Sweetpotato Vine Production

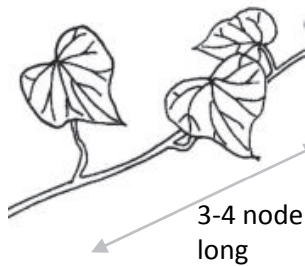


Profit Calculations from Different Vine Production Fertiliser Regimes in Tanzania in 2015

Production system	Fertiliser and application rate	Profit per 0.1 ha (US\$)
Vines-only	Control: no fertiliser	760
	Manure: 1 t/0.1ha	1,004
	NPK - 5:2.5:2.5 (kg/0.1ha)	1,142
	NPK - 5:2.5:2.5 (kg/0.1ha) & Manure 0.5 t/0.1ha	1,671
	NPK - 15:7.5:7.5 (kg/0.1ha)	1,743
	NPK - 25:12.5:12.5 (kg/0.1ha)	1,699
Dual purpose (vines plus roots)	Control: no fertiliser	330
	Manure: 1 t/0.1ha	360
	NPK: 5:2.5:2.5 (kg/0.1ha)	418

Source: Data shown in Figure 5.1 and Table 5.1 are from Gibson et al., 2016

Preparation of cuttings: Use 50 cuttings per square metre, so in a 1m x 5m bed you will plant 250 cuttings. For commercial vine multiplication, only use pathogen tested cuttings from a known source and seed class. For farmers multiplying vines for their own root production take healthy, disease and pest-free vines of two to three-month-old plants. Avoid using vines from older plants as they are more likely to be infested with viruses or insect pests and will have reduced vigour. The vine is cut



into pieces/ cuttings of 3-4 nodes (~10 -20cm) in length. (A node is the bump at which the leaves branch off).

Farmer-multipliers have found that for rapid vine multiplication, cuttings of at least 3-4 nodes (~20 cm length) are preferred to shorter ones of ~10 cm length. The longer cuttings have a higher survival rate and their management requirements are lower than for the very short 10 cm cuttings. Plant the cuttings with the leaves on if possible, as this leads to faster sprouting. However, if the cuttings have been stripped of leaves, they should be planted the same day.

Planting

Light irrigation should be applied prior to planting. The 3-4 node (~20 cm) long cuttings should be planted upright or at a slant at a spacing of 10 cm x 20 cm, with at least two of the nodes buried under the soil, to encourage faster plant growth. The nursery bed must be watered gently two or more times a day (in the early morning and late afternoon), particularly in the first few days, so that the surface never becomes dry. Make sure the cuttings are well planted so that they don't become exposed during watering. If it is very hot and dry, lightly shade the nursery bed with a small grass structure to protect it from excessive loss of moisture. But do not keep the nursery bed in heavy shade for more than two weeks as it will cause the vines to become etiolated (pale and elongated).



Recently planted planting material multiplication bed

Fencing

Protect the nursery bed from livestock damage through use of local (thorny bushes) or purchased fencing.

Management

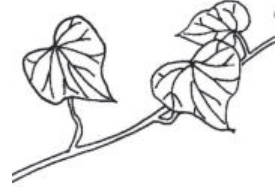
Periodically remove any weeds by hand. Check carefully for any diseased plants and rogue (pull out) any that you find and dispose of them at a distance from the plot (e.g. diseased vines can be used for animal fodder). After two weeks, check the establishment rate, and fill any gaps with new cuttings to try and maintain the optimum plant population density of 50 plants per square metre. Check the cuttings are well covered with soil and cover over any that have become exposed during the watering. For each bed, make waterproof labels and put them next to the bed to show which variety is in it and the date it was planted.



Using A Dual-Purpose System for Vine and Root Production

If the market for quality planting material is unpredictable, a dual-purpose system can be used to produce both planting material and storage roots.

Many farmer-multipliers may prefer a dual-purpose system where they produce enough planting materials to sell but also are able to harvest roots from the same plot. For a successful dual-purpose system, the farmer multipliers need to adapt the land preparation and spacing practices they use for root production. These may vary from country to country depending on soils, topography, rainfall and existing agronomic practices. Normally, farmers use ridges, except in Uganda, where they use mounds. The distance between ridges varies by location. In Malawi, most farmers use a hand hoe to prepare their land, and the distance is 75 cm between ridges, but if they use a hand tractor or animal traction, the distance is 90 cm. In Ghana, Nigeria and Burkina Faso, the distance between ridges is 1 m. If the field is on a slope, positioning the ridges along the contour is advised to prevent soil erosion. For planting material production, the distance/spacing between plants is 15 cm instead of 30 cm; the closer spacing limits the formation of storage roots and encourages more vine production.



Farmer-multipliers using the dual-purpose system with the sale of planting materials as their main objective, must rogue on a regular basis to maintain the quality of their seed, and vines should be harvested from plants of not more than three months old.

Farmer-multipliers who want to ensure adequate root yield in the dual-purpose system should only harvest one-third of the vines from each plant so as not to compromise yield, and the taste characteristics of the roots. This way, they will obtain 150-175 bags of vines/ha (est. 1 bag = 1,000 cuttings of 25-30 cm – depending on variety). A study found that when trying to optimise root production and harvest vines to sell, the vine harvest should be done just once for the whole field; and this should be done one month before the root harvest.

Review Questions

1. What methods of obtaining and selecting planting materials are used in bimodal areas vs. unimodal areas?
2. What is an RMT Nursery?
3. How much harvest is it recommended to collect for farmers who grow both roots and planting material for sale?

Unit 5 – Harvesting and Post-Harvest Management

Objectives

By working through this section, you will be able to:

- Explain the process of sweetpotato vine harvesting.
- Compare the first and second cuttings. Explain the concept of ratooning.
- Describe best post-harvest practices.

Key Points

- **Harvesting of sweetpotato vines can begin after 6-8 weeks into growth.**
- **Keep a record of the cutting yield per square metre, and you can use the information to optimise your business plan.**
- **To protect against weevils, don't cut the plant down to the root.**
- **Care must be taken in cutting, packing, and transporting vines.**

Harvesting

After 6 to 8 weeks the vines are ready for the first harvest. Make sure this is done either in the early morning or in the late afternoon to avoid excessive evaporation, wilting and transplanting shock. Starting from the tip of the vines, cut portions of at least 4 nodes (~20-30 cm) long. Do not cut right the way down to ground level, leave at least 15 cm of the base of the vine showing above ground level, as this helps avoid weevil infested planting materials. In many cases the vines are left in the shade for 2 hours before packing so they become 'floppy' and occupy less space during transport.



15 cm long stumps at base of vine

If the nursery bed is well maintained, a second set of cuttings can be taken from it about 45 days later. This practice is called ratooning and may be done up to three times.

For vine multipliers or root producers where there is high demand for quality planting material, the area under multiplication can be expanded as follows. At the first harvest, cuttings are taken and then planted out in an adjacent rapid multiplication bed, so that the quantity of planting material eventually obtained after a further 6 - 7 weeks is much greater. For example, if after 6 - 7 weeks, the original cutting has produced a vine long enough to be cut into 3 cuttings, and these 3 new cuttings are then planted out, after a further 6 to 7 weeks a total of 3 cuttings from each of the later planted cuttings, plus about 5 cuttings from the original cutting will be able to be taken and used or sold as planting materials.

Keep a record of how many cuttings you obtained from one square metre at each harvest, and then you can use these numbers to work out the multiplication rates of the different varieties you are producing and optimise your business plan.

For farmer-multipliers (seed producers) who are selling their planting materials, ventilated packaging and labelling of the material is essential.

Packing Vines

Jute sacks are better than the grain (polypropylene) sacks as they allow more air movement, but they are expensive. If using grain (polypropylene) sacks, pierce them to increase air flow. Do not overfill the sacks or you will damage the vines. The distance which the planting material will travel, or the estimated time before the material will be planted, can also influence the type of packing materials used.

Unit of Packing

50 cuttings typically weigh about 1kg. There will be some variation between different varieties.

Cuttings are often distributed by weight e.g. 4kg / 200-300 cuttings or larger bundles of 1,000 cuttings.

Distribution or selling by weight has the disadvantage that after harvest the weight reduces as water is lost from the cuttings (e.g. with Kabode, 50% of the weight can be lost in five hours). The decision as to the most appropriate unit to use when distributing or selling planting material (i.e. by number of cuttings, weight or volume) should be based on local factors (e.g. total quantities of planting materials being delivered, time required to use the different unit measurements).

During a mass multiplication and dissemination activity, it is unlikely that you will have time to count each cutting, so having a rough idea of how many cuttings there are per kg can make it much faster to pack, label, transport and distribute them, and the faster you can do this the better, as the vines are perishable.



Labelling Vines

Make sure you clearly label each variety whether distributed in sacks or bundles of vines. The label needs to give the variety, name and contact details of the multiplier and date of harvest. If possible also print details of the characteristics of the variety on the back of the label. A separate information leaflet on the varietal characteristics and good agronomic practices for root production can also be distributed with the planting material, if resources allow.

Transport of Vines

Take care when loading sacks or bundles onto trucks to avoid squashing and damaging the vines, if large trucks are used the vines can get squashed and overheat during transport. Use open medium-sized (6 - 8 tons) trucks for transporting the vines to reduce damage and try and transport them during the cool part of the day to minimise rotting or drying out of the vines. Tarpaulins should be available to cover the sacks when it rains during transportation, otherwise the vines will deteriorate and be unusable. If using polypropylene grain sacks, then pierce the sacks to increase ventilation. Make sure you transport the vines as soon as possible after harvesting them, as there can often be unexpected delays during transport and distribution.



Vine Storage Before Planting

Planting of sweetpotato cuttings should be done as soon as possible after they are cut. If this is not possible due to the cuttings needing to be transported, or the field is not ready, then the cuttings can be kept, but only for a maximum of 2-3 days. It is best to retain most of the leaves on the

cuttings so that they have better establishment. Then tie the cuttings in a bundle with their bases covered with a wet cloth or sack. The bundles should then be kept in a cool, moist and shady place. Alternatively, the cuttings can be partially buried in a narrow trench under the shade of a tree with the vines spread out along the trench, with two-thirds of the vines under the soil surface. If during vine storage, pencil roots develop, extra care must be taken during planting. In locations where weevils frequently attack young sweetpotato crops, vine cuttings can be dipped in a systemic insecticide before planting to minimize damage. Advice should be sought from the local agricultural extension officer or nearest research station about which pesticide is suitable, safe and available. Avoid the use of chemicals which are not recommended and ensure that all safety precautions are carefully followed when using any pesticides.

Review Questions

1. How long after planting can the first harvest begin?
2. What is the key factor in packing vines?

Unit 6 – How Farmers Can Preserve Planting Materials During the Dry Season

Objectives

By working through this section, you will be able to:

- Describe two methods farmers can use to preserve sweetpotato planting materials during the dry season.
- Explain step-by-step how to set up a Triple S seed system.
- Describe what opportunities Triple S can bring farmers, and which aspects they need to pay attention to maintain the quality of the stored roots.

Key Points

- **At harvest, healthy planting materials can be selected and moved to a dry season plot, (e.g. a swampy area, by a water point, under a shady tree, in the backyard), so they can be looked after during the dry season.**
- **They can then be multiplied in time to have sufficient planting materials when the rains start.**
- **Triple S provides smallholder farmers in areas with a long dry season with a means of preserving and producing sufficient sweetpotato planting materials in time to plant at the start of the rains.**
- **Triple S involves placing layers of undamaged small to medium-sized roots in a basin lined with newspaper and filled with cool dry coarse sand, storing the basin in a cool dry low light place and monitoring the roots monthly.**
- **About 6-8 weeks before the rains start.**

How Farmers Can Preserve Planting Materials During the Dry Season

In areas where there is a prolonged dry season, sweetpotato vines typically die due to lack of moisture or through being eaten by livestock and so are not available to supply cuttings. When the rains come, and farmers want to plant straight away, there are no planting materials available. Farmers typically then must wait for the rains to cause vines to emerge from old roots that were left in the field from the previous season's crop. But this takes time and means the planting gets delayed. This lack of planting materials at the on-set of rains is a major constraint to sweetpotato production in Sub-Saharan Africa.

Farmers need healthy sweetpotato planting materials, in sufficient quantities in time to plant as soon as the rains start. There are two ways they can do this:

- Dry season conservation and multiplication of *vine planting materials*, in areas where the water table is high or where the crop can easily be irrigated
- Dry season preservation of *sweetpotato roots in dry sand, followed by forced sprouting* in time for the onset of the rains. This is known as the Triple S system – *Storage in Sand and Sprouting*

For farmers to access sufficient high-quality planting materials at the time they want them, they may need to produce clean planting materials on their own farms and to obtain clean planting materials from external sources.

Dry Season Conservation and Multiplication of Vines for Cuttings

To ensure planting materials are available at the start of the rains, dry season preservation is necessary. During the final harvest of the sweetpotato crop, care must be taken to select healthy planting materials, to carefully conserve and multiply in specially selected locations during the dry season.

Dry season conservation and multiplication of vine planting materials can be done by planting vines in a swampy area, or around a well or water point, or under shade (trees or banana plants), or near homesteads where planting materials can be easily looked after.

The dry season planting material conservation method selected will vary based on the socio-ecological characteristics of the household. The conservation and multiplication practices commonly used in areas with short dry seasons (1-2 months) are different from those commonly used in areas with prolonged dry seasons (3.5-5 months).

The dry season vine conservation and multiplication plot should be:

- Somewhere which has a reliable source of water, but is not in danger of flooding, or of becoming water-logged once the rains start;
- Somewhere with suitable soils;
- Somewhere the farmer visits regularly during the dry season, as it will require good care;
- In a clean area, not next to an old or existing sweetpotato plot which may be harbouring pests and diseases;
- Protected from livestock damage by fencing the plot with thorny bushes or other materials. Note: during the dry season when there is little other green vegetation available and livestock are often left to wander freely, the sweetpotato dry season plot can be very attractive to them. The tethering or enclosing of goats and pigs helps reduce this problem.
- Regularly monitored for virus infection, and any infected plants immediately rogued out (removed and fed to livestock) to prevent rapid spread of the virus.

Planting Materials

The vine planting materials to be used in the dry season plot, must be carefully selected to ensure they are clean and healthy. They should come from disease and pest-free sweetpotato plants and should be inspected to ensure there are no signs of weevil damage. Even a small hole can indicate the site where a weevil's eggs have been laid. The varieties used should have appropriate virus resistance. Thus, in areas where there is not much virus around, virus susceptible varieties can be grown as there is low risk of them becoming infected.

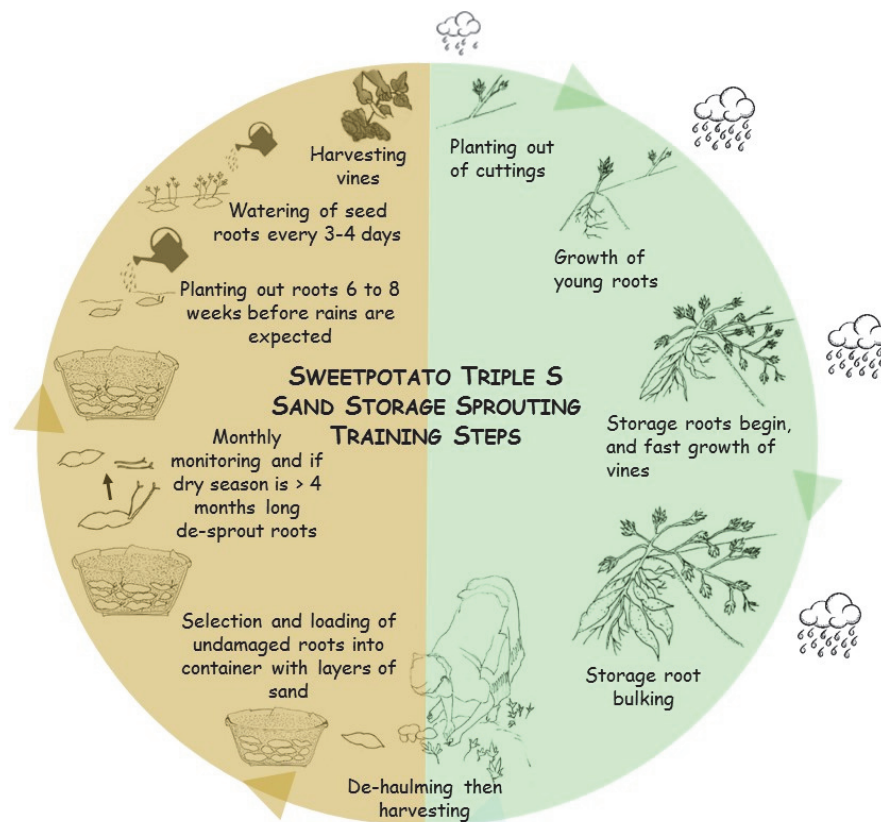
- Only cuttings taken from the younger and middle parts of the vine, rather than from the older basal parts should be used as planting material.



Dry Season Preservation of Roots to Produce Planting Materials – the Triple S System: Storage in Sand and Sprouting

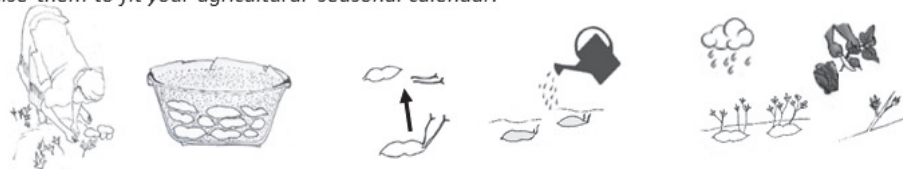
Triple S stands for **S**and, **S**torage and **S**prouting, which are the three main steps used for storing sweetpotato roots to conserve planting materials during the dry season.

The roots are stored in coarse dry sand, and then planted out and watered before the rains arrive so their sprouts can grow and provide planting materials at the start of the rains. The calendar below can be used to determine when your different Triple S activities will need to occur.



TRIPLE S CALENDAR EXAMPLES FROM DIFFERENT COUNTRIES

Remember Triple S timing is driven by the rains, not by calendar dates so the below are just examples, and you will need to contextualise them to fit your agricultural seasonal calendar.



Location [add your timings]	Harvesting, root selection & storage of Triple S roots	Dry-season period [months], monitoring	De-sprout roots	Planting out in root bed & water every 3-4 days (6-8 weeks before rains)	Start of rains. Vine harvesting & planting of cuttings every 4 weeks from:
Mozambique	Apr/ May	Jun to Sept [3]	No need	Oct to Nov	Jan/ Feb
Kenya -Western	July/ August	Sept to Jan [5]	Oct/Nov	Feb/March	April
Uganda -Northern	Nov/Dec	mid Nov to Mar [4]	No need	mid Jan/ Feb	mid Mar/Apr
Ethiopia -Tigray	Oct/Nov	Oct to Jun [9]	Jan and Apr	May/ June	Jun/Jul
-SNNPR - Belg	Oct/Nov	Oct to Feb [4]	No need	February	Mar/April
-SNNPR - Meher	Oct	Oct to Apr [9]	Jan/Feb	March	Apr/May
Nigeria -Derived savannah	Oct/ Nov	Nov to Apr [6]	No need	February	Apr/May
Burkina Faso -Western	Oct - Dec	Nov to Mar [5]	Dec/Jan	April	June/ July

The equipment required and details of each step of the Triple S process are shown below.

A detailed Triple S 'Guide for Trainers' is available online and in different languages along with a set of training charts and farmer handouts at: www.sweetpotatoknowledge.org/training-materials/

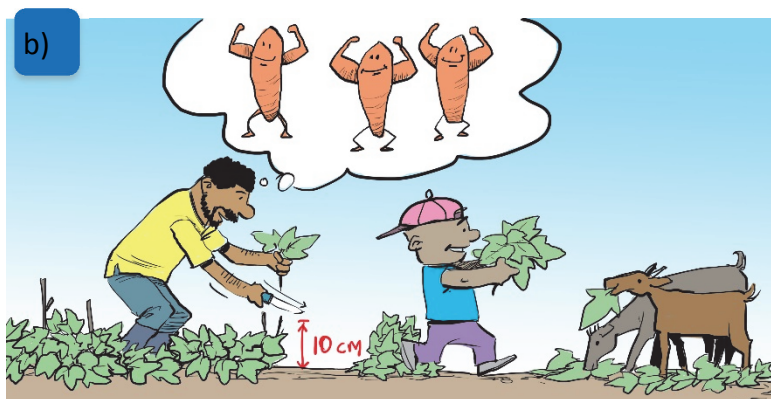


Selecting Healthy Roots for Your Triple S

Only store healthy mature roots in your Triple S.

Walk through your field and peg healthy plants (~25 plants per Triple S basin).

Two weeks before harvest, check the plants to make sure none have weevil or virus disease symptoms.



De-Topping Sweetpotato Plants to Cure Roots

Cutting the foliage off the pegged healthy plants 3-5 days before harvest, helps their roots to produce a thicker skin which protects them from disease and loss during storage.

When cutting, leave 15cm of stem above ground.



Careful Harvesting

Harvest carefully to avoid damaging the roots. Work slowly. Using a fork hoe may help.

Place roots in shade. Do not wash the roots.

Do not overload sacks or drop or squash roots during transport.



Root Selection

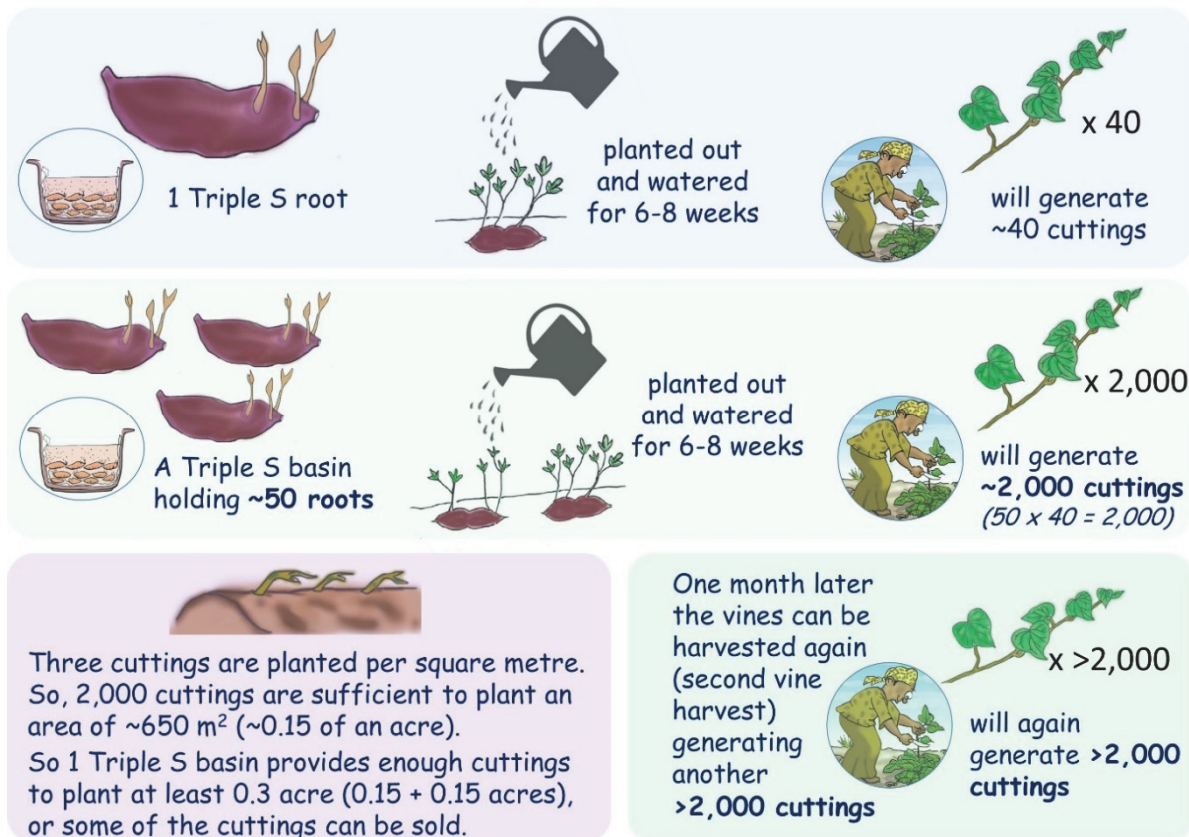
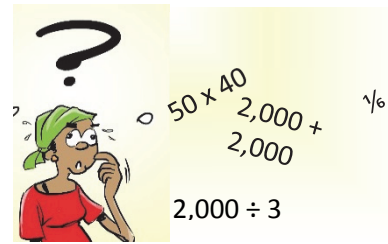
Due to the long storage period, only store healthy roots. Harvest them from healthy mature plants (e.g. signs of soil cracking, yellow lower leaves).

Use roots that:

- Are small-medium sized
- Have no weevil holes, rots or damage

Triple S Calculations

The calculation below helps you to determine how many Triple S roots to store. Generally, 50 roots will generate about 2,000 cuttings at the first vine harvest which will be sufficient to plant 0.15 of an acre, and one month later another 2,000 cuttings can be cut from the Triple S roots providing seed for another 0.15 acre.



Setting-Up and Managing Your Triple S

Gather all the necessary equipment together in a shady spot



1
Old **basin**, or other container for storing the roots in

A few pages of an old **newspaper** for lining the basin

Coarse, dry, cool sand – which can be swept from the yard

About 50 small to medium-sized undamaged **sweetpotato roots**

Sticks to peg plants

Fork hoe to harvest

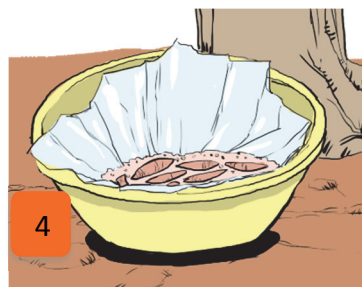
Watering can to water seed roots after planting them



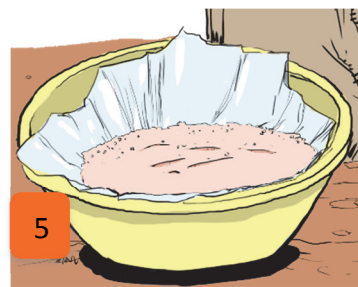
Place the newspaper inside the basin, to act as an absorbent layer across the bottom and sides of the basin.



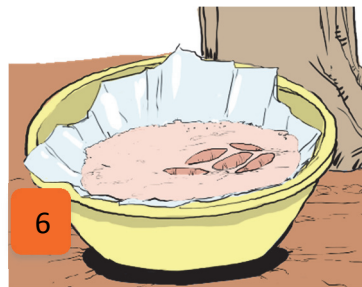
Add a layer of cool, dry, coarse sand about 2-3 cms deep. This can be swept from around the yard but must be cool before adding to basin.



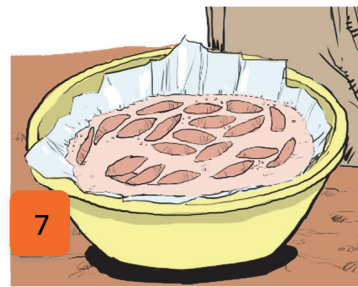
Add a layer of undamaged, healthy roots. Position the roots so that none of them are touching each other, and so that they are not touching the edge or base of the container.



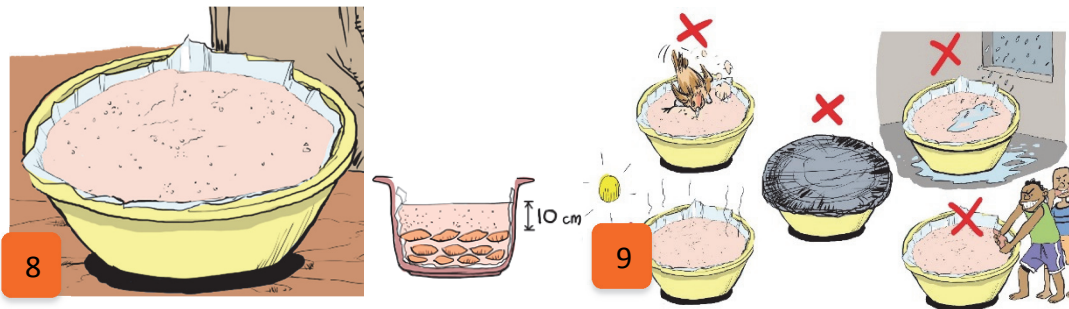
Cover the roots with a layer of cool, dry, coarse sand.



Add another layer of roots, again making sure they do not touch each other or the edge of the basin. Cover them with a layer of cool, dry, coarse sand.



If there is space in the basin, add a third layer of roots. Again, make sure they do not touch each other or the edge of the basin.



Finish with a deep layer of sand (~10 cm thick) to help prevent rodent or weevil damage and sprouting.

Store the container with the sand and roots in it in a relatively cool, dry place, e.g. in the house or a roofed hut. Make sure it is away from chickens that might like to nest in it, rain, children who might like to eat the roots, and heat. Do NOT cover the basin tightly.



Monitoring

Monitor your Triple S roots every month.

Unload all the roots, one-by-one and discard any that are rotten or weevilled.

The layer of newspaper should be changed if it has disintegrated, which can be a sign of rotting.

Keep a record of any observations made, or actions taken and the date of each monitoring.

Reload the Triple S basin as per at set-up.



De-sprouting

If your dry season is longer than 4 months, then the stored roots will need de-sprouting

If dry season is 5 months, de-sprout at 2 months

If dry season is >5 months, de-sprout at 3 months

De-sprout by breaking off the sprouts by hand. It usually takes 4 weeks for new sprouts to grow.

Sprouts deplete the nutrients stored in the roots. Storing roots in a cool low-light location can help reduce sprouting.



Preparing the Root Bed

Plant out your Triple S roots 6-8 weeks before the rains are due to start.

The root-bed should be in a fertile area that is easy to water and monitor.

A fence will protect it from livestock.

Plant roots at a spacing of 60 x 60 cm, and depth of 10 cm below soil surface with small sprouts facing up. 50 roots will require a bed of 6m x 2m, or 3m x 4m. If water is very scarce, plant roots at 30 cm x 30cm and form a small depression between every 4 roots for watering.



Watering

Water roots at planting, and then twice a week for 2 weeks, then reduce to once per week.

50 roots will require about 3 watering cans (10 litres/ can) of water each time. Make a small depression above each root to help conserve moisture.

Shoots should become visible about 2 weeks after planting out the roots.

When rains are 1 to 2 weeks away, stop watering to help the vines harden.



Vine Production

Vine harvesting from Triple S roots can usually start 6-8 weeks after planting but should not be done until the start of the rains.

To harden the vines before harvest, watering should be stopped 1 week beforehand.

The field area where the cuttings will be planted should be prepared prior to vine harvesting so that the time between vine harvesting and planting is as short as possible.

15



Vine Harvesting and Planting

The top/ apical, 3 node-long (~20-30cm) portion of vines of healthy-looking plants should be used as planting materials. This part establishes fastest and is likely to be free of insect eggs and larvae.

If the vine is long, several cuttings can be taken, but 15 cm of plant stem must be left above soil level to produce the next vines. Only cut vines once the rains have established.

Remove the leaves, and plant the cuttings upright or slanting, at a space of 3 cuttings/ m², with two of the nodes buried under the soil. If there is a delay between vine harvest and planting, keep cut vines in a cool place.

Review Questions

1. What are the two methods of preserving seed?
2. How is seed preserved in longer dry seasons?

Unit 7 – Choosing Your Planting Material Multiplication and Dissemination Strategy

Objectives

By working through this section, you will be able to:

- Explain the factors to consider when deciding on an appropriate multiplication and dissemination strategy.
- Discuss the advantages and disadvantages of centralised and decentralised planting material multiplication and dissemination strategies.
- Determine whether your project should use a single-shot or on-going planting material distribution strategy.
- Identify whether a centralised or decentralised planting material multiplication and dissemination strategy would work best in your project.
- Describe at least 10 criteria which are important when selecting DVMs.
- Describe factors that contribute towards and against farmers willingness-to-pay for sweetpotato planting materials.
- Explain how vouchers can be used as part of a planting material dissemination strategy.

Key Points

- **Careful planning of material multiplication and dissemination is necessary to have a meaningful impact on sweetpotato growing communities.**
- **Multiplication and dissemination strategies for sweetpotato must consider agro-ecological and climatic factors as well as existing seed systems and demographic/social factors. What are the constraints on a social level in your area? Is rainfall bimodal?**
- **Varietals that are available or preferred must be taken into consideration as well.**
- **National development strategies and key stakeholders should be consulted in any sweetpotato material multiplication and dissemination strategy.**
- **Organizations like NGOs and private sector companies should be considered in sweetpotato planning.**
- **Centralised planting material multiplication offers more expert advice and widespread control of various factors, but decentralised planting material multiplication is less risky, as planting materials remain under local control and are less subject to large-scale losses.**
- **Single shot dissemination processes are most often used in emergency situations.**
- **Many factors will influence the planting material multiplication and dissemination strategy to use**
- **Understand the existing seed system before planning any seed system interventions.**

Choosing Your Planting Material Multiplication and Dissemination Strategy

Achieving impact at scale on issues such as improving yields or reducing vitamin A deficiency in under 5-year olds, will require careful planning and implementation of a planting material multiplication and dissemination strategy.

Planting material multiplication and dissemination strategies do not come in a one-size-fits-all option. Instead, careful thought and planning is required to determine which dissemination strategy/ies would be most suited to your specific situation. The reason behind why you are distributing planting material will also influence your decision; is it to distribute a new variety or a

clean stock of a current variety, or simply to increase the supply of planting material? On-going monitoring of your multiplication and dissemination strategy and the general context in which you are operating is crucial, so you can adjust the strategy as conditions (e.g. climatic, institutional) on the ground change.

Decision-Making Factors for Planting Material Multiplication and Dissemination Strategies

The seed of grain crops such as maize, can be produced, dried and stored centrally and then distributed when needed through agro-dealer outlets, or government programmes. However, for sweetpotato, a different strategy is needed as the seed or planting material is a living crop, which is perishable and cannot be stored for more than 2 - 3 days and is bulky to transport or distribute.

The use of the multi-stakeholder framework for intervening in roots, tubers and banana seed systems, can help to analyse the key constraints which affect the availability, access and quality of the existing sweetpotato seed system.

Key factors to consider when deciding on your planting material multiplication and dissemination strategy include:

Agro-ecological and Climatic Factors

In dry agro-ecologies or uni-modal rainfall areas the challenge with the conservation and multiplication of planting material, is the need for access to a permanent water source throughout the dry season. Irrigation technologies are important. DVMs can also use the Triple S system to store some roots, before planting out in seed root beds to provide planting material at the start of the rains.

In bi-modal rainfall areas, avoiding the accumulation of seed borne pests and diseases in planting materials is a challenge. The net tunnel technology can be used by DVMs to protect and maintain clean basic material, which they use to replenish the system, through open field production of certified seed or QDS/ QDPM for sale to farmers.

- Key questions to answer to help decide on your strategy: how long is the dry season in the target area, are water sources permanent? What is the sweetpotato vine multiplication and root production calendar?

Existing Seed System Factors

Where sweetpotato is already grown, farmers will have developed means of maintaining, or obtaining planting material. Where possible, strengthen this existing seed system. This requires an analysis of opportunities and bottlenecks for the different seed system functions: seed availability, access to seed and seed quality from the perspective of different stakeholders

- Key questions to answer to help decide on your strategy: what existing seed system is there? Who is involved? What multiplication practices are used, how do they differ between male and female farmers. What is the gender division of labour, resource allocation, and decision-making? How commercial is the seed system, what prices are charged? What scale does it operate at? What are its strengths and weaknesses?
 - What is the gender-based division of labour for different tasks related to vine multiplication? What gender-related constraints do women farmers and men farmers face in producing and accessing planting materials?
 - What are male and female farmers' perceptions of a good sweetpotato vine multiplier and seed system? What resources do existing women and men multipliers use for vine conservation and multiplication? (Who has access to these resources in terms of gender, wealth, status etc.? What constraints would women and youth face in accessing these resources? What strategies would be needed to ensure that women and youth could

access these resources?) What would existing multipliers need to reach more clients?

Socio-economic and Demographic Factors

The socio-economic characteristics of farmers influence their seed demand characteristics. Market factors also influence the type of dissemination strategy. If there is low purchasing power and no market for vines, the likelihood of DVMs maintaining a commercial enterprise will be low. If there is a strong market for roots, farmers may be more willing to invest in regular seed purchases, and therefore a DVM might be able to sustain a commercial enterprise. Infrastructure will also influence the movement of roots and vines.

- Key questions to answer to help decide on your strategy: what the population density is, what is the economic status of the target farmers, are the roots widely sold and how will these factors affect the pricing and logistics of delivering the planting materials.

Varietal Factors

Varieties need to be attractive in terms of customer preferences or range of uses.

- Key questions to answer to help decide on your strategy: what are the varietal characteristics which consumers and farmers are looking for (agro-ecological suitability, yield, market demand, taste, processing, storage traits etc.)? Are there varieties (land races and released) which are more popular for men, women or children or for different end-uses (e.g. fresh root consumption, processing, livestock fodder)? Are the varieties you want to promote virus-resistant and able to remain virus free even if the target area is a virus hot spot, or will clean virus free planting materials need to be regularly re-introduced? Varietal turnover – how long have the varieties grown been in the system, do better varieties now exist?

Policy and Institutional Factors

There may be conducive policy factors in support of seed system development or for entrepreneurs to set up seed enterprises (e.g. business development service providers, credit facilities).

- Key questions to answer to help decide on your strategy: are there government policies which promote or support some crops in relation to others? Are there policies or programmes which promote free seed distribution in response to emergency situations? Could this be an extra market for vine multipliers or will it damage their businesses by offering similar materials for free? Are there government health and nutrition policies which provide opportunities for promotion of biofortified crops such as OFSP? Is there an organisation or entity which has responsibility for coordination of seed systems and how is this done?

Project Specific Factors

The project funder (e.g. national government, or donor funded) will have its own priorities in terms of type of target group, short- and long-term objectives, which need to be taken into consideration.

- Key questions to answer to help decide on your strategy: how many beneficiaries need to be reached in what time frame, what type (gender, age, economic status) of beneficiaries are they and where are they located? Which intermediaries will be involved, where are they located and working, and how will communication and coordination between different players in the seed system be managed? What can the project's human and financial resources best manage? Is long-term sustainability of the seed system an important criterion?

National Development Context

A country may be on a steady development trajectory, or in a post disaster, post conflict situation. There may be preferential strategies towards high potential or marginal areas or particular population groups.

- Key questions to answer to help decide on your strategy: is the country investing in long-term agricultural development, where increased availability of improved seed is a critical strategy. Or is there an emergency, post disaster, post conflict situation. This will affect the amount of time available to meet sweetpotato seed requirements, and also the level of investment or funding available.

Key Stakeholders and Their Roles and Responsibilities in the Seed System

The customer for sweetpotato planting material is the farmer; however, his or her needs will differ depending on the scale of their root production, and which market they are targeting. They may be producing for their own consumption, for the fresh root market, for processors, institutional markets, and/or livestock keepers. Intermediary buyers, such as government departments or NGOs, may purchase and then distribute the planting materials to other multipliers or farmers.

Other stakeholders include: vine multipliers (farmers/farmer group vine multipliers, seed companies) producing different classes of seed, traders and transporters, extension agents from the public and private sector, NGOs, plant health regulatory bodies, and researchers.

The typical roles and responsibilities of the different seed system stakeholders are discussed below:

Customers for the End Product

- Have a key role, as end users of the fresh or processed product (e.g. roots or leaves for consumption, and vines for fodder); they drive demand for different types of varieties (and therefore influence the decisions of seed producers).

Customers for Quality Seed

- Include root producers at different levels of commercialisation, and institutional buyers. the quantities and timing of seed production. Root producers should be helped to understand and see the benefits of using clean planting material and providing feedback on varietal attributes. Farmers also have household level practices for conserving planting material between seasons and clearly play a key role in farmer-to-farmer dissemination of planting material and new varieties.

Registered Seed Producers Including Seed Companies and Decentralised Vine Multipliers (DVMs)

- Key role is to establish and manage their multiplication sites, using pathogen tested starter material from known source. They are expected to undertake the recommended practices for quality vine conservation and multiplication, which include:
 - Planning their vine multiplication cycle to ensure adequate quantities of planting material are available to farmers at the beginning of the rains for root production,
 - Accessing pathogen tested starter seed from known sources, replenishing their clean stock, and obtaining new varieties on a regular basis,
 - Pre-planting practices and preparations,
 - Practices for planting and management of multiplication fields (including roguing of infected plants),
 - Depending on the customer, there will be different recommended harvesting and post-harvest handling practices for quality vine multiplication, including adequate labelling,

- Registering and requesting seed inspection services at the appropriate time,
- Dissemination of planting materials to nearby farmers, and acting as a source of information and advice on sweetpotato vine and root production,
- Developing demonstration plots as an awareness raising strategy of the value of clean seed and showing characteristics of new varieties,
- Conservation of planting material during the dry season,
- Providing feedback to extension agents and researchers on disease and pest outbreaks in their multiplication plots and performance of different varieties during multiplication.

Seed Producer Associations

- Can strengthen the collective action and voice of individual vine multipliers. They may also provide a capacity building role. There should be strong links between the regulatory body and seed producer associations.

Traders

- Can play an important role in creating demand for new varieties amongst consumers, and in feeding back consumer choice type information to the producers. Traders may be involved in trading both roots and planting materials, as well as agro-dealers and input suppliers selling accessories for irrigation and/or fertilisers.

Transporters

- Play a key role in ensuring that planting material arrives in the best quality condition.

Public Extension and/or NGOs

- Are responsible for building the capacity of farmer/ farmer group vine multipliers in managing multiplication at the decentralised level. They provide:
 - Training to farmers/ private sector on quality vine multiplication techniques; the training and site visits should be designed and implemented considering any gender-based constraints which male and female multipliers might have,
 - Linkage between DVMs and reliable sources of clean planting materials,
 - Technical guidance and supervision of the initial establishment of multiplication sites
 - Demonstrations of the practice of negative selection of planting material (i.e. Discarding diseased and unhealthy material and only selecting material which looks healthy and disease and pest free) to the vine multipliers,
 - Facilitation of linkage between the vine multipliers and markets and other services such as credit facilities (e.g. To obtain irrigation equipment), and business development services to provide support in enterprise development,
 - Conduct seed inspections under the delegated authority of the regulatory body
 - Awareness raising/ sensitisation amongst the community and local leaders regards the availability of planting material, importance of using clean planting materials, and information about the key characteristics of different sweetpotato varieties,
 - Through regular visits to the multiplication plots, feedback from the multipliers on any challenges they have and encourage the use of recommended practices.

Business Development Services

- Provide advice and services on business and financial planning and can link to credit providers to support capital investment and seasonal input requirements.

Private Sector

- Includes seed companies, tissue culture laboratories and seed entrepreneurs. Increasingly they are key investors in the seed system, complementing public sector investment.

Seed Regulatory Bodies

- Play the role of developing national seed standards and inspection procedures in consultation with key seed system stakeholders. They may delegate seed inspection duties to district officials or establish a system of authorised seed inspectors. They are responsible for issuing labels according to seed class for material which meets the seed standard.

Researchers

- Have the role of generating new varieties from the research station and evaluating them under farmer conditions. NARIs also produce pre-basic seed for sale to basic multipliers. Researchers also building the capacity of NGO or government staff or farmer representatives as ToTs on quality vine multiplication. Researchers may also make inspection and certification visits in collaboration with the national seed regulatory bodies to multiplication sites.

Centralised and Decentralised Planting Material Dissemination Strategies

Whilst there are a wide range of options for planting material multiplication and dissemination strategies, a lot depends on local context. A key difference is whether the strategy should be a single shot approach or an on-going access approach. These two approaches are discussed below.

Note that a single shot approach, does not refer to a ‘truck and chuck’ approach. In any situation where there is to be a delivery of planting materials, a well-organised system is needed to:

- Ensure planting materials are of preferred, adapted varieties and arrive when the farmers want them, e.g. At start of rainy season.
- Ensure recipients are aware and prepared to receive the planting materials on a specific day, e.g. This could be combined with a market day when many farmers will gather in one place, however it is important that the recipients are aware in advance so that they will have already prepared their land to plant the planting materials in.
- Ensure the planting materials are cut, packed and carefully transported without undue delay.
- Ensure the planting materials are carefully labelled with their variety name (to prevent varieties getting mixed up), date of harvest and name of the multiplier.

Single Shot Dissemination Approach

A one-off distribution of planting materials to the target community, who then integrate them in their farming systems and maintain their own planting materials.

A single shot approach to planting material dissemination is often used in response to an emergency. It is also used for the dissemination of a new variety and can work well in situations where the dry season is not prolonged, for example in locations where there are two planting seasons per year and therefore planting materials are not so easily lost between planting seasons or in locations where farmers are experienced at dry season preservation of planting materials. If

the varieties being distributed have resistance to viruses, then it is likely that the planting materials the farmers and farmer multipliers maintain will continue to yield well for many years.

The quantity of planting materials distributed will be influenced by the planned number of target beneficiaries, the existing supply of planting materials and its multiplication rates, and the budget. A larger quantity distributed per household (e.g. 8-12 kgs (about 400-600 cuttings)) can result in higher visual impact than the distribution of smaller quantities, and this may then speed up demand and spread in subsequent years. However, there are obvious trade-offs between the high visibility impact of distribution of larger quantities of planting materials versus the number of households reached and the costs and logistics.

A single shot approach is usually subsidised and is often free.

Ongoing Access Dissemination Approach

Annual or repeated/ ongoing distribution of planting materials to the target community.

Annual or repeated distribution will be necessary for some years in areas with a prolonged dry season, where access to planting materials at the start of the rains is a serious constraint to productivity.

If the varieties being distributed are susceptible to viruses, a regular injection of clean planting materials will help maintain yields. However, if possible, distribution of virus susceptible varieties should be avoided.

Extent of commercialisation: can range from being 100% subsidised to 100% commercial, and the degree of subsidisation should decrease over time, as the target communities become familiar with the new varieties and their importance in the food system increases, and as locally-based decentralised vine multipliers increasingly offer planting materials of these varieties for sale.

Where purchasing power is low, or to target a particular group (e.g. pregnant women), there may be a permanent need for subsidised planting material. This may be a complete or partial subsidy and might involve a voucher system (see Box 5.4 on vouchers). Whereby, targeted vulnerable households are given vouchers, which they can use to obtain planting material; the planting material supplier is then reimbursed for each voucher used. Note: voucher systems make it hard to accurately analyse willingness-to-pay by consumers and may act as a disincentive to careful preservation of planting materials.

Where there is sufficient purchasing power, good market linkage and consumer demand for certain varieties, planting materials can be sold for profit.

Decisions regarding the degree of subsidisation and whether it is a supply or a demand subsidy and whereabouts in the system it should come will need to be made and revisited over time and will influence the use of your budget. To persuade farmers to grow an unknown variety at a moderate scale, you may need to put some subsidy in during the first year. Then in the second year you can move towards a more commercialised system (especially if the market demand for roots of the new variety is increasing in the target area).

Extent of decentralisation: An ongoing access approach can also range from being completely centralised to very decentralised. Training of DVMs in vine multiplication and dissemination can enable a sustainable source of high-quality planting materials to be available to the community each year without external intervention. Your strategy needs to consider how such a decentralised system would be set up, which players are involved, what support and training they

require, how to ensure the supply is continuous and how farmers will access it. Pros and cons of centralised and decentralised vine multiplication and dissemination strategies are shown in the table below.

So how do you decide which planting material dissemination strategy would be most suitable for your situation? The following diagram aims to help with this decision making. For each key driving factor (agro-ecological, varietal, socio-economic, and institutional), identify the boxes that best fit your situation, and note their colour, shading and border patterns. Purple hashed shading suggests a single shot subsidised dissemination approach would be possible. Green suggests an on-going access dissemination approach would be more suitable, with the green boxes with broken borders suggesting that an increasing degree of commercialisation would be possible aiming eventually towards a self-sustaining commercial sweetpotato seed dissemination system. Keep a score, to help identify which is the most suitable dissemination strategy for your situation.

Factors Influencing Which Sweetpotato Planting Material Dissemination Strategy to Use

Agro-ecological and climatic factors:

at least 2 reliable evenly spaced rainy seasons per year?

a long (>3 months) hot dry season?

Does your target area have

high virus pressure (high incidence of white flies and aphids)?

access to lowlands with residual moisture during the dry

Varietal characteristics:

varieties that are virus resistant?

varieties that are virus susceptible but have other popular attributes?

Are you promoting.....

Socio-economic and demographic factors:

Does your target area have

a low population density and poor access to markets?

good access to markets for roots or vines and means of transport?

a significant percentage of households (>30%) who already purchase vines each year?

some households in each village who have access to a source of water that could be used for

Institutional factors:

Does your target area have

Strong public sector extension services or public institutions (agricultural colleges) with access to land and water?

Significant numbers of NGOs engaged in agricultural activities with smallholder farmers?

Government policies which promote free seed distribution in response to emergency situations?

Existing traditional farmer multipliers who are interested in producing the project's focal varieties?

Relatively strong farmers' organisations existing at local level?

Concurrent promotion of market development for roots?

Planting Material Dissemination Systems

Single shot, subsidised

On-going access, subsidised

On-going access, with increasing commercialisation

Note: For each key factor (agro-ecological, varietal, socio-economic, and institutional), identify the boxes that best fit your situation, and note their colour and border pattern. Purple/hash suggests a single shot subsidised dissemination approach would be possible. Green suggests an on-going access dissemination approach would be more suitable, with the green boxes with broken borders suggesting that an increasing degree of commercialisation would be possible aiming towards a self-sustaining sweetpotato seed dissemination system.

Note that the existing seed system and project specific factors listed above should also influence your decision-making regards which planting material dissemination strategy to use. It is important not to unwittingly destroy the existing seed system by the ill-advised use of free or subsidised planting material. You might want to field test different strategies to decide which to continue with or you may need to use more than one strategy. It is unlikely that a commercialised dissemination strategy would work immediately, but over time a dissemination strategy can work towards becoming more commercialised and self-sustaining. Make sure you have an exit strategy whereby the new situation will be better than the pre-existing one.

In some situations, centralised mass multiplication and mass dissemination of sweetpotato planting material is appropriate. In other situations, it is important to consider how planting material can be readily available at the farmer and community level. This is called a decentralised approach, using existing or establishing trained multipliers. In addition, the slow rate of multiplication or bulking of planting material, means that there needs to be linkages through the seed system from decentralised multipliers to sources of new varieties and clean material. It is therefore necessary to consider a multiplication and dissemination strategy which ensures that farmers have easy access to quality planting material, close to their root production sites.

A comparison of the pros and cons of centralised mass multiplication of planting materials and decentralised vine multiplication by local multipliers is given in the table below. There may be good reasons to keep both systems operating after the first year if some of the varieties being promoted are susceptible to viruses and thus a regular injection of clean planting materials can help maintain yields, or if new varieties are being introduced each year.

Pros and Cons of Centralised and Decentralised Planting Material Dissemination Strategies

	Pros	Cons
Centralised Mass Multiplication and Dissemination	<ul style="list-style-type: none"> • Easier quality control of planting material due to specialist management • Easier for public sector management • Clear knowledge of which varieties have been disseminated and where • Large scale distribution in a relatively short time (e.g. common system for emergency response) • Capacity strengthening of multipliers not required 	<ul style="list-style-type: none"> • Higher risks of loss if hit by: disease, irrigation failure, labour disputes, theft, livestock damage • The timing of distribution may not be compatible with individual farmers' land preparation arrangements and may lead to wastage and drying up of vines • Higher transport costs than decentralised • Good roads and good means of transportation are essential • Potential for high loss of planting materials during harvesting and transport for distribution • Requires strong management capacity

Decentralised Trained Vine Multipliers (DVMs)	<ul style="list-style-type: none"> • Perishable vines are closer to recipients thereby reducing losses • Locally based skilled vine multipliers who can continue to meet farmers demands in subsequent seasons, i.e. a more sustainable seed system • Risk spreading by having several sources of planting materials and developing several skilled multipliers • Farmers can agree with the multipliers as to when they will collect their planting materials and thus ensure they have prepared their fields beforehand • Trained DVMs can act as sources of knowledge about vine preservation and multiplication, different varieties, production and harvesting in their communities • Trained DVMs could evolve into commercialized multipliers • Vines produced by DVMs can cost less than when produced centrally by a project • Can bring increased recognition and benefits to women multipliers in systems where women are responsible for seed sourcing and multiplication 	<ul style="list-style-type: none"> • Seasonal demand for vines fluctuates, making it difficult to estimate vine production requirements • Vine multiplication as a money maker often cannot compete with vegetable production • Need to be flexible in terms of their production strategy, whether for vines only or for dual purpose (roots & vines) • High initial training and supervision requirements/ costs • Harder to reach a large number of beneficiaries than centralized system within a short time frame • Continued coordination and communication needs • If not well supervised, they may mix varieties up or include lower quality materials • Significant time is required to identify and screen existing farmer multipliers and, or potential DVMs • More investment required in small-scale irrigation equipment • Additional and specific support may be required to ensure that gender-based constraints for vine multipliers are addressed
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Centralised and decentralised planting material multiplication approaches require well trained multipliers and supplemental irrigation. However, decentralised multiplication approaches involve a lot more multipliers than a centralised mass multiplication plot. It is therefore important how these decentralised vine multipliers (DVMs) are selected, and how the training addresses their needs. Additionally, many farmers need to experience the yield difference between ‘clean’ planting material and their normal planting material to fully grasp the association between virus infection and reduced yields. DVM hosted demo plots and “seeing is believing” demonstrations help farmers to understand this concept, and to realise that they can achieve higher yields; so that they will invest time and resources in purchasing, selecting and maintaining clean planting materials from DVMs.

As discussed earlier, it is important to understand the existing seed system in your target areas, and to see whether any of the existing male and female farmer vine multipliers would be interested in being involved in producing and supplying the varieties you are promoting. Given that they already

have experience in multiplying vines, selling to other farmers, access to water etc., it may make more sense long-term sustainability-wise to boost their skills, and work with them as opposed to starting the operations from scratch with a new farmers group. However, introducing a new variety, particularly something different such as an OFSP variety, may be risky for the existing multiplier so they may need to be subsidised until the market value of the new variety becomes established.

The following criteria to select the DVMs can be discussed and adapted to your own context:

- a) 10 kms minimum distance between multipliers
- b) Willingness to have 750 sq. meters of vine multiplication, and if the DVM will be registered as a seed producer, sufficient land to be able to meet isolation distance and rotation practice requirements.
- c) Resident in target areas
- d) Prior experience growing sweetpotato; and as sweetpotato is recognized as a female crop want $\frac{1}{3}$ of participants to be women
- e) Access to water during the dry season
- f) If risk of animal grazing is high, willingness to invest in fencing
- g) Adequate resource base at household level (land and labour for multiplication)
- h) Know how to read and write and willing to keep records
- i) Recognized by the community as an honest member
- j) Accessible to members of the community (near road or major path)
- k) Willing to have demonstration plots (to compare new varieties with local material in a separate plot on the multiplier's farm)

It should be noted that several of these criteria (for example, b, g and h) *are likely to exclude women and poorer people*. It may be possible to work with existing active farmer groups to be more inclusive and still meet the above criteria. Often by working in groups, women and/or poorer farmers are more easily able to access land. It must be remembered that the idea behind having DVMs is that they will continue to produce clean planting materials at community level after the project has finished. It is therefore important to ensure that the subsidy the project is offering is not the main incentive for the DVMs to produce the planting materials, otherwise after the project they will cease to produce them. It is worth taking time to include the existing multipliers and their strategies, as there is always competition from other crops (e.g. high value horticultural crops) for water access during the dry season, it is important to understand these other competing enterprises to help judge what might be the most sustainable options.

Decentralised demonstration plots, where the new and/or cleaned-up varieties are grown so that the local community can be involved in monitoring and evaluating the performance of these varieties in their own situation are a useful awareness raising, demand creating and validation tool. Demonstration plots can also be a way of disseminating a new variety. It can be useful for the DVMs to set up these demonstrations (which need to be well-labelled to have maximum impact), so that local farmers get to associate the DVMs as the source and knowledge point regarding these new sweetpotato varieties.

There is also the need to understand how the sweetpotato seed system links to other segments in the sweetpotato value chain, i.e. how the seed system can be demand-driven, rather than “pushed” by public sector or NGO actors. An example of a successful intervention linking the sweetpotato seed system and various market segments is seen in the CIP-led pilot project “Jumpstarting orange-fleshed sweetpotato in West Africa through diversified markets”. It concluded that by creating market segments such as bakeries, gari production (Ghana), school feeding program (Nigeria), and as a government-promoted food security crop (Burkina Faso), commercial production of OFSP vines can be stimulated.

Subsidised and Commercialised Planting Material Dissemination Strategies

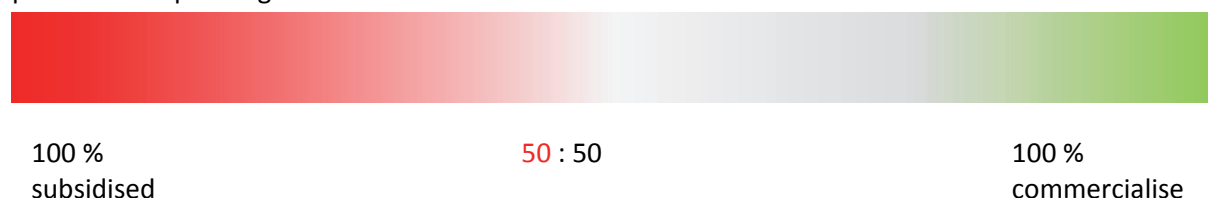
For reasons of sustainability, community empowerment and because of the typically short lifespan of most agricultural projects, the intention is usually to support the development of seed systems which will continue to enable farmers to access clean, high yielding planting materials of nutritious varieties. Such seeds systems are more likely to be sustainable if they are run commercially, but for this to work farmers need to be willing-to-pay for sweetpotato planting materials.

Factors influencing farmers' willingness-to-pay for sweetpotato vines are shown in the table below. Right from the outset, projects need to work at developing and encouraging the factors which contribute towards farmers' willingness-to-pay, if they want to support the development of a sustainable sweetpotato seed system.

Factors Contributing Against and Against Farmers' Willingness to Pay for Vines

Factors contributing AGAINST farmers' willingness-to-pay (WTP) for sweetpotato vines	Factors contributing TOWARDS farmers' willingness-to-pay (WTP) for sweetpotato vines
<ul style="list-style-type: none"> • The existence of a tradition of vine sharing within the community • The presence of other organizations distributing vines for free • Limited purchasing power • Limited importance of sweetpotato in the diet and few markets • Continuous production of sweetpotato so that a farmer can obtain vines for her new crop from a mature current crop 	<ul style="list-style-type: none"> • The availability of new sweetpotato varieties • Sweetpotato is a main crop • A long dry season • Recognition of nutritional benefits of sweetpotato, especially OFSP • Awareness of the yield benefits of early planting and use of disease-free vines • Markets, perhaps with specific varietal preferences, where roots gain a good price • Awareness of and access to vines for sale at the start of the rainy season

Production and dissemination of sweetpotato planting materials can be 100% subsidised or anywhere from 1 to 100% commercialised, and many projects start off by providing planting materials for free, and then gradually reduce the amount of subsidy as the project continues and as the nutritional and market values of the new varieties and benefits of using virus-free planting materials become known amongst the local community and they begin to value them enough to purchase the planting materials.



The subsidy may be on the demand side or on the supply side, or both. There are several ways of operationalising a subsidy. The box below describes how vouchers can be used in a planting material dissemination strategy.

Using Vouchers as Part of Your Planting Material Dissemination Strategy

A voucher is a printed form that entitles someone to receive planting material. A voucher can be given a monetary value or can be subsidized entirely (free to the beneficiary) or partially (the beneficiary pays a part of the total actual cost of producing the vines). Usually when someone pays something for the vines they value them more and take care of them.

Vouchers can be simple (Figure a) or used to collect more information about the person receiving the material and who they got it from (Figure b). Vouchers should be printed in a different colour or have a special mark made on them so that they cannot be easily photocopied and falsely used. You can have vouchers printed in booklets, using a self-carbonizing paper to easily make a copy to facilitate record keeping. The vouchers can be informative and part of an awareness campaign.

Figure a. Simple voucher: has an identification number, amount of vines and their value, the variety selected can be circled

Figure b. More complex voucher: Obtaining additional information on who received and who provided the vines.

Note: A promotional slogan, the recommended planting spacing, the typical time to harvest, the price, a coding system which identifies the disseminating partner and year can also be added.

Vouchers are useful if you want to:

1. Target certain groups of people, such as women with young children, pregnant women
2. Provide access to vines (using vouchers) at a location different from where the vines are growing (for example, to women at a health clinic)
3. Provide an incentive for farmers to try a variety they do not know and recognize that the new variety has a value.
4. Encourage farmers to learn where the vine multiplier is located, so that if they need vines again in the future, they know where to go.
5. Have an easy way to capture data about: when vines are picked up for planting; where they are likely to be planted; how many and which type of beneficiaries used their vouchers.

Using vouchers does require planning ahead to have them printed in advance. It is more costly to use vouchers than just having sheets to record who has received vines. The cost of implementing a voucher-based system may be more than the value of the planting material which is distributed. A project needs to agree on the objective of using a voucher-based system and think carefully about the pros and cons of using vouchers.

Review Questions

1. What are the advantages of decentralised Vine Multipliers?
2. When is single-shot dissemination approach most often used?
3. What are some of the reasons to use vouchers for dissemination?

Unit 8 – Constructing Your Multiplication and Dissemination Plan

Objectives

By working through this section, you will be able to:

- Calculate how many cuttings of each variety need to be planted how many months in advance to obtain the targeted amount of planting material at the start of the rains.
- Explain the importance of the multiplication rate in determining how much planting material will be produced.
- Create a work plan describing which activities need to be done when, how and by who and what they cost in order to achieve a planned planting material multiplication and dissemination strategy.

Key Points

- **Your multiplication and dissemination plan need to link to the local agricultural calendar.**
- **The production of large quantities of healthy planting materials can take a long time and significant advanced planning is required.**
- **Multiplication rates of planting materials differ by variety, soil type, field and water management and it is best to field the focal varieties and then use those figures in your calculations.**

Constructing Your Multiplication and Dissemination Plan

Aligning Your Multiplication and Dissemination Plan to the Local Sweetpotato Agricultural Calendar

As agricultural calendars differ across locations, it is important to sketch out the actual sweetpotato calendar with key informants from the target area.

You can use the calendar to find out about:

- When each of their sweetpotato farming activities typically occurs;
- When they can start preparing their land and how long it takes;
- Which crops they plant, what order they plant their different crop types and why;
- Who does which activities;
- When they want to start planting sweetpotato;
- Typical sweetpotato planting material management practices;
- Preferred sweetpotato varieties and characteristics;
- Key constraints, trends and changes, and
- The local sweetpotato value chain.

Once you know when farmers in your target area need to plant, you can then work backwards from that date to calculate when the different multiplications and then the dissemination of planting materials would need to happen. Remember, if you are introducing new varieties and need to build-up large quantities of planting materials ***you may need to start this process at least 7 months in advance of the dissemination period*** due to the low multiplication rate of sweetpotato and differences in the multiplication rates between varieties.

After having created your initial multiplication and dissemination plan you must regularly revisit it, as your expectations and estimates can be directly influenced by the performance of the rains, disease pressure, fluctuating exchange rates, personnel change etc.

You need to answer the following questions (see table below) before you can decide how to construct your initial multiplication and dissemination plan.

Questions to Use to Determine Your Planting Material Multiplication and Dissemination Plan

Question	Why do you need to know this?
When do farmers in the target area want to plant their sweetpotato fields?	<p>So, you can work backwards from the farmers' planting date, to calculate when each of your multiplication plots need to be prepared and planted.</p> <p>If the vines are needed soon, more labour-intensive rapid multiplication techniques will need to be used, fertilizer applied, and good water and pest management employed.</p>
How many households do we want to distribute sweetpotato planting materials to AND how many cuttings or kgs (of how many varieties) per household?	To help calculate the amount of sweetpotato cuttings you are aiming to produce (e.g. X cuttings for each of Y households).
Which varieties do we want to promote in the target area, and what are their multiplication rates?	<p>So, you can calculate how many cuttings of each variety to produce (e.g. X cuttings of variety A and B for each of Y households)</p> <p>AND so, you can calculate whether the multiplication rates of the different varieties vary a lot and will then require you to set up multiplication plots at different times and of different sizes. This will ensure you can produce the same number of cuttings of each variety to be ready for distribution at the same time (e.g. Variety A has a multiplication rate of 1:3 in a 2-month period, while Variety B has a multiplication rate of 1:4 in a 2-month period).</p> <p>Varieties can differ significantly by ease of establishment, growth rates, and number of nodes per 30 cm length (each node can be a future plant).</p> <p><i>Note: Decisions on which are the most appropriate varieties should be made in conjunction with a representative sample of the community (female and male farmers, traders, vine multipliers, and consumers) to ensure all factors and perspectives are covered.</i></p>

Is virus-free planting material available for the desired varieties?	Pre-basic seed is the first generation of material produced from disease-free <i>in vitro</i> plantlets maintained by national research programs. If such material is not available, it can take from six to 12 months to “clean-up” virus infected materials before beginning primary multiplication. This process obviously slows down any distribution effort. Projects sometimes opt to go with existing material that “looks” healthy instead. This can be done through appropriate selection methods (negative or positive selection).
Is virus-free planting material available for the desired varieties?	Pre-basic seed is the first generation of material produced from disease-free <i>in vitro</i> plantlets maintained by national research programs. If such material is not available, it can take from six to 12 months to “clean-up” virus infected materials before beginning primary multiplication. This process obviously slows down any distribution effort. Projects sometimes opt to go with existing material that “looks” healthy instead. This can be done through appropriate selection methods (negative or positive selection).
Are we doing a centralized mass multiplication, OR are we also using decentralised multiplication levels and if so how many DVMs do we have, and what training needs do they have?	<p>So that you can calculate whether all the planting materials will be produced at one centralised location or not.</p> <p>If decentralised multiplication sites are being used, this information will help you plan when and what quantity of cuttings from the pre-basic site will be required at each decentralised site.</p> <p>You will then need to calculate not only how many cuttings are required at each site at the different time points, but also how much land needs to be hired and prepared, and how much labour needs to be obtained for preparation, planting, management, harvesting, how much fertiliser and irrigation access/ equipment is required etc.</p> <p>Anyone engaged in vine multiplication must be trained on how to produce high quality planting material. Projects should budget at least two days for training and six follow-up visits for first-time farmer-multipliers. If a group DVM is being used, then training in group leadership and management may be required. One hectare of project-managed vine multiplication can cost US\$3,500–\$4,000 a year. Farmer-managed operations tend to be smaller in size with lower unit production costs. Government and NGO extension officers also need initial and refresher training. High turnover of trainers and DVMs will lead to a need for refresher trainings.</p> <p>If the dissemination model also uses farmer multipliers, additional training will be required on the chosen dissemination model (e.g. voucher based system, record keeping).</p>
Where will the multiplication sites be located?	Vines are perishable. The closer the multiplication sites are to the target households, the lower the cost of delivery and the loss rate. Pre-basic planting material is usually maintained on research stations; while decentralised sites are located closer to the target areas to reduce the distance between the source and target areas. Any multiplication site requires: access to adequate water, sufficient human resources to manage and protect the site, and, preferably, reasonable road access. Decentralized vine multipliers can serve up to a 30-50 km radius.

How far apart are the different target areas, and how many households in each target area will receive what number of cuttings?	<p>This enables you to plan your dissemination routes, and to work out what quantity and volume of cuttings you will be transporting to each target area, and how many trucks you will require to do so, and how long each journey will take.</p> <p>You will need this information to work out the size of the trucks to hire, and when to prepare the community in each target area for the arrival of their planting materials.</p> <p>However, if your dissemination strategy is very decentralised, farmers may be able to make their own way to the multiplication sites. Although you would still need to do some awareness-raising amongst the local leaders and target customers about the varieties and the location of the farmer multiplier.</p>
How well is your project's funding stream aligned with the agricultural calendar?	If it is not well aligned, initial multiplication may have to begin in the dry season, thus requiring an irrigated area, which might be in short supply or require infrastructure investments.
How much to charge for the cuttings to be commercial?	To enable you to understand the longer-term economics of sweetpotato planting material supply in your target areas, to help you build the sustainability of the seed system.

As multiplication rates differ by variety, soil type, irrigation schedule, field management level and temperature it is difficult to provide general figures for this (*although an attempt has been made to do so in Box 5.5 below*). It would be better to set up some trials to work out in your own specific situation using the actual varieties that the target customers are most interested in growing, what the multiplication rate for each of them is. You can then use that information to calculate more realistic data on costs, profits and timings for your business activities.

Box 5.5 Explaining Vine Multiplication Rates

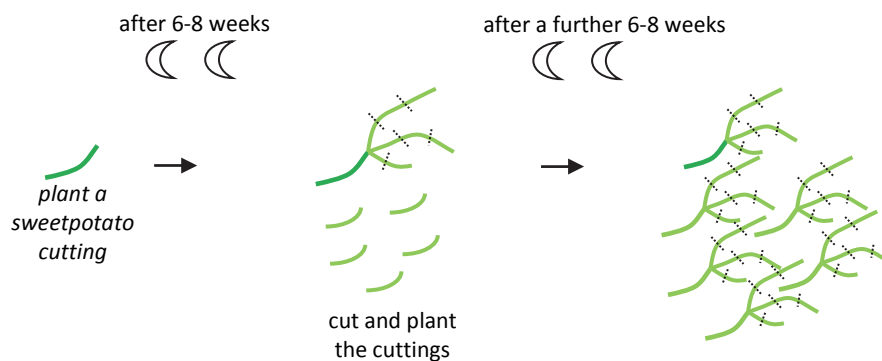
For example:

UNDER **CONVENTIONAL MANAGEMENT** (spacing of 30 cm between plants, 1 m between ridges; fertilizer can be applied if the soil native nutrient level is low):

- 1 sweetpotato cutting produces 10-15 cuttings (3 node cuttings) after 4 months.
- So if you start with 3 cuttings per sq m you will end up with 30-45 cuttings from that sq m after 4 months. The multiplication rate is between 1: 10 and 1:15 in 4 months.
- Roots will be harvested as well as vines. Note: cutting vines before 3 months may affect root yield.

UNDER **RAPID MULTIPLICATION** (spacing of 10 cm between plants and 20 cm between rows, with fertiliser (*note: proper fertilization can double multiplication rates*) and good water and disease management, and cuttings at least 3 nodes long (~20 cm length) of which 2 nodes are planted under the soil):

- 1 sweetpotato cutting can produce 30 - 56 (based on multiplication rate of 5 - 7) cuttings (3 node cuttings) after 4 months. (Note: this would be based on harvesting cuttings at 6-8 WAP and planting those cuttings, and then harvesting from both the initially planted cutting and the second lot of cuttings after a further 6-8 weeks – (two cycles in 4 months))



- So if you start with 50 cuttings per sq m and you obtain 250-350 cuttings from that sq m after 2 months, and plant those new cuttings you will then reach 1500 – 2800 cuttings (3 nodes long) after 4 months in your now expanded area (5 -7 sq m). The multiplication rate is between 1: 30 and 1:56 in a 4-month period.

Multiplication rates vary by variety (especially spreading vs. erect types), management scheme, seasonal temperatures (growth is slower when it is cooler), micro-environment (e.g. net tunnel) and agro-ecology. During the first season you need to measure your actual multiplication rates and then use that figure in your future calculations. However, monitor your multiplication plots closely to ensure that production rates are as expected.

Once you know how many target households and cuttings per household, and which varieties you require by a certain date, you can then work backwards to calculate how long it will take to produce that many cuttings. Two examples of such a calculation are given in the table below (which works backwards from November 2020 to July 2019 when the specified number of cuttings need to be planted in order to reach your target).

Example of Multiplication Calculations Working Backwards from the Number of Cuttings Required by A Certain Time, Using Two Different Multiplication Rates

Months working backwards	Example 1			Example 2 - higher multiplication rate		
	Target no. of households and timing	No. of cuttings of variety A	Multiplication rate in a 4-month period	Target no. of households and timing	No. of cuttings of variety B	Multiplication rate in a 2-month period
November 2020				100,000	20,000,000	
October 2020						
September 2020					6,666,667	3
August 2020						
July 2020					952,381	7
June 2020						
May 2020					136,054	7
April 2020						
March 2020					9,070	15
February 2020						
January 2020					605	15
December 2019						
November 2019					40	15
October 2019						
September 2019						
August 2019						
July 2019						

These figures provide you with some idea of the scale of operation you will need to support. You then need to decide whether you will operate in a centralised or decentralised manner and depending on this you can then determine how many farmer vine multipliers (if any) you need and what land areas they will need to put under vine multiplication. If they want to simultaneously produce roots they will plant at a wider spacing than if they are just focused on producing vines and this will affect the amount of land required to produce the specified number of vines. As described in section 5.4.1, vine multiplication can be intensified through using a rapid multiplication technique which requires closer spacing, use of fertiliser, good irrigation and careful management (e.g. roguing of any virus infected plants). Optimum root production requires a standard spacing of 1 m between ridges and 30 cm between plants which gives a plant population density of about 33,000 plants/ ha.

A step-by-step worksheet is given to help you with these calculations (see the table below), see link below table for online version. To use this worksheet, you need to know the following figures in advance:

- Target number of households
- Number of cuttings required per household
- Planting spacing = no. of cuttings/ sq. m
- Proposed size of each multiplication plot (sq m) for each cycle
- Multiplication rate in a 2-month period for each cycle

Step by Step Worksheet for Calculating Your Planting Material Multiplication Strategy

	A	B	C	D	E	F	G	H
1	No. of cuttings required per household:			200				
2	Planting spacing = no. of cuttings/ sq m:			50				
3	Level of multiplication	Proposed size of each multiplication plot (sqm)	Months working backwards	Target no. of households and timing (200 cuttings/hh)	No. of cuttings of variety B	Area required (50pp/sqm)	No. of multipliers needed	Multiplication rate in a 4 month period
4	Farmer root production		Nov-13	100,000	20,000,000			
5					Step 1. = total no. of cuttings needed = target no. hh x no. cuttings per hh =D4xD1			
6			Oct-13					
7			Sep-13					
8			Aug-13					
9	TMS	100	Jul-13		1,000,000	20,000	200	20
10					Step 2. =no. of cuttings reqd at TMS level = no. cuttings reqd by farmers / multiplication rate at TMS level =E4/H9	Step 3. = area reqd at TMS level = no. of cuttings required/ planting density of cuttings =E9/D2	Step 4. = no. of multipliers needed = total TMS area reqd/ size of each TMS plot =F9/B9	
11			Jun-13					
12			May-13					
13			Apr-13					
14	SMS	750	Mar-13		33,333	667	0.9	30
15					Step 5. =no. of cuttings reqd at SMS level =no. cuttings reqd by TMS level / multiplication rate at SMS level =E9/H14	Step 6. =area reqd at SMS level=no. of cuttings reqd at SMS level/ planting density of cuttings =E14/D2	Step 7. = no. of multipliers needed =total SMS area reqd/ size of each SMS plots =F14/B14	
16			Feb-13					
17			Jan-13					
18			Dec-12					
19	PMS		Nov-12		833	16.7		40
20					Step 8. =no. of cuttings reqd at PMS level =no. cuttings reqd by SMS level / multiplication rate at PMS level =E14/H19	Step 9. =area reqd at PMS level =no. of cuttings reqd at PMS level/ planting density of cuttings =E19/D2		

Note this worksheet: does not account for any wastage factor; assumes that all cuttings harvested from one generation are then replanted for the next; assumes a multiplication rate of 1:3 at the last multiplication cycle.

Online link to excel version of this table: <http://sweetpotatoknowledge.org/projects-initiatives/reaching-agents-of-change-rac/rac-tot-course-forms/Table%205.7 PM Multiplication Strategy Calculation Worksheet.xlsx/view>

Work Plan to Support Planting Material Multiplication and Dissemination Activities

Once you calculate your planting material multiplication numbers and stages making sure they match with the farmers' planned planting time. You can then create a work plan of the activities which need to be done at each stage in preparation for the final dissemination to all your target households. This activity work plan should be as detailed as possible. The template (table below, Outline for Sweetpotato...) may help you in creating this plan, guidelines for calculating the multiplication and dissemination costs are given in the section above. An example calendar of decentralised multiplication and dissemination activities is shown in see table 'Example Calendar' below. Remember you will need to constantly revisit your workplan and multiplication calculations to make sure they do not need updating as a result of unexpected changes (e.g. loss of cuttings during irrigation failure, faster or slower multiplication rate than anticipated, pest and disease outbreak etc.). Remember: if the multiplication is carried out in the dry season, this period is often cooler, and the multiplication rate will be lower. Also, if using net tunnels (see Appendix 5.2) which create a micro-climate the multiplication rate may be higher.

Outline for Sweetpotato Planting Material Multiplication and Dissemination Work Plan

What	When	Who	How	Cost
1. Identify target communities and record their sweetpotato agricultural calendar and varietal preferences and options.				
2. Agree on the scale of your initial planting material distribution. <ul style="list-style-type: none"> No. of districts No. of households No. of varieties Quantities of planting materials/ h'hold Monitoring data requirements Available budget 				
3. Make a calendar (see table below) showing when and where the multiplication activities are needed.				
4. Multiplication implementation phase. <ul style="list-style-type: none"> Prior arrangements (this will differ depending on whether you are going to have a centralised mass multiplication. strategy or a decentralised strategy) Land preparation and field activities 				
5. Pre-distribution activities <ul style="list-style-type: none"> Community awareness raising on OFSP Group meeting to organise who will receive planting materials and when, & communication strategy. Transport arrangements (vehicle size, timing, destinations & routes) Community meetings: Advanced notification to 				

communities of exactly when the planting materials will arrive (or when they can collect them), and demonstration of how they should handle and then plant them, and what prior field preparations they need to make.				
6. Distribution				
7. Monitoring				
8. Planning for distribution in subsequent years				

Example Calendar of Decentralised Multiplication and Dissemination Activities

Activities	Months																	Details	
	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J		F
Short rains																			
Long rains																			
PRE-BASIC SEED MULTIPLICATION																			
- Dry season conservation	X	X																	
- Planning	X	X																	
- Land preparation		X	X																
- Preparation of cuttings			X																
- Planting of cuttings			X																
- Irrigation			X	X	X	X													
- Weeding				X	X														
- Monitoring and maintenance			X	X	X	X	X												
- Harvesting, packing and labelling of cuttings							X												
Training of Basic & Certified seed multipliers						X													
Distribution of cuttings to Basic & Certified multiplication sites							X												
BASIC & CERTIFIED SEED MULTIPLICATION																			
- Planning		X			X	X													
- Land preparation						X	X												
- Planting of cuttings							X												
- Irrigation							X	X	X	X									
- Weeding								X	X										
- Monitoring and maintenance							X	X	X	X	X								
- Harvesting, packing and labelling of cuttings											X								

Review Questions

1. What are the important aspects to consider when creating a multiplication and distribution plan?
2. What are some of the factors impacting multiplication rates?

Unit 9 – Sweetpotato Seed Standards and Inspection Procedures

Objectives

By working through this section, you will be able to:

- Describe the importance of QDS/ QDPM for enhancing farmer access to good quality planting materials and hence increasing their productivity.
- List and describe the types of sweetpotato seed.
- Explain Quality Declared Planting Material (QDPM). Describe its standards and how they can be adhered to.

Key Points

- **We need to help farmers become more aware of the importance of using quality planting materials to increase their productivity and reduce their pest and disease problems.**
- **QDPM/QDS still requires inspection to ensure the agreed standards are being met, this is typically done twice, first at 4-6 weeks after planting, and then 2 weeks before harvest to check whether pests and diseases are within the tolerance level.**
- **Free planting material can help in an emergency but used on a regular basis it distorts and weakens the market for planting material.**
- **Different classes of seed exist:**
 - **Pre-basic seed is produced by research stations and private seed companies;**
 - **Basic and certified seed is produced by medium to large scale commercial seed producers; and**
 - **Quality declared seed is produced by DVMs and farmer groups, it is a seed category not a class.**

Sweetpotato Seed Standards and Inspection Procedures

Most countries have a legally based seed certification system for cereal crops such as maize. This includes testing and labelling seed to certify that it is true to type, has a guaranteed germination rate and is free from pests and diseases. Some countries also have a voluntary system for Quality Declared Seed (QDS) as a practical quality assurance scheme for seed production. This is less demanding than full quality control systems and is more easily implemented in situations where resources are limited.

For vegetatively propagated crops, where the planting material is often exchanged from farmer-to-farmer there is the risk of disease and pest build up which leads to reduced productivity. The production of vegetatively propagated crops and their “seed systems” are becoming more commercialised and there are advanced technologies available to support the production of disease-free materials. Seed control and plant health regulatory bodies are concerned with: increasing farmer awareness about the benefits of using quality planting material; protecting farmers from unscrupulous seed traders; and minimizing the spread of diseases through planting materials. In some countries a similar system to QDS is being piloted for vegetatively propagated crops. This was initially referred to as Quality Declared Planting Material (QDPM) by the FAO but is also referred to

as QDS². An overview of the status of sweetpotato seed standards in selected SSA countries is shown in the table below. (SHIFT to Annex) **Contact the Ministry of Agriculture and national seed regulatory body (National Plant Protection Organisation) in your country to obtain a copy of the sweetpotato seed standards and inspection procedures; and information about how to register as a seed producer.*

Status of Sweetpotato Seed Standards Across Sub-Saharan Africa (As of June 2017) *

Country	Status
Ethiopia	Approved 2015. Under implementation.
Kenya	Recently included under schedule two in the Kenyan law (Cap 326) which warrants mandatory certification of vines (seed). Yet to be circulated for use. N.B. Kenya does not recognise quality declared seed as a class or category of seed.
Malawi	Draft certification standards and protocols for root and tuber crops reviewed in June 2016. The recommendations were included in the country's Seed Act and Policy and are awaiting government approval.
Mozambique	Protocol for seed quality control and genetic purity of sweetpotato varieties finalized. To be submitted to the Ministry of Agriculture for approval.
Nigeria	Undergoing stakeholder consultation. Burkina Faso Inspection protocol was validated in April 2017 and sent to the National Seed Service for approval.
Rwanda	Stakeholder consultations completed. The Rwanda Standards Board (RSB) has submitted the proposed standards for approval.
Tanzania	Approved in January 2017. Ready for implementation.
Uganda	Technical guidelines for inspection and certification of sweetpotato planting material in Uganda completed in consultation with Makerere University, National Agricultural Research Organization (NARO), International Potato Center (CIP), HarvestPlus and Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The guidelines have been tested by the Crop Inspectors from MAAIF.

² The use of the terms QDPM and QDS differs between countries but in this manual are used interchangeably.

What Are the Quality Standards for Sweetpotato Planting Materials?

In 2010, FAO published protocols and quality standards for planting materials of vegetatively propagated crops, including sweetpotato. These FAO standards proposed tolerance levels for different pests and diseases affecting sweetpotato planting materials. Many SSA countries have piloted and gazetted their own sweetpotato seed standards, see the table above. The FAO standards for sweetpotato QDPM should be seen as a goal which multipliers work towards, and can be adapted to the locally specific contexts, which take into account what level of seed quality farmers want and are willing to pay for.

The standards for other seed classes for sweetpotato have also been gazetted in some countries. This includes: pre-basic, basic, and certified seed. In some cases, pre-basic and basic seed is not inspected and certified, but the facility (e.g. tissue culture lab, or production unit) is accredited by the regulatory body.

There needs to be an increased awareness among farmers as to the benefits of better-quality planting materials and trained and equipped inspectors for seed standards to be successfully introduced. Any system of standards, where the “quality” may not be immediately visible is also built on trust. Labels are issued by the regulatory body to match the seed class of the inspected seed. Each class has a different coloured label with the following information: name of multiplier and contact number; variety and date of harvest; number of cuttings in the bundle or sack.



Example of sweetpotato QDS/ QDPM label used by a project

Summary of Sweetpotato Planting Material Quality Declared Seed Field Standards From FAO, Tanzania And Ethiopia

Parameter	Field inspection standards				
	FAO's QDPM (G4)	Tanzania QDS**	Ethiopia***		
			Pre-basic/ Basic/ Certified 1	Certified 2 or QDS 1	Certified 3 or QDS 2
Minimum rotation time	4 y	3 seasons	3 seasons	2 seasons	2 seasons
Min. isolation distance (*barrier crop)	-	20 m/ (5m*)	10m/(5m*)	10m/(5m*)	10m/ (5m*)
Maximum other varieties or off-types	2 %	2 %	2 %	2 %	2 %

Maximum virus symptoms	5 %	5 %	5 %	10 %	10 %
Maximum <i>Alternaria</i> blight		5 %	1 %	2 %	2 %
Max. plants with signs of SP weevils	0 %	10 %	0 %	5 %	10 %
Max. plants with signs of SP butterfly	-		1 %	1 %	1 %
Weeds	Reasonably free from				

****Note:** For every 10 beds of each variety, 3 beds will be randomly sampled, and in those beds two complete inner rows (but not the middle row) of plants are inspected to determine the % of plants showing symptoms for each parameter. ******* Sampling will be done in accordance with ES 471 for at least 10 % of the lots.

Source: FAO, 2010; United Republic of Tanzania, 2015; Ethiopian Standards Agency, 2015

Seed Inspection

The inspection of a vine multiplication plot to assess whether the planting material being produced meets the agreed standards may be done by the national seed regulatory body, the research system, or delegated to an “authorised inspector” at a decentralized level for example a district crop protection officer, or a village extension officer trained in the seed inspection procedures. A minimum of two inspections are typically done, the first about 4-6 weeks after planting when disease symptoms would first start to show up, and at which point the multiplier can be advised to rogue or spray the crop and to label it. The second inspection should be done about 2 weeks before harvest, and if the pest/ disease level is above the tolerance level (see Table 5.3) the plot is rejected. During this second visit, the estimated quantities of planting materials which can be harvested from the plot are also calculated. A third inspection may be done at harvest if the customer is an institutional buyer.

The production of QDS/QDPM and the associated inspection system have costs, and someone must pay for these, whether it is the producer (multiplier), customer (farmer or institutional buyer), or government. The cost will depend on the level of quality required (i.e. production practices needed) and who does the inspection. Normally, multipliers who want to trade in quality declared seed or planting material need to be registered with the national regulatory body and the varieties which they multiply should be officially released. Farmer-multipliers can also be trained to inspect their own plots to determine whether the material reaches the quality standards. QDS/QDPM standards need to be appropriate to the specific context. Overly stringent standards may leave farmers in a worse-off situation if they result in standards being ‘by-passed’ or multipliers being closed down instead of upgraded. National policy should provide an enabling environment, ensure that there is adequate awareness among all stakeholders, and capacity building, and that the experience from implementation can be used to adapt standards and procedures to ensure the long-term sustainability of the seed system.

The Different Classes of Sweetpotato Seed

Previously, sweetpotato seed multiplication was organised based on primary, secondary and tertiary multiplication levels. However, to align with national policy and regulations on seed standards (see table below), many countries have updated their terminology for different levels of sweetpotato seed production. An explanation of the current or proposed terminology as per national seed policy is given in the table below, and a more detailed description of the seed classes follows it.

Sweetpotato Seed Categories and Classes, Proposed Definitions and Responsibilities (February 2017)

Seed Category	Proposed Definitions	Responsibility	Existing Terminology
Breeder	Handled by breeder after variety release; maintained in small plots with maximum possible quality; should be true to type; may or may not be virus indexed (or pathogen tested).	Research station	Breeder
Pre-basic	Generation directly derived from breeder seed multiplied under the control of research centres or private sector under the supervision of the breeder.	Research stations; private seed companies	Foundation, Nuclear, Primary
Basic	Generation derived from pre-basic and produced by registered seed producers.	Large scale commercial seed producers	Secondary
Certified 1 (C1)	Generation derived from basic seed and multiplied in open field by legally registered and approved seed companies.	Medium to large scale commercial producers	Secondary
Certified 2 (C2)	The generation derived from certified-1 and multiplied in open field with legally registered and approved seed companies.		Secondary
Quality Declared Seed (QDS)	Derived from basic/certified and produced in open field by trained and registered farmer-multipliers.	DVMs, farmer groups (may be dual-purpose for vines and roots)	Tertiary
Emergency and Standard	Normally approved by ministerial proclamation: any seed that is distributed to farmers to mitigate or respond to a disaster.	Varies by situation	Emergency

NB: in a formal seed system, seed producers need to be registered and inspected

- **Breeder seed** is maintained by the breeder after a variety release. It should be true-to-type and is maintained in small quantities. It is not subject to inspection by the seed regulatory body. It may or may not be “clean” but should be virus indexed before it is multiplied for dissemination as seed.
- **Pre- basic seed** is usually the sole mandate of agricultural research institutes. However, as national seed laws are liberalised private sector seed companies may also be legally permitted to produce pre-basic seed, often under the oversight of the breeder. The research institute or private seed company may have tissue culture laboratories and/ or other means of maintaining stocks of virus-free planting material. There should be strong internal quality assurance mechanisms. Depending on the national seed regulations, pre-basic seed may not be subject to external phytosanitary inspections, but there may be an audit of the facility, or “joint observations” by the breeder and the regulatory body.

- **Basic seed** is produced by registered seed producers in the public or private sector. Basic seed production is a commercially viable enterprise. There needs to be strong links with the research institute or organisation responsible for producing pre-basic seed. The multiplication sites must have access to permanent water for irrigation. The sites should meet the national seed standard regulations for isolation distance, rotation practice and multiplication of released and registered varieties. Seed inspections should be conducted twice a season.
- **Certified seed** (C1 and C2) is produced by registered seed producers. Production practices should follow national seed standards. There are examples where NGOs have established a registered seed company to be able to produce certified seed. Local extension staff may provide technical backstopping. Seed production is based on rapid multiplication techniques and requires a permanent supply of water for irrigation. These sites also need to be physically easy to access, especially in the rain season.
- **Quality Declared Seed (QDS)/ Quality Declared Planting Materials (QDPM)** is produced by registered DVMs, either individuals or groups. They may be existing farmer vine multipliers whose skills and range of varieties have been boosted through training by a project, or they may be new vine multipliers. They aim to directly provide planting materials to farmer group members and/ or neighbouring farmers for sweetpotato production. DVMs are typically small in size, numerous and are technically backstopped by extension staff, NGOs etc. Access to water by DVMs is crucial in areas with a long dry season, and it is ideal if they have mechanical irrigation, but difficult and costly to ensure they all do. DVMs need capacity support to develop their business plan (see section 5.10.1). DVMs also need a sensitisation, marketing and promotion strategy, using radio, SMS, and meteorological early warning system information.
- **Emergency seed**, is also called 'standard' seed in some countries. In a disaster situation, if there is a shortage of certified seed, the Minister of Agriculture may approve the distribution of planting materials which have not undergone the inspection and certification process, and so are of unknown source and health status.

While ideally, it is DVMs who interface with farmers providing them with planting materials either at commercial or subsidised value. In practice, farmers may purchase seed from basic and certified seed multipliers. One multiplier may produce and sell different classes of seed. However, if basic seed is produced by the public sector, with subsidised production costs, it may be able to sell basic seed at a lower price than private sector basic seed multipliers and therefore undermine the commercial viability of private basic seed producers. Moreover, the common practice of distributing planting material to farmers for free, creates a sense of dependency and distorts the market and commercial orientation of the seed system.

Review Questions

1. What are the three types of seed?
2. What is QDS?

Unit 10 – Seed Multiplication as a Business

Objectives

- Explain how a seed entrepreneur can benefit from using a business plan as a tool.
- Explain why a business plan that includes sweetpotato seed and root farming requires SMART objectives.
- Describe the attributes and uses of a strong business plan and list the steps to developing a plan.
- Estimate the costs of supporting a planting material multiplication and dissemination strategy by completing the template for calculating the costs.

Key Points

- **Learning business principles and planning tools is a valuable skill for all community members.**
- **A SMART business plan needs clear objectives that are Specific, Measurable, Achievable, Realistic, and Timebound.**
- **Running a business means accounting for both external and internal factors. Understanding vine multiplication and planning planting and harvesting activities in advance is necessary in any sweetpotato farming business.**

Developing a Business Plan for a Sustainable Seed (and Root) Enterprise

“Farming as a Business” is a popular slogan. However, if we are going to support farmers in operating as businesses we need to be able to explain business concepts and how to make decisions and apply them in their own context to male, female, youth or older sweetpotato seed and root entrepreneurs. Many farmers and community-based groups involved in sweetpotato vine multiplication have social and welfare objectives; and usually also want to generate income for the group. Learning about business principles and planning tools is a valuable life skill for men, women and youth.

Planning is the first critical step for a sweetpotato seed and root entrepreneur or owner of the business to enable them to understand the net return on their investment in the business.

What Is A Business Plan?

The business plan is a tool which the seed entrepreneur can use to:

- Analyse whether the enterprise will be profitable in his/her specific context;
- Run the business successfully;
- Understand how profitability might be improved.

The business plan must therefore have clear objectives. These objectives should be SMART (**S**-Specific, **M**-Measurable, **A**-Achievable, **R**-Realistic and **T**-Timebound). The business plan contains information on the sweetpotato business environment including market analysis, level of investment required, economic and financial viability of the business and marketing strategies to help run the business successfully. The plan is a working document that should be reviewed regularly and adapted to the business circumstances as and when there are internal and external changes.

The following sub-section explains basic business concepts and the steps for developing and using a business plan as an operational tool to guide the sweetpotato seed business³. When a seed enterprise is operated as a joint family business it is important that both husband and wife are included in training opportunities, as both have different knowledge and skills which will influence the success of the business and are quite likely to have different perspectives on how the revenue and benefits should be used.

Steps to Develop A Business Plan

Analysing the Business Environment

Firstly, to run a business successfully, the seed entrepreneur must understand the business environment for sweetpotato; the **external factors** which are beyond the control of the entrepreneur but may still affect the business. Such factors include government policies, climatic conditions, market situation i.e., price and demand for the product, the distribution systems (marketing channels) and market segments (type of the buyers/customers) and their preferences.

It is also important to understand the **internal factors** such as strengths and weaknesses of the seed entrepreneur to run the business. The strengths might include experience with sweetpotato production, good standing in the community; while weaknesses could include a lack of information about potential markets or customers. If the entrepreneur can identify these factors, then strategies can be formulated to address weaknesses and leverage strengths, to run a sustainable and innovative production model, manage customers' demands and improve revenue to have a successful business.

However, the business environment is dynamic and differs from place to place and product to product. Therefore, strategies, should have a short and long-term objective and consider both internal and external factors which may influence the business environment.

Understanding the Vine Multiplication Cycle and Preparing A Calendar

As part of a business plan, the seed entrepreneur must plan his or her production activities based on the sweetpotato vine and root production calendar for their location. The crop calendar should be prepared for sweetpotato vine multiplication (see table below).

After identifying the production activities, a financial analysis must be conducted to understand whether the business will be profitable or not. Therefore, estimating the cost of production and determining the price for the product is an important activity. The cost estimates will help seed entrepreneurs to understand the level of profit that they can generate from their crop sales revenue. A financial analysis needs to be carried out for each crop as the production costs and sale price differs by crop. This analysis can be performed either before the production season (ex-ante) or at the end of the season (ex-post measurement). A budget calculation sheet to use in a financial analysis is given in the table below. The financial analysis focuses on costing the activities undertaken in a season. This is called the recurrent production costs and so does not include fixed costs (e.g. facilities, land, equipment).

³ This section provides guidance to develop a business plan for a sweetpotato seed enterprise. In practice, many sweetpotato vine multipliers also produce roots for sale, and a combined enterprise may be more profitable than focusing on vine sales alone. The guidance and templates can be adapted to prepare a business plan for a combined enterprise.

Crop Calendar Template

	1st month		2nd month		3rd month		4th month		5th month		6th month		7th month		8th month		9th month		10th month		11th month		12th month	
	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half	1st half	2nd half
Activities																								
Season (rain)																								
Purchase Inputs																								
Land preparation																								
Planting																								
Weeding																								
Pesticide application																								
Harvesting																								
Grading and packing																								
Sales																								

Example of A Simple Budget Calculation Sheet to Use in A Financial Analysis

	A	B	C	D	E	F	G	H	I	J	K	L
1		ENTERPRISE:		STARTING SEASON (PLANTING TIME):			MONTH:		YEAR:		COUNTRY:	
2		CROP NAME:		ENDING SEASON (HARVEST TIME):			MONTH:		YEAR:		DISTRICT:	
3		TOTAL AREA PLANTED UNDER THIS CROP (ACRE):		PURCHASE INFORMATION				USE FOR THIS CROP				
4	S/ NO	CATEGORY / ITEM		TOTAL QTY PURCHASED	PURCHASE UNIT NAME	COST PER UNIT	TOTAL SPENDING (COST)	LOCAL CURRENCY NAME	TOTAL QTY USED	USED UNIT NAME	WHAT IS THE QTY OF 'USED UNIT' PER 'PURCHASED UNIT'? ¹	TOTAL COST SPEND FOR THIS CROP
5	1	INPUTS		fill-in only numbers	fill-in unit name	fill-in only numbers	fill-in currency name	fill-in only numbers	fill-in unit name	CONV. FACTOR		
6		SEED					=F6*D6					=(G6/K6)*I6
7		CHEMICAL FERTILIZER					=F7*D7					=(G7/K7)*I7
8		MANURE					=F8*D8					=(G8/K8)*I8
9		PESTICIDE					=F9*D9					=(G9/K9)*I9
10		INPUT 1					=F10*D10					=(G10/K10)*I10
11		TOTAL INPUTS COSTS OF PRODUCTION (SUB-TOTAL)						=SUM(G6:G10)				=SUM(L6:L10)
12	2	LABOUR/ ACTIVITIES		NO. OF LABOURERS	LABOUR	NO. OF DAYS	TOTAL SPENDING (COST)	LOCAL CURRENCY NAME	COST PER DAY AND PER LABOURER	NO. OF LABOURERS USED FOR THIS CROP	NO. OF DAYS REQUIRED FOR THIS CROP	TOTAL COST SPEND FOR THIS CROP
13		LAND PREPARATION			LABOUR				=(G13/D13)/F13			=I13*J13*K13
14		PLANTING			LABOUR				=(G14/D14)/F14			=I14*J14*K14
15		AGRONOMIC PRACTICES			LABOUR				=(G15/D15)/F15			=I15*J15*K15
16		HARVESTING			LABOUR				=(G16/D16)/F16			=I16*J16*K16
17		ACTIVITY 1			LABOUR				=(G17/D17)/F17			=I17*J17*K17
18		TOTAL LABOUR COSTS OF PRODUCTION (SUB-TOTAL)						=SUM(G13:G17)				=SUM(L13:L17)
19	3	MARKETING/ ACTIVITIES		NO. OF CROPS	UNIT NAME	COST PER CROP	TOTAL SPENDING (COST)	LOCAL CURRENCY NAME				TOTAL COST SPEND FOR THIS CROP
20		TRANSPORT			CROPS	=G20/D20						=G20/D20
21		MARKETING 1			CROPS	=G21/D21						=G21/D21
22		TOTAL MARKETING COSTS OF PRODUCTION (SUB-TOTAL)						=SUM(G20:G21)				=SUM(L20:L21)
23	4	ANY OTHER COSTS										
24	5	TOTAL COSTS (EXCLUDING PRE-POST HARVEST LOSSES)										
25		COST OF PRODUCTION FOR TOTAL AREA CULTIVATED UNDER SWEETPOTATO										= L11 + L18 + L22 + L23
26		TOTAL COST OF PRODUCTION PER ACRE FOR SWEETPOTATO EXCLUDING PRE-POST HARVEST LOSS (LOCAL CURRENCY)										=L25/C3
27	6	OUTPUT OF THIS CROP		TOTAL QTY	UNIT NAME							
28		TOTAL PRODUCTION (MARKETABLE AND NON-MARKETABLE)										
29		TOTAL PRODUCTION PER ACRE (YIELD)		=D28/C3								
30	7	COST PER PRODUCTION UNIT										=L25/D28
31	8	PRE & POST HARVEST LOSSES		TOTAL QTY	UNIT NAME							HARVEST LOSSES (COSTS)
32		POST-HARVEST LOSSES (NON-MARKETABLE)										=D32*L31
33	9	TOTAL COSTS (INCLUDING PRE-POST HARVEST LOSSES)										
34		COST OF PRODUCTION FOR THE TOTAL AREA CULTIVATED UNDER										=L32+L25
35		TOTAL COST OF PRODUCTION PER ACRE FOR SWEETPOTATO INCLUDING PRE-POST HARVEST LOSSES										=L34/C3
36	10	SALES		(fill-in numbers only)	UNIT NAME							TOTAL REVENUE RECEIVED
37		TOTAL QUANTITY SOLD										
38		VALUE ADDITION (REVENUE RECEIVED FROM THE VALUE ADDED PRODUCTS)										
39		REVENUE PER ACRE										=(L37+L38)/C3
40	11	NET PROFIT		TOTAL								=(L37+L38)-L34
41		TOTAL NET PROFIT PER ACRE										=L40/C3

¹MENTION THE VALUE IN USED UNIT e.g., if purchased unit is bag and used unit is cuttings which is 1000 cuttings per bag, then fill-in the number of cuttings i.e., 1000 or if you bought 8 bags and used only 3500 cuttings, then we need to know how many cuttings per bag, if it is 1000 cuttings, then fill-in the number of cuttings i.e., 1000 or if it is 500 cuttings per bag, fill-in 500 only. Similarly if you bought 2 bottles of chemicals, used only 0.5 liter, then we need to know how many liter per bottle i.e., 5 liter, then you need to fill-in 5

Budgeting, Financial Analysis and Record Keeping

A successful seed entrepreneur will record their expenses and revenue on a regular basis, so that at the end of the season they can accurately calculate their profit level. To complete the budget calculation sheet with the cost information, the entrepreneur should list all the activities undertaken for vine production and understand the type of cost information required to prepare a budget and conduct a financial analysis.

Types of Production Activities

The seed entrepreneur should complete information on all the activities which have costs. For example, the budget sheet classifies activities into: inputs, labour, marketing and outputs.

The main inputs are seed, fertilizers, pesticides and water, which need to be specified in terms of quantity, unit of purchase and sales along with price of the product. For water, there are some cases where the entrepreneur pays for water, or spends time to collect water, or operates a diesel or petrol pump. So, these resources (money and time) need to be included in the cost calculation. If a diesel pump is used to irrigate multiple crops including sweetpotato vines, then s/he must know the pump's horse power and the number of hours the pump is run to irrigate the multiplication plot to calculate the amount of fuel which will be utilized for vine production. This figure will then be included to estimate the cost of production for the sweetpotato seed crop.

The labour section focuses on activities where the entrepreneur hires workers. When family labour is used for production activities, it is necessary to use the market value for labour to carry out similar tasks. It is important to put a real value to the cost of family labour so that even when family labour is used in the enterprise, the entrepreneur measures and understands the true cost of production.

Marketing costs include: transport costs, off-loading, uploading, market entry fee, marketing costs (i.e., promotional activities) and procurement of inputs (i.e., transport costs for procuring inputs).

The output section focuses on sweetpotato vine (seed) production. Postharvest losses also need to be estimated (e.g. non-marketable vines) to be able to estimate the total cost of production. The total revenue received from the sales of vine and value-added products (i.e., root sales) which are produced during the season, should also be recorded in the template.

Type of Cost Data

The budget calculation sheet has two main sections: 'Purchase information'; and 'Use for this crop'. Sometimes, the seed multiplier buys a product which will be used for all crops and only part of it will be used on a specific crop; therefore, the multiplier should first record the information on the product that was purchased in the first section (i.e., purchase information) and then the quantity of input used for that crop in the second section (i.e., use for this crop). For example, a seed entrepreneur purchases 10 tons of manure; but only uses 2 tons on the vine multiplication plot and the rest is used for another crop. In this case, the template should be completed by writing 10 tons *purchased* in the first section and 2 tons *used* in the second section for the sweetpotato vine production.

Similarly, if the enterprise hired labour for weeding the farm which included other crops in addition to sweetpotato vines; then in this case, the template should be completed with the total number of labourers hired for weeding for all plots and then how much he/she paid for hiring all the labourers. Then for sweetpotato vine multiplication, the template is completed, specifying how many labourers were involved for how many days for weeding the vine multiplication plot. If labourers were hired for weeding the sweetpotato vine multiplication plot only, then the template should be completed with the same information in both sections.

Worked Example of How to Complete the Budget Calculation Sheet

	ENTERPRISE:	Sweet Sales	STARTING SEASON (PLANTING TIME)			July	MONTH	2018	YEAR	COUNTRY	XX
	CROP:	Sweetpotato vines and roots	ENDING SEASON (HARVEST TIME)			March	MONTH	2019	YEAR	DISTRICT	YY
	TOTAL AREA PLANTED TO CROP (ACRE)	0.5	PURCHASE INFORMATION					USE FOR THIS CROP			
SN O	CATEGORY	ITEM	TOTAL QTY PURCHASED	PURCHASE UNIT NAME	COST PER UNIT	TOTAL SPENDING (COST)	LOCAL CURRENCY NAME	TOTAL QTY USED	USED UNIT NAME		TOTAL COST SPEND FOR THIS CROP
	1	INPUTS	fill-in only numbers	fill-in unit name	fill-in only numbers		fill-in currency name	fill-in only numbers	fill-in unit name	CONV. FACTOR*	
		SEED	1	bag	100.00	100.00	K	1000	cuttings	1000	100.00
		CHEMICAL FERTILIZER: NPK	5	kg	80.00	400.00	K	1	kg	1	400.00
		MANURE	1	cart	75.00	75.00	K	1	cart	1	75.00
		PESTICIDE				0.00					0.00
		INP1				0.00					0.00
		INP2				0.00					0.00
	TOTAL INPUTS COSTS OF PRODUCTION (SUB-TOTAL)						575.00				
2	LABOUR	ACTIVITIES	NO OF LABOURERS	LABOUR	NO OF DAYS	TOTAL SPENDING (COST)	LOCAL CURRENCY NAME	DAY AND PER LABOURER	NO OF LABOURERS USED FOR THIS CROP	NO OF DAYS REQUIRED FOR THIS CROP	TOTAL COST SPEND FOR THIS CROP
		LAND PREPARATION	2	LABOUR	2.0	32.00	K	8.00	2.0	2.0	32.00
		PLANTING	2	LABOUR	1.0	16.00	K	8.00	2.0	1.0	16.00
		AGRONOMIC PRACTICES	2	LABOUR	3.0	48.00	K	8.00	2.0	2.5	40.00
		HARVESTING	2	LABOUR	3.0	48.00	K	8.00	2.0	3.0	48.00
		WATERING	2	LABOUR	10.0	160.00	K	8.00	2.0	10.0	160.00
		ACT2		LABOUR				0.00			0.00
TOTAL LABOUR COSTS OF PRODUCTION (SUB-TOTAL)						304.00					296.00

Conversion Factor

In the second section, there is a column for the conversion factor (i.e., 'CONV. FACTOR'). In this column, if the unit of purchase is different to the unit of use; then the unit for each must be specified. For example, if the entrepreneur bought 10 bags of vines and used 3,500 cuttings, in this case the purchase unit is a bag and the unit of use is a cutting. Therefore, it is important to state the number of cuttings per bag (e.g. 1 bag equals 1000 cuttings), in the appropriate column. The same logic should be applied if a five-litre bottle of pesticide was purchased, but only one litre was used for spraying the multiplication plot. If you specify 1 bottle in the purchased unit and used 2 litres, it is necessary to mention in the 'CONV. FACTOR' column, that 1 bottle is 5 litres, by entering '5'.

Calculating and Understanding Net Profit

The net profit is the difference between revenue generated from the crop sales and total expenses incurred for all production activities. If revenue is greater than total expenses, then net profit is positive, and the business is more profitable. In the spreadsheet, the net profit for sweetpotato vine and root business for a specific season will be estimated automatically. This calculation is based on the values entered under the revenue section and the expenses incurred from the sweetpotato seed and root production and sales activities. If the business is incurring losses, then the net profit will be negative. From the revenue and expenses figures, the net profit margin can also be determined by calculating the ratio of net profit (i.e., revenue minus expenses) to total revenue. The equation to calculate net profit margin is $\text{net profit margin} = \text{net profit} / \text{total revenue}$. This measures the amount of profit received for each unit of sales of sweetpotato seed and root. These calculations can be

performed for different crops to compare the net profit margin for sweetpotato seed versus other crop production activities.

Marketing Channels

The seed entrepreneur must understand market segmentation, which is a process of classifying customers into different types or categories, e.g. institutional customers, small-scale farmers, large-scale farmers. This can provide a picture about the volume of business coming from each category and highlights potential customers for the seed enterprise. Once the entrepreneur identifies his or her potential customers, then they should keep the contacts and sales history in a simple customer database system. The entrepreneur can then follow up with his or her list of customers prior to each season to determine the varieties, and quantities of sweetpotato cuttings which will be needed, and critically when these should be ready. During this process, a successful seed entrepreneur will also understand competitors' marketing strategies. The seed entrepreneur can then adjust their marketing strategy, through branding, advertising, choice of sales point, and type of varietal and agronomic information provided to attract more customers and increase revenue.



A vine multiplier keeps a record of his sales to farmers

As part of the marketing plan, the seed entrepreneur also needs to develop a pricing strategy to sell their product with an appropriate profit. Suitable pricing is key to ensure adequate revenue flows to support production and to maximize profitability for each unit sold. This underlines why it is important for the seed entrepreneur to record and calculate the accurate costs for their seed production to be able to identify where costs can be reduced, without jeopardizing the quality of the seed. Once accurate costs have been identified and the entrepreneur has understood her competitors' prices, a margin and mark-up can be added to determine an appropriate price for the vine.

Market Assessment

As markets are dynamic and potential customers differ from over time, the sweetpotato entrepreneur should monitor the market situation regularly using a simple market assessment chart (see chart below). By completing this chart, the information about the market, and price trends for different varieties can help the seed entrepreneur understand the market situation and plan their seed multiplication activities accordingly.

Simple Market Assessment Charts for Market Information and Price Trends

S. No	Information needed	Market 1	Market 2	Notes
	Market name and the distance from the farmers:			
	Type and Name of the market person (buyers):			

	Telephone Number:
1	What kind of variety do you prefer?
2	What quantities do you require and when?
3	Who do you buy vines from? (competitors)
4	How much are you willing to pay for quality planting material?
5	Do you pay in advance, cash on delivery or after delivery
6	Do you pay cash, by cheque, mobile money or deposit to bank account?

Guidelines for Calculating the Cost of Multiplication and Dissemination Activities

Budget preparation involves costing of the activities undertaken at each of the multiplication levels. Include all activities that are of economic value in the process of multiplication of quality seed vine.

For example, in a project the likely activities would include:

- Community awareness raising activities
- Rent of land
- Planting material multiplication plot establishment
- Maintenance of the multiplication sites
- Monitoring of the multiplication sites (which may include some on-site training and mentoring and may be monthly depending on the budget and service provider)
- QDS/QDPM inspection of multiplication sites to assess quantity and quality of planting materials (at 1.5 months after planting and 2 weeks before harvest)
- Community planning meetings on distribution dates, strategies, advanced field preparations and planting methods for the planting materials
- Harvesting of the planting materials
- Packing
- Labelling
- Transportation and distribution of the vines
- Monitoring planting material performance in communities, awareness, demand and spread
- Managing and paying staff
- Seed system stakeholder planning and feedback meetings
- Reporting to donor and local government technical and administrative structures
- A framework into which you can put your information is provided in the table below, each of the steps can be further broken down into smaller steps to help with initial planning and costing.

You will need to use figures specific from your own situation and note that costs are often higher for research station managed multiplication plots than farmer-managed plots, due to higher labour and supervision costs and distance to the researcher managed multiplication site.

Template for Calculating Costs of the Set Up and Implementation Steps of Your DVM or MM Multiplication and Dissemination Strategy

Setting up Decentralized Vine Multipliers (DVMs)	Setting up Mass Multiplication (MM)	Categories of Cost				
		Staff time	Allowances	Transport	Stationary	Materials
DVM Setup Steps	MM Setup Steps					
Site identification (geo-reference)	Site identification (geo-reference)					
Preparation of training & communication materials	Preparation of training & communication materials					
Decide on degree of subsidization of vines & equipt.	Decide on degree of subsidization of vines & equipt.					
Order labels and vouchers	Order labels					
Introduction to local leaders						
Staff training	Staff training & multiplier training					
DVM identification & contract signing						
DVM Training						
Site establishment	Site Establishment					
Supply of planting materials	Supply of planting materials					
Provision of equipment & location sign at each DVM	Provision of equipment					
Supervision visits (at least 3 monitoring visits /DVM)	Supervision visits (at least 4 monitoring visits)					
DVM Dissemination steps	MM Dissemination steps					
Inventory of material at DVMs	Inventory of material at MM sites					
Dissemination plan	Introduction to local leaders					
Sensitisation meetings/promotion events	Sensitisation meetings					

	Mapping the catchment area					
	Training orientation of community level assistants					
	Initial committee registration at village level					
Registration of beneficiaries	Registration of beneficiaries					
DVM orientation	Verification of land preparation by beneficiaries					
Voucher distribution at community level & <i>tracking</i>	Radio spots and other promotional events					
Other promotional events	Vine harvesting, packing, labelling					
	Transport to the dissemination sites					
Voucher redemption & collection of vines by beneficiaries	Collection of vines by beneficiaries & recording of who received what					
Collection of vouchers from and payment of DVM						
Data entry of vouchers	Data entry of mass multiplication forms					
	Establishment of district conservation plots					
	Management of conservation plots					
Evaluation of effort	Evaluation of effort					

Review Questions

1. What is a business plan used for?
2. What are SMART objectives?
3. Why is keeping records critical for running a business effectively?

Unit 11 – Gender and Diversity Aspects of Sweetpotato Seed Systems

Objectives

By working through this section, you will be able to:

- Describe some of the gender and diversity dimensions of the existing seed system.
- Analyse how women and men DVMs could be supported to produce better quality planting material and reach more clients.

Key Points

- **Access to and control over resources such as land, water, labour, transport, training may differ between male and female farmers and can affect planting material multiplication.**
- **A gendered seed system analysis is required to best understand how seed systems can be supported to best meet their clients demands and the project's aims.**

Gender and Diversity Aspects of Sweetpotato Seed Systems

A thorough discussion of gender and diversity aspects in relation to sweetpotato is presented in *Topic 11, Gender and Diversity Aspects*. However, key gender and diversity issues of sweetpotato seed systems include:

- Understanding the gender and diversity dimensions of existing seed systems. The gender situation analysis checklist in Appendix 11.1, will assist in this. Specific issues include:
 - Sweetpotato planting material multiplication practices: differences between male/female and wealthier/ poorer sweetpotato farmers; gender analysis of: division of labour, resource allocation, decision-making; different strategies farmers use for accessing planting materials, what constraints are faced, how could these be overcome, and how do different types of farmers cope if they do not access sufficient planting materials?
 - Exploring female and male farmers' perceptions of qualities of a good sweetpotato vine multiplier and seed system.
 - What resources do existing women and men multipliers use for vine conservation and multiplication?
 - Who has access to or control over these resources in terms of gender, wealth, status etc.?
 - What constraints would women face in accessing these resources?
 - What strategies would be needed to ensure that women could access these resources?
 - What would women and men multipliers need to reach more clients?
- Evaluating DVM selection criteria to understand whether they inadvertently lead to the exclusion of any types of people (e.g. do criteria related to literacy, land ownership, labour requirements, training arrangements exclude women), and if so, is there a case for adjusting the criteria to make them more inclusive (e.g. if DVMs could include existing farmer groups would it help alleviate some of these issues).



Review Questions

1. What are some of the criteria for vine multipliers?

2. How could those criteria affect women or the poor in some areas of SSA?

Unit 12 – Scaling Sweetpotato Seed Systems

Objectives

- Discuss key components of the innovation package that should be in place to scale sweetpotato seed systems.
- Explain the best times in a project to discuss scaling.
- Define a theory of scaling and list the steps involved in creating one.

Key Points

- **There is no one-size-fits-all approach to scaling.**
- **A seed system is not a single piece of technology, but a system into which many components feed and contribute.**
- **Theory of Scaling is the framework for how scaling can be achieved**

Scaling Sweetpotato Seed Systems

Everyone talks about “scaling”. However, often this is only discussed at the end of a project, leading to unrealistic expectations and limited strategic thinking about the capacities, resources and types of partners required for effective scaling. There is no “one-size-fits-all” approach for scaling; there may be multiple pathways. Monitoring and learning during the scaling process, is important to assess when it is necessary to adapt the strategy to reflect changes in context and conditions.

With seed systems interventions we often start with projects on a small-scale in defined geographical and target group. However, if we want to have impact on more farmers over a wider area we need to assess our level of readiness of different components of the seed system.⁴ This will help us to identify bottlenecks and potential entry points to leverage progress from the current state to a desired state. This is termed a “theory of scaling”. Thinking about scaling can be integrated into project design, budgets and implementation from the start, through identifying strategic scaling partners and expertise.

As we have seen in this module, a seed system is not a specific technology such as a variety, but different technologies, activities and actors which interact together. This can be called an innovation system or package, where different components and conditions need to be in place to support scaling.

An example of this is a cell phone. The cell phone alone is of little value, unless other components of an innovation package are in place.

- Technological innovations: varieties, multiplication technologies, Triple S–
- Market innovation: customer demand for OFSP, and clean seed
- Policy innovation: climate smart agriculture and nutrition sensitive agriculture
- Value chain innovation: sweetpotato processing & product diversification
- Service provision innovation: tissue culture laboratories, seed inspection; public and private extension services
- Mindset innovation: quality diets, healthy living
- Educational innovation: training at scale, using schools, health facilities as entry points, video & radio

⁴ A readiness scale can score the readiness level as an idea is born and then developed through proof of concept, testing under controlled conditions, piloting in the real world until it is ready for widespread use without support from the originators.

- Infrastructural innovation: ICT for seed tracking, marketing
- Technological innovation: hand held computer with mobile operating system, integrated network for voice, messaging & data
- Infrastructural innovation: cellular network
- Market innovation: promotions, incentives to keep up with the latest model
- Policy innovation: telecommunication providers, mobile money transfer
- Value chain innovation: availability of sim cards & air time
- Service provision innovation: providing solar charging sales points for smart phone users without access to power grid
- Mindset innovation: youth are leading use of technology as it is 'cool'
- Educational innovation: spin-offs for app developers; social enterprises use for health & market benefits



The steps involved to prepare a theory of scaling include:

1. Participatory analysis of innovation package: what are the different components needed for the seed system to function. What component may have been overlooked, which is essential for the seed system to be scaled effectively e.g. communication and marketing strategy; or advocacy with policy makers for appropriate seed regulations.
2. Assessment of scaling readiness:
 - a) Component readiness: do the components work as they are supposed to in an operational environment – score low to high readiness
 - b) Extent of use beyond project and partners: is the component being used outside of the project, beyond initial partners, in the wider “livelihood system”? Who is using the component? Is it used by all types of seed producers and seed users, or only particular groups, which may act as a brake on further scaling?
3. Management decision: what components are high in readiness and use; and which ones are low in readiness and use. Are the components which scored low readiness, essential?
 - a) Can they be dropped?
 - b) Can they be substituted? E.g. include other varieties that are well adapted; use of positive and negative selection if virus indexed materials are not available.
 - c) Can they be improved? E.g. training materials need to be translated or converted into video materials. What changes could be made to improve the component for different types of farmers or multipliers
4. Partnership and intervention strategy: who are the scaling partners, and what specific capacities are they bringing e.g. networks of influence, knowledge, advocacy. What will be their roles and what co-investment will they make?
5. Monitoring, evaluation and learning (MEL): how do we know we are moving from our current state to our desired state whereby more male and female farmers have timely availability and access to quality seed. As the readiness of one component improves; another may then become the “weakest link”, and thus actions needed to strengthen that as well.

Review Question

1. What is the Theory of Scaling?
2. What are the steps of preparing Theory of Scaling?

Activities

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

Activity 5.1 Vines for Planting: Clean and Multiplied

In this field activity participants will learn to identify clean planting materials, take vine cuttings, cut them into planting materials, learn how to plant them in a rapid multiplication bed, discuss how to care for them, when and how to plant them out, and calculate vine multiplication rates.

Objectives

Participants will be able to:

- Identify, select and conserve clean sweetpotato planting materials
- Explain the principles of positive and negative selection and preservation of sweetpotato planting materials
- Calculate vine multiplication rates
- Describe how varieties' rates differ



Time

2.5 hours plus travel time to the field and back – best done in morning.

Materials

- Nearby planted sweetpotato field with some virus infected plants
- Half completed nursery bed
- 5 cutting knives
- 2 full watering cans
- 2 hand hoes
- A nearby rapid multiplication plot which had been planted 8 weeks prior to the course with two varieties with different multiplication rates
- Flip chart
- Pens

Preparation

- Make arrangements with the owner of the field for the participants to visit, select and take vine cuttings. It should be a field with virus and weevil problems, so the participants can practice negative selection (i.e. roguing diseased material and discarding unhealthy material and only selecting planting materials which look healthy, and disease and pest free).
- Set up a rapid multiplication plot 8 weeks prior to the course planted with cuttings of two varieties with very different multiplication rates, e.g. 1sqm (50 cuttings) of Variety A, 1 sqm (50 cuttings) of Variety B.
- Set up half a rapid multiplication bed at the field, so the participants can complete it and then practice planting out the cuttings they have taken, shading, and watering it.

Suggested Steps

1. Explain that the group are going to collect planting materials to set up a rapid multiplication plot, as though the on-set of the rains are close. Go to the field.
2. At the field, ask the participants to get into groups of 5 people, and to imagine they were farmer multipliers setting up their rapid multiplication plots to produce planting materials both for their own field and to sell. Ask each group to work in different areas of the field. Give them 5 minutes to walk around together and find some very healthy and some virus infected plants. The facilitator should move between the groups to check they are able to correctly identify the virus

infected plants.

3. Call the whole group together, and ask them 'if they were farmers where would they select their planting materials from?' Use probing questions to ensure they discuss:
 - Selection from clean healthy plants;
 - The need to rogue out any virus infected plants in the field;
 - The process of taking a cutting (which portion of the vine, why we don't use the part of the vine closest to the soil (e.g. Likelihood of weevil infestation), number of cuttings, length of cuttings (e.g. 3 nodes (~20cm) long), best time of day to take cuttings (e.g. Early morning or late afternoon)).
4. Give each group of 5 people a knife and ask each group to cut a total of 20 cuttings each 3 nodes long (~20 cm lengths) from healthy sweetpotato plants, and to bring them to the site of the half prepared rapid multiplication nursery bed.
5. Ask them where they should put their cuttings before they plant them and why? (e.g. in the shade of the tree to keep them cool and fresh). Ask them how they should transport planting materials if they needed to take a large quantity of them by vehicle to a different area (e.g. help them discuss why they should transport them as soon as possible after harvest, and in the early morning when it is cool and in an open truck; using jute sacks or pierced polypropylene sacks to increase ventilation; not squashing the vines by overloading the sacks or truck; labelling the sacks with variety name, harvest date and multipliers contact details; 50 cuttings typically weighing 1kg etc.).
6. Ask the whole group to move to the rapid multiplication plots which were set up 8 weeks before the course. Explain to the group that the two plots (e.g. 1 sqm of Variety A, and 1 sq m of Variety B) have different varieties in them, and that some varieties multiply faster than others. Ask them to cut cuttings 3 nodes long from an area of 50cm *50 cm of the plot of Variety A and an area of 50cm *50cm of the plot of Variety B. They should count how many cuttings of Variety A and of Variety B they obtained from this small area and then calculate how many cuttings of each variety they could obtain from the 1 sqm plot. Use a flip chart to note their findings. Ask them to put the cuttings in the shade keeping the two varieties separate.

Then discuss the different multiplication rates of the two varieties, and how this will influence their calculations about the time, space and start cuttings needed to produce a set amount of planting material. Explain how at 6-8 weeks the vines in the rapid multiplication plot can be harvested, and each of the new cuttings planted out in an adjacent area of the rapid multiplication plot, and then after a further 6-8 weeks they can harvest cuttings from *both the initial cuttings and the second lot of cuttings – (two cycles in 4 months)*; a total of 4 harvests can be made from the cuttings. Ask them what differences they noted between cuttings taken from the farmer's field and those taken from the RMT plot.

The facilitator should explain how QDS/QDPM inspections are done, and the participants could practice assessing SPVD or weevil incidence in the RMT plot. Explain that you will work more on planting material multiplication and dissemination plans and strategies on Day 7 of the course.

1. Show them the half-prepared rapid multiplication nursery bed. Ask them where one should site the nursery bed and why (e.g. somewhere not too far from a water source so it can be irrigated, protected from livestock, easy access for the farmer so they are more likely to monitor it regularly). Ask them to look at the half-made nursery bed and discuss important aspects of it (e.g. the nursery bed should be made of loose fertile soil, raised 20cm above ground level to prevent water logging, farm yard manure or NPK fertilizer (at 100g/m²) can be added to increase fertility and vine production, need to lightly irrigate the bed before planting). Ask them to help complete the nursery bed.
2. Ask two people to show the others how they would plant their cuttings in the nursery bed. After watching, ask the group what the important aspects were: spacing, ensuring at least two nodes were under the soil level, making sure the vine was the right way up etc. Then after discussing

these aspects, ask them to plant the rest of their cuttings in the nursery bed using a spacing of 10cm * 20cm.

3. In their small groups (5 people) ask them to discuss for 3 minutes how they would now take care of the nursery. Then in plenary, ask each group to share one key care taking task. Ensure they mention: irrigation (2 times each day, in early morning or later afternoon), shading, protecting from livestock, monitoring (frequency), roguing of any virus infected plants. Ask two of them to gently irrigate the new cuttings.



Activity 5.2 The Triple S System: Storing in Sand and Sprouting

Objectives

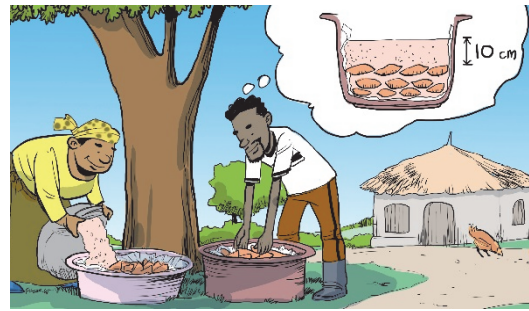
Participants will have experience in setting up the Triple S system.

Time

90 mins

Materials

- 200 sweetpotato roots – some damaged and a range of sizes
- 6 plastic basins
- Newspaper
- 5 buckets
- 5 brooms
- Plus, one Triple S system set-up 3 months in advance of the tot course so that the students can see the sprouting roots



Advanced Arrangements Required

Set up a Triple S system 3 months before the ToT course, so the students can uncover the roots and find them sprouting and can practice planting them out.

Suggested Steps

1. Ask participants to get into 5 groups. Explain that they will practice setting up the Triple S seed system which they have just learnt about in the presentation. Ask them to divide the roots into 5 groups and each group to carry their roots to a different area of the room. Ask them how they will decide which roots to use in their Triple S system. Get them to find some examples of damaged roots, and to explain why they would not use those ones.
2. In their small groups ask them to work together to set up a Triple S system. The facilitator should move around the groups to check they are:
 - Selecting their roots carefully, and using small or medium-sized undamaged roots,
 - Stacking their roots carefully in the container,
 - Letting their sand cool before using it,
 - Covering their roots with a top layer of at least 10 cms of sand.
3. Ask one person from each group to come to a central table and ask them to together explain and repeat the process of setting up the Triple S system as though they were demonstrating it to a group of farmers. The facilitator should watch carefully, and make sure they are following the correct steps and clearly explaining why they are doing what they are doing. At the end, invite a discussion from the whole group about how they could have done their demonstration differently, also ask them to think about when during the season they would set up their Triple S system (*e.g. at the start of the dry season*).
4. Ask two of the participants to explain to the others where they are going to now store their Triple S system, and what monitoring or care (*e.g. cool, dry, safe place, away from children and chickens*) it needs for the next few months, and what they might expect to see changing in it (*e.g. sprouting, and if this happens too early >3 months before the rains are expected then the sprouts can be removed*).
5. Ask another two of the participants to explain what the next steps are before the rains arrive
 - About 6-8 weeks before the rains start, plant the sprouting roots in a nursery bed near the home. The soil needs to be fertile and the area fenced against grazing animals.
 - Bury the whole of the root and sprouts, unless the sprouts are very long. Plant the

sprouting roots at a spacing of 60 x 60 cm (~2 ft x 2 ft) and in a slight depression at a depth of about 10 cm (to help watering).

- The roots should be watered at planting, then twice / week for 2 weeks, then once/week.
 - By the time the rains come, the roots will have sprouted vigorously, and large amounts of planting material can be cut. Just 40 roots can generate ~1,500 cuttings. [10 mins]
6. Bring out the Triple S system which was set up a few months in advance of the ToT course and ask the participants to uncover and take out the sprouting roots. If there is time the group could practice planting some of the roots which had already sprouted.

Activity 5.3 Planning Your Multiplication and Dissemination Strategy

Objective

Participants will design a dissemination program for two different scenarios to reach 5,000 households with clean planting material of known origin.

The two scenarios are:

Scenario 1

El Nino destroyed crop in Northern Zone, relief agency needs to supply 4 kgs of planting materials to each of 5,000 households (HHs) before the next rain season in 9 months' time. Plan.

Scenario 2

Your project aims to improve the vitamin A intake (through OFSP consumption) of a total of 5,000 HHs with children under 5 years old across three dispersed regions of Country X within 3 years, and to build sustainable decentralised seed systems in all 3 of these regions. Each household should receive 2 kgs of two different varieties of OFSP to test. Plan.

Time

3 hrs

Materials

- Flip chart
- Markers
- 35 copies of blank template of sweetpotato activity calendar
- 35 copies of worksheet for calculating your sweetpotato multiplication strategy
- 35 copies of template of sweetpotato dissemination plan

Suggested Steps

1. Explain to the participants that they are going to design a dissemination program for two different scenarios to enable them to reach 5,000 households with clean sweetpotato planting materials. Ask them to get themselves into groups of 8 people, if possible each group should contain an extension worker and if possible a programme manager. Ask the groups to choose a leader and a rapporteur.
2. The groups need to discuss and agree on the following aspects for each scenario:
 - a) When are the rain seasons (approximate start and end dates)?
 - b) Is the area unimodal or bimodal? How long is the dry season – are there rivers, swamps etc. which could be used for planting material multiplication and/or conservation?
 - c) What is the population density? Where are most of the farms located (i.e. close to transport infrastructure for easy distribution)?
 - d) What is the existing sweetpotato seed system?
 - e) What infrastructure and organisations are available to support multiplication activities: e.g. research stations, existing farmer multipliers, NGOs, prisons, private sector multipliers?
 - f) What infrastructure and organisations are available to support dissemination or distribution (e.g. schools, health centres, markets which could be used)?
 - g) What is the most common method of transport (in particular to transport vines: i.e. foot, bicycle, existence of traders for vines and roots)?
 - h) Where are the nearest markets located?
 - i) Which types of sweetpotato are preferred in these markets. Are there any gender or age

differences in preferences? Are there any preferences depending on utilization (e.g. fresh roots, processed)?

- j) Which OFSP varieties have similar characteristics to those preferred by the market?
 - k) Do any of these OFSP varieties with the preferred market characteristics also have virus resistance?
3. Then ask each group to develop the sweetpotato vine multiplication and root production calendar for their target regions. Encourage the participants to work backwards from the start of the rainy season (i.e. when planting material should be available to farmers) to plot when the different steps of their project's planting material multiplication and dissemination activities need to occur. They should work together on a large flip chart version of the calendar first and then transfer this to the A4 handout sheets (see Handout 5.11.3a Calendar).
 4. Explain that each group will develop two different sweetpotato dissemination plans: one for mass dissemination (Scenario 1) and another for annual access through DVMs (Scenario 2).

Scenario 1

The plan for the emergency distribution (Scenario 1) should be able to reach 5,000 households (HH) with 4kgs planting materials/ household within 9 months. They can choose either variety A or B.

Scenario 2

The DVM based strategy (Scenario 2) should be able to reach 5,000 households (HH) with each household receiving 2kgs of planting materials of variety A and 2kgs of planting materials of variety B within 3 years and should have a basis for sustained production of planting material to continue after the end of the project intervention.

Note: Variety A has a multiplication rate of 1:10 after 4 months. Variety B has a multiplication rate of 1:30 after 4 months.

The groups should use the blank worksheet (Handout 5.11.3b) to help with the calculations. They need to complete all the highlighted cells first, and then work step by step through the calculations.

The groups should start by working on answering the questions in the Handout 5.11.3c for each of their Scenarios, they should highlight any challenges they anticipate on a flip chart.

The facilitator will need to move around between the groups and help them to use the multiplication rates (see Box 5.5) in their calculations to determine the timing, size, type, location and number of multiplication plots required. Make sure they also put their information together in a way that can then be briefly presented and shared with the other participants during a short presentation.

1. Presentation of plans. Each group has 10 minutes to present their plans (5 min per plan) to the rest of the participants. Then discuss the challenges the groups faced during the exercise and how they overcame them, what additional information they felt they needed, what differences they saw between the way different groups worked on the exercise.
2. The facilitator can then summarise the session by highlighting the following key points:
 - Develop your sweetpotato vine multiplication plan at least 9 months before you need the planting materials.
 - From the group work we found that key administrative and agricultural information requirements include: population density, population figures per agreed administrative unit; number of extension workers/ work load/ priority crops/ number of farmer groups each extension worker is meant to cover/ transport provision for extension worker/ lunch allowance/ per-diem rate/ availability of in-service training to include sweetpotato in.
 - It is important to understand the different multiplication rates of different sweetpotato varieties and in different locations and under different management and the need to

keep records in order to be able to plan more accurately in future seasons.

- Plan to produce sufficient materials to cover some losses due to drought, pests, livestock, theft, loss during packing, transportation (at least 10%) etc.
- Together with your project's managers and finance team cost each activity in advance to enable you to plan timely availability of funds.

Sweetpotato Agricultural Calendar Handout

Sweetpotato activities	Months													Who does the activity?
	O	N	D	J	F	M	A	M	J	J	A	S		
Short rains														
Long rains														
Conservation of planting materials														
Multiplication of planting materials														
Purchase of planting materials														
Record keeping														
Land preparation														
Ridging														
Planting														
Weeding (1 st , 2 nd , 3 rd)														
Monitoring of crop														
Leaf harvesting as vegetable														
Uprooting of any virus infested plants														
Hilling up														
Piecemeal harvesting														
Final harvesting														
Transporting SP from farm to home														
Transporting SP from home to market														
Marketing of fresh sweetpotato roots														
Preparation of fresh roots for meals														
Sun drying of chipped sweetpotato														
Storage of dried sweetpotato														
Purchase of sweetpotato roots														
Other:														
Other:														

Calculation Grid for Working Backwards from The Number of Cuttings Required by a Certain Time

Months working backwards									
	Target no. of HH & timing	No. of cuttings of variety ...	Multipli-cation rate in a 4-month period	Target no. of HHs & timing	No. of cuttings of variety ...	Multipli-cation rate in a 4-month period	Target no. of HHs & timing	No. of cuttings of variety ..	Multi-plication rate in a 4-month period

Worksheet for Calculating Multiplication Strategy Figures

	A	B	C	D	E	F	G	H
1	No. of cuttings required per household:							
2	Planting spacing = no. of cuttings/ sq m:							
3	Level of multiplication	Proposed size of each multiplication plot (sqm)	Months working backwards	Target no. of households and timing (200 cuttings/hh)	No. of cuttings of variety B	Area required (50pp/sqm)	No. of multipliers needed	Multiplication rate in a 4 month period
4	Farmer root production		Nov-13		—			
5					Step 1. = total no. of cuttings needed = target no. hh x no. cuttings per hh =D4xD1			
6			Oct-13					
7			Sep-13					
8			Aug-13					
9	TMS		Jul-13		—			
10					Step 2. =no. of cuttings reqd at TMS level = no. cuttings reqd by farmers / multiplication rate at TMS level =E4/H9	Step 3. = area reqd at TMS level = no. of cuttings required/ planting density of cuttings =E9/D2	Step 4. = no. of multipliers needed = total TMS area reqd/ size of each TMS plot =F9/B9	
11			Jun-13					
12			May-13					
13			Apr-13					
14	SMS		Mar-13		—			
15					Step 5. =no. of cuttings reqd at SMS level = no. cuttings reqd by TMS level / multiplication rate at SMS level =E9/H14	Step 6. =area reqd at SMS level=no. of cuttings reqd at SMS level/ planting density of cuttings =E14/D2	Step 7. = no. of multipliers needed =total SMS area reqd/ size of each SMS plots =F14/B14	
16			Feb-13					
17			Jan-13					
18			Dec-12					
19	PMS		Nov-12		—			
20					Step 8. =no. of cuttings reqd at PMS level = no. cuttings reqd by SMS level / multiplication rate at PMS level =E14/H19	Step 9. =area reqd at PMS level =no. of cuttings reqd at PMS level/ planting density of cuttings =E19/D2		

Template for Sweetpotato Planting Material Multiplication and Dissemination Plan

What	When	Who	How	Cost
1. Identify target communities and record their sweetpotato vine multiplication, root production and post-harvest activity calendar and varietal preferences and options.				
2. Agree on the scale of your initial planting material distribution. <ul style="list-style-type: none"> No. of districts, No. of households, No. of varieties, Quantities of planting materials/ household Monitoring data requirements Available budget 				
3. Make a calendar (<i>see example in manual</i>) showing when and where the multiplication activities are needed.				
4. Multiplication implementation phase <ul style="list-style-type: none"> Calculate for variety A and/or B <ul style="list-style-type: none"> The quantity of planting materials required for 5,000 households to receive 4 kgs each. The quantity of planting material required if 50 cuttings are planted per m² using for variety A a multiplication rate of 1:10 after 4 months, and for variety b a multiplication rate of 1:30 after 4 months. Calculate the number of months required to provide 5,000 households with 4kgs planting materials for scenario 1. Calculate the timing of DVM multiplication operations to ensure 5,000 have 2kgs of each variety (A and B) within 3 years for scenario 2. Plan timing and scale of land preparation and field activities including harvesting, packaging and labelling. 				
5. Pre-distribution activities <ul style="list-style-type: none"> Community awareness raising on 				

<p>OFSP</p> <ul style="list-style-type: none"> • Group meeting to organise who will receive planting materials and when, & communication strategy • Transport arrangements (vehicle size, timing, destinations & routes) • Community meetings: Advanced notification to communities of exactly when the planting materials will arrive (or when they can collect them), and demonstration of how they should handle and then plant them, and what prior field preparations they need to make 				
6. Distribution				
7. Monitoring				
8. Planning for distribution in subsequent years				

Activity 5.4 Working with DVMs

Objectives

Participants will understand the benefits of and training requirements for a successful DVM strategy.

Time

2.5 hrs

Materials

- A nearby sweetpotato demo plot with two distinct varieties separated, labelled and containing clean planting material
- Second plot with a mixture of clean/ virus infected planting material and mixtures of varieties is required for training
- Flip charts
- Marker pens
- Masking tape
- Copies of the above Handouts



Advanced Arrangements Required

Locate or plant two nearby sweetpotato plots with two varieties planted separately in each. Rogue one to remove any diseased material, leave the other plot in the hope that virus infection and symptoms occur.

Suggested Steps

1. Use discussion and open-ended questions to get the participants to share their understanding of:
 - How to select and multiply disease and pest free vigorous planting material.
 - The point of labelling planting materials.
 - The point of keeping different varieties distinct.
2. Use the pictures in the Handout to stimulate discussion on the challenges associated with vine dissemination. Ensure all participants contribute to the discussion.
3. Explain to the participants that you are now going to visit two sweetpotato planting material nursery plots. Ask them to work in groups of five people, and on arriving at the nursery plots to carefully observe the plants in both plots and to think about why they would choose one of them as a planting material multiplication plot. Ask the participants to select planting material from the two plots and return with them to the learning room. Ask representatives from two of the groups to present their observations and thoughts about the nursery plots and the planting materials in them. Use probing questions to ensure that planting material health, the importance of separating different varieties, and roguing are mentioned.
4. Ask the participants in their groups to think about how they might select a decentralized vine multiplier (DVM) in their target area. (The participants should work in the same groups as for the prior activities when they developed their two-planting material multiplication and dissemination strategies). They should come up with a list of 10 criteria they would use for selecting DVMs and should explain why each criterion is important. They should also think about whether their criteria might exclude any particular groups of the community and whether that could be a problem for their project and how they might overcome that. Ask each group to record their findings on a flip chart (using a table like the one shown below) and then stick the flip charts up on the wall.

DVM Selection Criteria	Reasoning behind that selection criteria	Who might these criteria exclude, and what could be done to overcome that
1		
2		

- The participants should look at each of the flip charts and see whether there are any key differences between groups. (The facilitator can also refer to the DVM selection criteria mentioned in Unit 6).

The whole group should then choose 12 key DVM selection criteria, these should be recorded on another flip chart. The facilitator can then demonstrate how these criteria could be used to identify and select DVMs during a project, or to rank different DVMs to help in deciding which ones to work with.

The facilitator should raise the discussion of whether a project should focus only on existing farmer multipliers or should focus only on training other farmers or entrepreneurs to become DVMs, or whether to use a mixture of the two approaches and why. The facilitator should highlight the problem that many farmers claim to be farmer multipliers and it may be wise for a project to visit the target area at the beginning of the rains and find out who is actually selling planting materials and in what quantities.

- In their groups ask the participants to discuss and identify the training needs they think DVMs would have in order to ensure they could successfully produce clean healthy planting materials. Give the groups 10 minutes to discuss this and make notes on a flip chart. Then go around the groups, asking the first one to present all their ideas, and the subsequent groups to only present any new ideas which have not yet been mentioned by the others. Make a list of these combined training requirements and ensure the participants note it down. Ask them to think about how they might organize this training given the decentralised nature of the DVMs and the need for very practical learning-by-doing training approaches - if they had 4 visits to each DVM (or group of DVMs) when should those visits occur and what should be done in each of them.
- Referring to the previous activity on multiplication and dissemination calculations (Unit 10) ask the groups to calculate the amount of planting material needed for 8,000 households to each receive 2kgs (~100 cuttings) of both Variety A (*multiplication rate 1:10 after 4 months*) and Variety B (*multiplication rate 1:30 after 4 months*) and to then calculate how many vine multipliers (with what sized plots) they will need if they are to achieve this within a 3 year project (Handout 5.11.3b might assist them). Ask the groups to summarise and share the results of their calculations (3 mins per group), highlight any key issues or mistakes that arise.
- Ask each group to select one person to act as a DVM. The others will then interview the DVM on the costs associated with their vine enterprise and use Handout 5.11.4b and Table 5.XX to calculate the profit the DVM is making.
- Ask the participants to raise any problems they faced when using the budget analysis tool, and what suggestions they saw for improving the profitability of the DVM's enterprise.



Handout 5.11.4a.



Handout 5.11.4b.



Glossary

Centralised planting material dissemination strategy: where planting material is mass multiplied at one location typically by a research station or large-scale seed enterprise, and then distributed to a large number of farmers. This contrasts with the decentralised approach

Cuttings: the pieces of vines which are cut off the plant and used for planting the new crop, they are usually at least 2 - 3 nodes long (but the length can vary by variety)

Decentralised planting material dissemination strategy: where a number of sweetpotato vine multipliers (typically located in the farming communities) produce quality planting materials

Dissemination: distribution of planting materials from the vine multiplication site to the farmers

Dual purpose multiplication system: one that is used to produce both sweetpotato vines and roots

Decentralised vine multipliers (DVMs): trained vine multipliers who typically produce vines for sale to farmers in their local area, and may also act as a source of information about sweetpotato agronomy

Farmer-based seed systems: seed systems in which farmers produce and disseminate seed/ planting materials

Multiplication plot: location where sweetpotato planting materials are multiplied

Multiplication rate: the number of cuttings produced from an initial cutting during a set time period (e.g. 4 months). Multiplication rates vary by variety, management scheme, temperature etc.

Negative selection: the removal (by roguing out) of plants with virus symptoms or those that are not true to type in order to leave only the healthy plants in the field

Node: a small bulge on the plant stem from which one or more leaves emerge

Planting materials: in sweetpotato these are the vines and cuttings used to plant the next crop

Plantlet: a small sweetpotato plant produced using tissue culture techniques to help ensure the planting materials are virus-free

Ratoon: a repeat harvest of vines from a group of sweetpotato plants, ratooning can be done up to three times

RMT (rapid multiplication technique): a process used to multiply and produce sweetpotato planting materials very quickly, e.g. first harvest of planting materials within 6 to 8 weeks

Seed systems: cover the integrated series of activities, the different actors and their interactions, and the enabling environment all of which need to function together to enable farmers to access good quality seed. They can operate at different levels and scales from farmer barter-based systems to commercial private companies following strict regulations

Triple S: storage of healthy sweetpotato roots in sand during the dry season and then planting them out prior to the arrival of the rains and watering them to produce planting materials in time for the start of the rains

True seed: seed produced by a fertilised sweetpotato flower, the seed are small, hard and dark brown and will produce a plant that is genetically different from any other sweetpotato plant

QDPM (quality declared planting materials): healthy planting materials produced by trained farmers using a set of agreed standards to help farmers access and plant disease-free productive crops

QDS (quality declared seed): healthy seed/ planting materials produced using a set of agreed standards to help farmers access and plant disease-free productive crops. In this manual the terms QDPM and QDS are used interchangeably

Answers to Review Questions

Unit 1

1. What is a 'seed'?
 - *The cuttings from vines that are generally used to create new plants in sweetpotato cultivation.*
2. What is a "true seed"?
 - *True seed is produced by fertilising the flower of a sweetpotato plant, usually with pollen from another plant.*

Unit 2

1. What are some of the characteristics of Effective Seed Systems?
 - *Producing high quality seeds of a range of varieties; Seeds are available in right quantities to right stakeholders at right times and places.; Seed are affordable; Seed systems work for different climate variations and are tailored to regions that have bimodal/unimodal growing cycles; There is capacity to breed new varieties of seed; Effective disease and pest management is in place.*
2. What is the purpose of "Multi-stakeholder framework for intervening in RTB seed systems" tool?
 - *To support the systematic analysis of seed availability, access, and quality from the perspectives of different stakeholders; To plan a future intervention or to analyze the recent history of one.*

Unit 3

1. Why does exchanging planting materials from farmer to farmer help spread viruses?
 - *Planting materials not tested.*
2. What is tissue-based culture method?
 - *Lab process to remove viruses, 'clean up' of viruses.*
3. What are the recommended sources of healthy seeds?
 - *NARI, private sector seed enterprise producing pathogen tested seed, trained multiplier or farmer groups who obtained their starter materials from NARI.*

Unit 4

1. What methods of obtaining and selecting planting materials are used in bimodal areas vs. unimodal areas?
 - *In bimodal areas use still-growing vines; In unimodal areas use Storage in Sand and Sprouting (Triple S) method.*
2. What is an RMT Nursery?
 - *Rapid Multiplication Technique (RMT) Nursery is used to quickly reproduce pathogen tested cuttings.*
3. How much harvest is it recommended to collect for farmers who grow both roots and planting material for sale?
 - *No more than 1/3 of vines from each plant.*

Unit 5

1. How long after planting can the first harvest begin?
 - *8-9 weeks*
2. What is the key factor in packing vines?
 - *Air flow – using jute sacks, not overfilling sacks.*

Unit 6

1. What are the two methods of preserving seed?
 - *Conservation and multiplication of vine planting materials; Dry season preservation in dry sand (Triple S System).*
2. How is seed preserved in longer dry seasons?
 - *By de-sprouting of cuttings.*

Unit 7

1. What are the advantages of decentralised Vine Multipliers?
 - *Closer to recipients, reduces vine loss; Locally tailored; Good communication between VMs and farmers.*
2. When is single-shot dissemination approach most often used?
 - *In emergencies.*
3. What are some of the reasons to use vouchers for dissemination?
 - *Target certain groups; Provide access to vines at a location different from where the vines are growing; Provide an incentive for farmers to try a new variety; Encourage farmers to learn where the vine multiplier is located, so that they know where to go in the future; Have an easy way to capture data.*

Unit 8

1. What are the important aspects to consider when creating a multiplication and distribution plan?
 - *Linking to local agricultural calendar; talking to local farmers; understanding when and why individual farmers plant, typical sweetpotato managing practices, preferred varieties and characteristics, local sweetpotato value chain, number of households involved and how much each intends to plant; Local soil, water, field management conditions have an impact on planning.*
2. What are some of the factors impacting multiplication rates?
 - *Soil type; Irrigation schedule; Temperature/climate; Growing season length.*

Unit 9

1. What are the three types of seed?
 - *Pre-basic seed is produced by research stations and private seed companies; Basic and certified seed is produced by medium to large scale commercial seed producers; Quality declared seed (QDS) produced by DVM's and farmer groups, it is a seed category not a class.*
2. What is QDS?
 - *Quality Declared Seed - a system of quality and disease control in planting materials to monitor tolerance levels for pests and disease.*

Unit 10

1. What is a business plan used for?
 - *Analyse whether the enterprise will be profitable in his/her specific context; Run the business successfully; Understand how profitability might be improved.*
2. What are SMART objectives?
 - *Specific, Measurable, Achievable, Realistic, and Timebound.*
3. Why is keeping records critical for running a business effectively?
 - *For budgeting and financial analysis, seed entrepreneurs need data to know profit level*

and plan improvements.

Unit 11

1. What are some of the criteria for vine multipliers?
 - *Landowners; Literate; Able to purchase or provide labour; Able to attend time consuming trainings.*
2. How could those criteria affect women or the poor in some areas of SSA?
 - *Women are often less literate than men in some areas of SSA, poor people may not own land or be able to attend trainings.*

Unit 12

1. What is the Theory of Scaling?
 - *Theory of Scaling is the framework for how scaling can be achieved.*
2. What are the steps of preparing Theory of Scaling?
 - *Analyze components that make seed system function; Assess scaling readiness; What components are high in readiness and use? Partnership and Intervention Strategy; Monitoring, Evaluation, and Learning (MEL).*

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Appendix 5

Appendix 5.1. How to Transport, Receive, Harden-Off, Transplant and Manage Tissue Cultured Plantlets

Packing and transporting: Prior to transporting tissue cultured plantlets, the jars or pots of plantlets should be transferred to a slightly cooler room with ambient light, for two days. The jars should then be very carefully packed into big, strong cardboard boxes and labelled clearly with the word 'FRAGILE' and an arrow ↑ and the words 'THIS WAY UP' to clearly show which way up the boxes must be kept. If the plantlets are to be taken across a national border, the appropriate customs forms (e.g. plant import permit, phytosanitary certificate, phytosanitary statement, Standard Material Transfer Agreement (SMTA) and consignment description) need to be obtained and completed in advance to reduce delays and possible loss of materials. All accompanying documents should clearly indicate the registration number of the vehicle carrying the consignment, the number of packages, number of plantlet containers and total number of plantlets per variety in each package and date of dispatch. The documents should be photocopied for presentation during customs clearances.



The vehicle transporting the plantlets must be in good mechanical order, and all windows should be closed during the journey to reduce the entry of dust and air-borne pathogens. Driving speed should be kept between 60-80 km/ hour, emergency funds should be carried in case of a break-down and the journey should be made during the day to make it easier to access any mechanical or logistical requirements. If possible, a technician should accompany the consignment in case of any problems and the recipients contact details should be kept easily available during the journey.

Receiving: A week prior to receiving the plantlets, the recipient should disinfect the screened reception room to reduce the possibility of contamination. The screened reception room needs to have shelves in it to place the containers on and should be around 24-29°C, with evenly distributed light to enable the uniform growth of the plantlets. The purpose of the screened reception room is to provide a clean space for the plantlets to undergo their final hardening-off and recover after their long journey inside the dark boxes. On arrival, the jars should be carefully taken out of the cardboard packing boxes and surface sterilised using an alcohol mist spray. The person unloading the boxes should disinfect their hands and wear gloves to unpack the jars and place them in an upright position on the shelves in the screened reception room.

Hardening-off: If the plantlets appear stressed the jars or pots should be kept closed under high temperatures to maintain the relative humidity high for at least 3 – 7 days before opening. If the plantlets are not stressed, the containers should be kept closed for at least a day; and then using sterile gloved hands the lids can be loosened partially to a quarter open from day 2-4, and then fully opened and transferred to the final hardening shade on the 5th day. This partial opening of the containers gradually lowers the relative humidity, which stimulates growth of the wax layer (protective) coating on the leaves, minimises water loss from the plantlets and maintains sterile conditions.



The final hardening-off process is the most delicate stage as it exposes the plants to dehydration, nutrient loss and root or stem damage. It ensures that: the light is adequately moderated (by having a roof made of palm or bamboo leaves to allow light to diffuse through); care is taken to prevent

rain-damage or heavy winds blowing into the hardening shelter pest-free conditions are maintained especially with regards to cutworms, and plant diseases; compost, soil and potted polythene tubes are well prepared and treated.

In preparation for last stage of hardening, compost soil mixture of 1part forest soil: 5 parts sandy soil is sterilised by heating to kill off all microorganisms and must then be cooled before use. Sterile gloves need to be used when transplanting the plantlets into the polytube.

Carefully remove the plantlet from the artificial culture using forceps, gently wash off the agar from the roots by immersing them repeatedly in clean water until all the agar is completely removed. The roots are then dipped in a solution of fungicide (benlate) dissolved using sterilised water for 3 – 5 minutes. Plant each plantlet in a pre-made hole in the sterile organic compost soil in 10-cm high polytubes, ensuring that at least 2 nodes are below the soil surface, and that the soil is gently pressed around the root base of the plantlet. The planted polytubes are then placed into a wooden plank made frame, and a mist of water spray administered prior to covering the frame with a clean roof polythene cover to help maintain the relative humidity build up within the hardening chamber. It is best to avoid wetting the rest of the plantlet during water spraying and the polythene's tightness and the moisture of the beds are checked daily under high relative humidity growth tunnels maintained by using a clean polythene roof cover over each hardening tunnel. From the third to the 8th day the tunnel is gradually opened more and more, and mist watering continued as the plantlets are gradually exposing them to ambient conditions by removing the roof cover.

Foliar fertilizers should be applied when the plants are well established to stimulate faster growth. Dursban insecticide (or chlorpyrifos) 10g/litre is applied to control cutworms, aphids, and other pests that might invade the plants. Watering depends on the prevailing weather conditions. If it rains there may be no need of watering. The plants are kept in this final hardening-off house for one month.

Transplanting: When the plants are evidently growing vigorously, and have attained at least 4 – 6 new leaves, and do not show any signs of disease, pest or nutrient deficiency they can be transferred to open multiplication beds in the field. The field should be located at least 100m away from any



other sweetpotato crop, and should have well drained soil, be free of difficult weeds such as couch grass and be near a reliable source of irrigation. A pre-planting artificial compound fertilizer (NPK 25:5:5) at the rate of 100 gm per m² can be incorporated into the soil to stimulate vigour especially in sites with marginal soil fertility. The use of organic compost should be minimised at this point due to the risk of it being a source of disease infections. Five rows per bed should be planted at a spacing of 20cm between lines and 10cm within the row

or a total of 300 plants per bed. When transplanting large numbers of plantlets, ensure that adequate labour is available to complete the activity as quickly as possible and thus avoid exposing the young plants to possible infection. In case of dry spells, watering should be done either early in the morning or late evening. Any diseased sweetpotato plants should be rogued out as soon as they



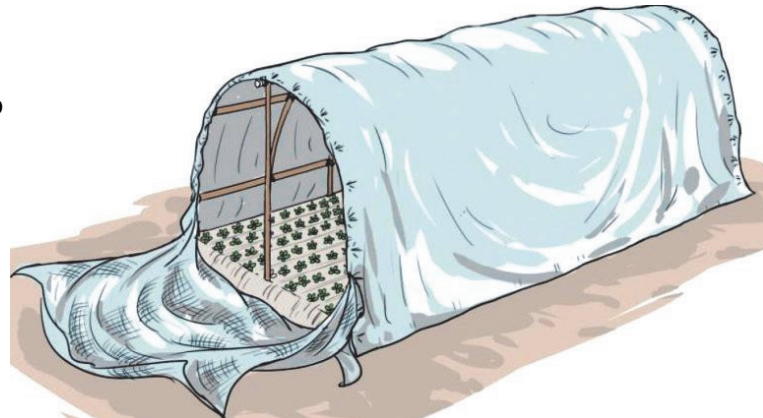
are seen. For a more detailed guide on hardening-off tissue cultured sweetpotato plantlets see Namanda *et al.*, 2013

Appendix 5.2. Construction and Use of Net Tunnels for Quality Seed Production

The lack of clean planting materials is a major yield-limiting factor in sweetpotato production.

Planting material multipliers, who produce and distribute or sell planting materials have to ensure that their planting materials are not infected by viruses or infested by insect pests, otherwise they could act as a source of infection for the farmers who buy and plant the materials.

A net tunnel can be used to keep planting materials clean and uninfected, and to accelerate multiplication rates. This is similar to a greenhouse structure but covered in a fine net instead of plastic. This net tunnel prevents aphids and whiteflies that spread sweetpotato viruses from accessing the covered sweetpotato materials and therefore protects them from being infected with sweetpotato



viruses. Research stations often use large expensive screen houses, but smaller net tunnels can be constructed which are more suited to the needs of community-level vine multipliers. Net tunnel use is an important part of increasing farmer access to quality sweetpotato planting materials in high virus pressure areas. While in areas with low virus pressure, planting materials can be maintained in isolated open-fields.

Instructions for constructing and managing three different but simple types of net tunnels which can be used to keep planting materials clean are given on the following pages (note the use of colour coding to identify the instructions for each).

Net tunnels have been promoted since 2009, and farmers in Ethiopia, Kenya, Mozambique, Nigeria, Rwanda, Tanzania and Uganda have already shown they can successfully use them. In 2017, the cost of constructing one tunnel and purchasing planting material was USD\$ 80 -130 depending on the location. The resulting root yields of varieties from planting materials produced inside the net tunnels are much higher than those obtained from planting materials of the same varieties produced outside the tunnels.

It is important to identify the period of peak demand for planting material and plan accordingly.

Depending on the growing conditions and management vine harvesting can be done 60-80 days after first planting, and the next ratoon (subsequent harvest) after a further 30 to 60 days. Care must be taken not to damage the netting when opening the tunnel. Apical (top) portions of vines at least 3 nodes long should be cut, while leaving some nodes on the remaining stems so they can grow again. If NPK fertiliser is available, after each harvest of vine cuttings, 1 teacup (~200g) of NPK (25:5:5) per net tunnel should be broadcast, to boost regrowth of shoots from the cutstem.

After vine harvesting, spray the tunnel with an insecticide (against aphids and white-flies) before covering again. The synthetic pyrethroid Duduthrin (1.75EC) can be applied at a rate of 10g/ 20 l of water using a back pack or hand sprayer.


The net tunnel protects the planting material from exposure to virus transmitting aphids and whiteflies, so the tunnel



should **ONLY** be opened when harvesting vines, or if weeding is needed. Any holes need to be repaired immediately.

A5.2.1 Which Net Tunnel Design to Choose?

Vine multipliers typically choose one of the following three net tunnel options.

Net tunnel type		Advantages	Disadvantages
A) Flexible wooden stick frame with end-ties (using bamboo or wooden poles)		<ul style="list-style-type: none"> • All materials for constructing the frame are locally available • Cheapest option • Can be constructed on site 	<ul style="list-style-type: none"> • Wood poles are susceptible to termite attack and weather vagaries (<i>depending on the tree species used and management practices this type of frame can last between two-to three years</i>) • Least durable frame of the three options • Permanently fixed – not movable once constructed • Wooden poles can break if bending not done carefully • Deforestation link if young growing trees used
B) PVC pipe frame with zipper or clothing line closing		<ul style="list-style-type: none"> • PVC pipe is easy to bend. • Cheaper than reinforcing bars/rods • Less wear and tear on the netting compared to using wooden sticks • Can be constructed with local labour • Durable and not damaged by termites 	<ul style="list-style-type: none"> • PVC is more expensive than wooden poles and sometimes not easily available • Iron pegs require a hack saw to cut • PVC pipes can lose shape over time under temperature fluctuations
C) Reinforced bar or rod frame, with full-length zipper closing		<ul style="list-style-type: none"> • Most durable of the three options • Does not use binding wire which can damage the netting material • Can be moved easily as a unit to different sites 	<ul style="list-style-type: none"> • Iron rods are more expensive than PVC and wooden sticks • Iron rods must be painted to avoid rusting • Iron rods need to be welded prior to moving to the site • Not user-friendly for irrigation with water cans due to roof shape making it difficult to reach • Welder and tailor required




A5.2.2 Net Tunnel Size and Design

The recommended standard size of one net tunnel is: Larger tunnels can be built, but the recommended size is very stable against wind and other weather factors.

Height	1.4 meters in the middle
Length	3 meters
Width	1.8 meters

A5.2.3 Materials Required to Construct A Net Tunnel

The materials below are required for constructing a net tunnel 3 m long x 1.8 m wide x 1.4 m high.

Net tunnel type >	A) Flexible wooden stick frame with end-ties	B) PVC pipe frame with zipper or clothing line closing	C) Reinforced bar/ rod frame & full-length zipper closing
Materials			
1. Insect proof netting			
Top cover:	4 m x 3 m	4 m x 3.2 m	4 m x 3.2 m
Front end:	2 m x 2 m	2 m x 1.7 m	2 m x 1.7 m
Back end:	2 m x 2 m	2 m x 1.7 m	2 m x 1.7 m
Total quantity will be:	20 m ²	19.6 m ²	19.6 m ²
NB. The most cost-effective way to purchase netting is in rolls. The equivalent of the OPTINET 50™ mesh size netting (0.26 x 0.83 mm mesh apertures) as sold in Kenya is recommended. A roll measuring 100 m x 3 m can make 15 net tunnels and a roll measuring 100 m x 4 m can make 20 net tunnels. Where OPTINET 50™ is not available try other insect proof nets. For instance, in Tanzania the Agronet™ produced by A to Z Textile Mills Ltd can be used. A roll of Agronet™ measures 30 m x 5.5 m and makes 6 net tunnels.			
2. Frame materials¹	30 flexible wooden or bamboo sticks ² , each 3.6 m long with a diameter of 4 cm	8 PVC pipes, each 5.1 m long with a diameter of 2 cm (or ¾ inch)	6 reinforced iron rods, each 10.7 m (or 35ft) long with a diameter of 1 cm
3. Binding wire for tying body frame	5 m	5 m	-
4. Manila string to tie ends of netting	11.5 m	-	-
5. Heavy duty two-headed zipper³ for closing netting	-	1.5 m long	5.2 m long
6. Small padlock for zipper	-	1 piece	1 piece
7. Iron pegs cut from a reinforcement rod	-	16 pieces, each 20 cm long with 1.3 cm (½ inch) diameter	-
8. PVC clothing line⁴ to attach netting to frame on each end	-	6 m	-

¹ PVC pipe is typically sold in 5.1m lengths, and iron rods in 10.7m lengths, they will then be cut to fit tunnel

² Wooden poles can be coated with engine oil to reduce the risk of termite attack

³ Zippers must be heavy duty and of high quality, so they do not rust. Prior to fitting the net covering, the zippers should be firmly tailor sewn onto the net

⁴ PVC coated clothing line made of copper wires is strong and does not rust – this is important.

A5.2.4 Constructing a Net Tunnel

Construction of a Net Tunnel for Protecting Sweetpotato Planting Materials from Virus Vectors

Step 1: Site selection: Select a site that is:

- Near a permanent source of water, so that the tunnel can be irrigated all year-round
- On level/ flat land so that irrigation water will not run-off
- Safe from theft, vandalism, or damage-by-livestock, i.e. as close to one's home as possible. New net tunnels attract curious neighbours, fencing them can ward off livestock and children
- Easily accessible for regular management and monitoring activities
- Not under shade, so as to allow the maximum penetration of sunlight and rainwater, but avoid windy areas which may facilitate mite infestations and damage the structure
- Not heavily infested with weeds especially perennial weeds such as *Digitaria scalarum* or couch grass. Sites with spear grass should also be avoided
- Not near to an old sweetpotato crop which may harbor virus vectors and other pests
- Not exposed to water run-off from old sweetpotato fields. As the net tunnel will be a seed multiplication plot for 2-3 years, it is necessary to avoid any sources of contaminants (e.g. bacterial diseases can be spread through irrigation or run-off water from an old crop)
- The site must have fertile, easy-to-work, well-drained soils and be near a perennial source of water. If soils are poor, mix in 1 wheelbarrow of manure per sq m. Avoid old sweetpotato fields as they will be sources of diseases and pests, weed the area around the tunnel.

Step 2: Site and bed preparation:

- Clear the weeds from the proposed net tunnel site and an area 20 m around it
- Plan to construct one net tunnel per variety to maintain varietal purity. Planting two varieties in one tunnel may increase the virus infection rate, and if the varieties have different growth rates the more vigorous one might suppress and kill the slower one
- The size of the bed for each tunnel should be 2 m wide by 3.5 m long
- If working in a marshy area, prepare raised beds (40 cm high)
- If working in an area that requires frequent irrigation, prepare a basin-like bed (20 cm deep)
- Measure out an area of 1.8 m by 3 m for the tunnel placement
- A few days before planting, mix well-decomposed organic manure into the soil in the bed at a rate of three 20-litre (by volume) buckets per bed (bed size 1.8 x 3 m)

Construction of a Net Tunnel for Protecting Sweetpotato Planting Materials from Virus Vectors

Step 3: Constructing the frame:

for A) THE FLEXIBLE WOODEN STICK FRAME WITH END-TIES NET TUNNEL TYPE

- Bend the 3.6 m long flexible wooden poles (Figure A5.1), and push them into the ground to a depth of about 20 cm
- The distance between the poles along the sides should be 50 cm (Figure A5.2). You will likely need to join two poles (each 3.6m) to make one arch (14 poles to make 7 arches).
- Place two vertical 1.7 m long wooden poles at each end (front and back) and one 3 m long pole along the top (Fig. A5.2)
- Use the binding wire to connect the vertical end poles and all the bent poles to the long central top pole for increased stability

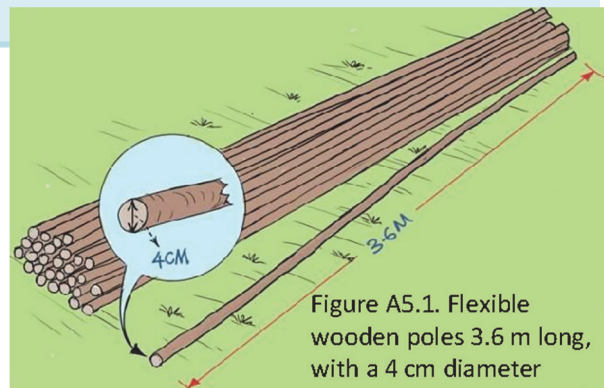


Figure A5.1. Flexible wooden poles 3.6 m long, with a 4 cm diameter

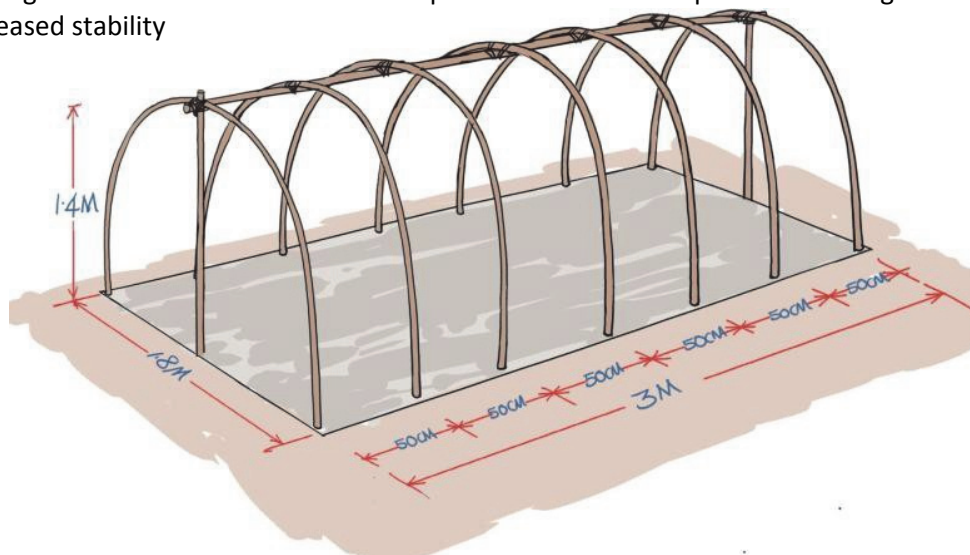


Figure A5.2. The flexible wooden poles are curved over into arches to create the structure (NB. 14 poles will be used to create the 7 arches, as you will need to join two poles to make each arch)

- Then place four additional 3 m long poles lengthwise on the sides and tie them with iron binding wire to the frame at the points where they cross the bent poles. If such long poles are not available, two shorter poles can be joined, but they should overlap by at least 50 cm to make the joint strong (Fig. A5.3)

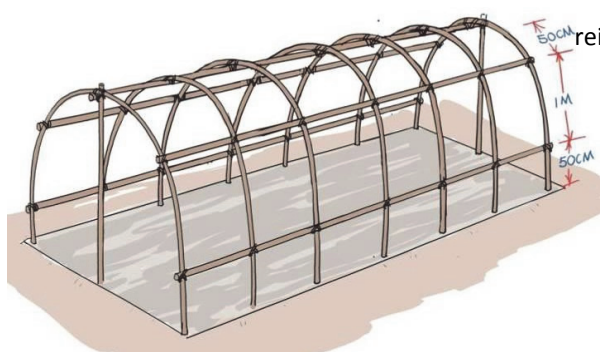


Figure A5.3. The stability of the tunnel is improved by reinforcing it with extra horizontal poles along each side

Step 3: Constructing the frame:**for B) PVC PIPE FRAME WITH ZIPPER OR CLOTHING LINE CLOSING TUNNEL TYPE**

- Push the ½ inch iron pegs into the soil to a depth of about 20 cm at intervals of 50 cm along each side of the bed. An additional iron peg should be put at the centre of both the opening and closing ends. The iron pegs will fit inside the PVC hollow pipes, assuring their stability
- Drive one straight PVC pipe measuring 1.5 m long onto the central pegs at both the opening end and closing ends. Ten centimetres of the PVC pipe should be below ground with the iron peg inside it leaving 1.4 m above the ground
- Lay a 3 m PVC pipe on top of the two vertical pipes and fasten with binding wire
- Fit the 3.6 m long PVC pipes onto the iron pegs along both sides of the bed making each into a smooth curve. Repeat this to make a total of seven arches (Fig. A5.4)
- Once the semi-circular structure is completed, attach one 3 m long PVC pipe along each side at a height of 80 cm above ground. Some farmers wait until the tunnel is planted before attaching the horizontal pipe (Figure A5.5)



Figure A5.4. Seven PVC arches



Figure A5.5. A complete net tunnel body frame with 3 m long horizontal PVC pipes on each side

Step 3: Constructing the frame:**for C) REINFORCED BAR OR ROD FRAME, WITH FULL-LENGTH ZIPPER CLOSING TUNNEL TYPE**

- Identify a welder who can construct the frame
- Using pairs of wooden or iron pegs, map out on the ground the semi-circular shape that each iron bar/rod needs to be bent into (Figure A5.6). The rod is bent into the correct shape, placing it through the paired pegs. The process is then repeated for another six rods/bars
- Then two pieces of the remaining rod are cut for the ends each 1.4 m long, and three pieces cut to 3 m long to go along the sides and top
- All the pieces are welded together into the tunnel shape. NB they are not tied with binding wire. The welded frame is transported to the desired site for the tunnel

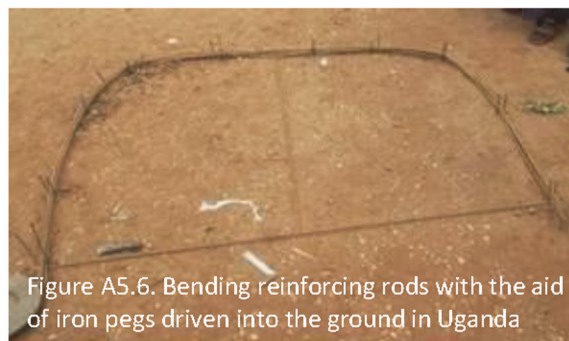


Figure A5.6. Bending reinforcing rods with the aid of iron pegs driven into the ground in Uganda

Step 4: Planting inside the frame

- Source cuttings from mother plants that have been tested and are known to be virus-free,
- e.g. from a research station or tissue culture laboratory. Each vine has bumps along it called nodes, and each node can generate roots.
- Cut each vine into pieces that are two to three nodes or 10 – 15 cm in length (Figure A5.7). Note that different varieties have different distances between their nodes.
- When planting, leave 10 cm between each plant within a row, and leave 20 cm between rows (Figure A5.8). If using three-node long cuttings, two nodes should go under the soil and if using two-node long cuttings, one node should go into the soil. Leaving 20 cm between rows, plant 9 rows with 30 plants per row (plant population total of 270) in the tunnel.

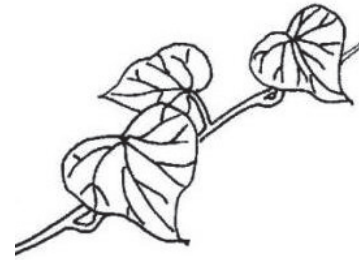


Figure A5.7. Cutting showing leaves emerging from each node

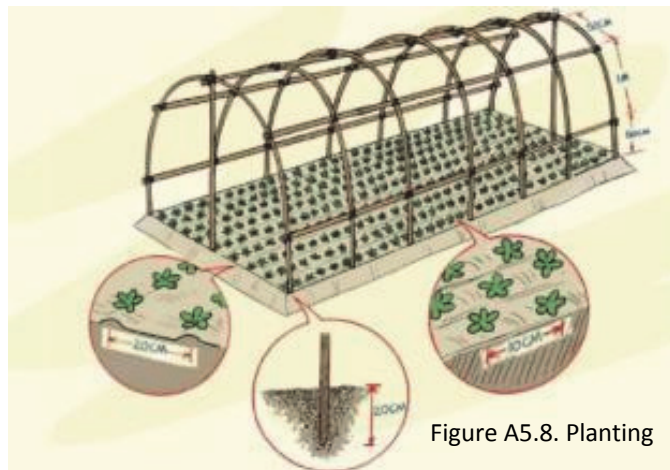


Figure A5.8. Planting

Step 5: Covering the tunnel

Sizes of netting required for the different tunnel type options:

A) Flexible wooden stick frame with end-ties	Cut netting into three pieces: Two pieces of 2 m x 2 m, plus one piece of 4 m x 3 m
B) PVC pipe frame with zipper or clothing line closing	Cut netting into three pieces: Two pieces of 2 m x 1.7 m, plus one piece of 4 m x 3.2 m
C) Reinforced bar or rod frame, with full-length zipper closing	Bring a competent tailor to measure the dimensions of the iron rod net tunnel frame, noting that 20 cm of extra netting will be needed to go into the soil on each side. The tailor will place the zipper as shown in the figure below and sew all the netting pieces together as one unit to fit over the top of the tunnel.



Fitting the netting on the different tunnel type options:

A) Flexible wooden stick frame with end-ties



Fig. A5.12. Tying the end pieces of net together



Fig. A5.13 Rolling net on wooden stick before covering with soil

Put the larger piece of netting on top of the tunnel frame such that there is an extra 20 cm extension of the netting beyond that which reaches the ground on all sides (Figure A5.10).

On each side, where the net tunnel touches the earth, place a pole along the length of the respective side and then cover it with 20 cm of soil, to make it storm-proof.

Place each end piece of netting on the frame as if it were a diamond (Fig. A5.11). Then using the manila string (each piece 3.5 m long), make a strong knot on each side of the front piece and on the top.

Take each string and tie the other end to the same location on the diamond shape piece on the back end (Fig. A5.12). For the bottom part on the front and back ends, take a wooden stick 1.7 m long and roll the netting on top of it, making sure it is level with bottom of the raised bed. Then cover with soil (Fig. A5.13).

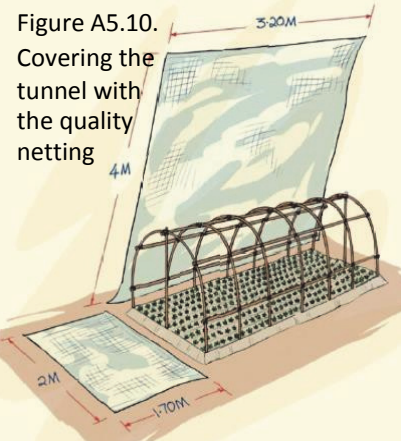


Figure A5.10. Covering the tunnel with the quality netting

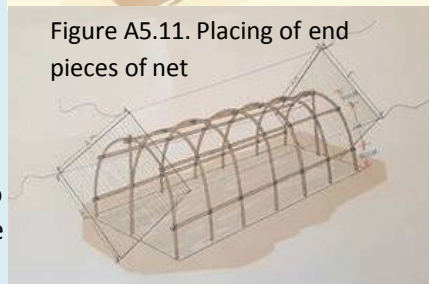


Figure A5.11. Placing of end pieces of net

B) PVC pipe frame with zipper or clothing line closing



Fig A5.15. Front piece with semi-circular zipper for opening

Put the larger piece of netting on top of the tunnel frame such that there is an extra 20 cm extension of the netting beyond that which reaches the ground on all sides (Figure A5.10).

On each side, where the net tunnel touches the earth, place a pole along the length of the respective side and then cover it with 20 cm of soil, to make it storm proof.

Leave at least 10 cm allowance of extra netting at front and back to connect with front and back cover (Fig. A5.14).

Holding the end piece on the frame as if it were a square, close the back piece to the main netting piece using the PVC clothing line. Take the 1½ m zipper and front piece to a tailor and explain that you want a semi-circular installation as shown in Plate A5.15. This design permits a person to enter the net for cutting the vines, without damaging the tunnel. After the tailor has returned the piece, fix it to the main netting and frame using the PVC clothing line.



Fig. A5.14. Netting laid over frame with 20 cm allowance at ground level, and 10 cm at front and back

C) Reinforced bar or rod frame, with full-length zipper closing	After placing the net on top of the iron frame, place fired bricks around the outside of the tunnel to retain the shape of the bed and add sand between bricks and the netting to hold the netting firmly on the ground. Use of bricks is optional but netting must be covered to make it storm proof.
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Step 6: Management recommendations for net tunnel planting material production

6.1 Irrigation

- Irrigate immediately after planting, and then lightly irrigate daily for 15 days until establishment.
- Frequency of irrigation after establishment should depend on prevailing weather conditions. Do not irrigate during the rainy season if rains are consistent as this might lead to waterlogging. But the tunnel should be irrigated each day (early in the morning, or late afternoon) when there has been no rain.
- If you have just a few tunnels use a watering can and apply water over the top of the net tunnel (i.e. do not open the net tunnel to water). Watering should be done in the early morning and/or late afternoon.
- A drip irrigation system is likely to be more practical if you have many net tunnels and large-scale production

6.2 Fertiliser application

- After each vine harvest add NPK (e.g. 25:5:5)⁵ fertiliser to boost regrowth of shoots from the cut stem at an application rate of 200 g/net tunnel. The fertiliser can be broadcast. This is equivalent to 1 level teacup full of fertiliser.

6.3 Pesticide application

- If pests (such as, caterpillars) are spotted in the tunnel, apply a pesticide such as one containing Cypermethrin inside the tunnel and then keep the tunnel carefully closed. Any pesticide should be applied per the manufacturer's recommended rates and guidelines for safe use and disposal.

6.4 Weed management

- If affordable, the use of black polythene sheeting as a mulch can effectively suppress weeds without affecting vine growth.
- Applying a mulch of rice husks after planting can also effectively suppress weeds (see picture below).
- Uproot all weeds and re-apply the mulch during each vine harvest.
- If weeds become a big problem during the vine production, open the net tunnel and uproot weeds. Ideally the net tunnel is only opened at vine harvest and weeding can then also be done, and before re-closing the tunnel a pesticide can be sprayed inside it to kill any insects that had entered while the tunnel was open.
- Also prior to construction and then each week remove any weeds emerging around the net tunnel



6.5 Repair of any holes in netting

- Remember it only takes a small hole for aphids or white flies to enter!
- Check the net tunnel regularly (at least once per week) to identify any holes or problems.
- Use a normal household needle and the type of thread used for shoe repair to sew

⁵ Consult extension staff for locally available fertilizer formulation.

up a damaged net. This can be combined with a patch of a small piece of net, cut carefully from the edges of the existing net or sourced from elsewhere. Apply pesticide after repairing the net.

6.6 Vine harvesting

- Cut apical (top) portions of vines, at least 10 cm above the soil level, leaving some nodes on the remaining stems to sprout again.
- If some plants in the tunnel have dried up, use cuttings from the harvested material to fill the gaps. If plant vigour has reduced, uproot all the
- plants and replant using cuttings from the same material or get new clean planting material from a research station or tissue culture laboratory.
- Harvest at the appropriate time (60 to 80 days after first planting) (Figure A5.17) to avoid intertwining of vines that increases the likelihood of damage to the plants during harvesting. The next ratoon (vine harvest), can be done after 30 to 60 days, depending on weather conditions and management.



Figure A5.17. Ready-to-harvest planting material in a net tunnel, Nyasenga village, Mwanza, Tanzania

6.7 Replenishment of net tunnel material using tissue culture-derived plantlets or cuttings

- With good management, the planting materials in the net tunnels can be used for two years after which new generation one virus-free cuttings or tissue cultured plantlets should be obtained and planted.

6.8 Labelling and record keeping

- Label each net tunnel or open-field multiplication plot clearly, indicating: i) date of planting, ii) source, iii) generation and iv) name of the variety.
- Keep a record of all harvesting dates and the number and weight of each variety cut to monitor the productivity of your tunnel.

6.9 Marketing and awareness creation

- Inform local leaders and farmers about the purpose of the net tunnels e.g. through local administrative meetings.
- Encourage farmers to place advance orders for clean planting material.
- Host field days to demonstrate the benefits of using clean planting material to obtain higher yields.

Find the full Constructing a Net Tunnel Guide here

http://1srw4m1ahzc2feqoq2gwbbhk.wpengine.netdna-cdn.com/wp-content/uploads/2017/10/hres_Brochure-NET-TUNNEL-2017-1.pdf

A5.2.5 The Cost Benefits of Using the Net Tunnel Technology

Research into the use of net tunnels for sweetpotato planting material production began in Kenya in 2009. Net tunnels were found to produce an overall net benefit of USD\$ 839 in a 33-month long period (determined by yields of planting materials from net tunnels versus open-field produced planting materials).

On average, one net tunnel generates 1,750 to 1,980 cuttings per harvest.

In 2017, the cost of constructing a tunnel ranged from USD\$ 80 to 130, depending on country conditions and the option selected. This includes the initial planting materials.

Production costs are heavily influenced by the cost of watering the tunnels and the price of the initial pre-basic seed. As research has expanded to Rwanda, Tanzania, Uganda and Nigeria the findings have reinforced the value of the use of net tunnels in high virus pressure areas.

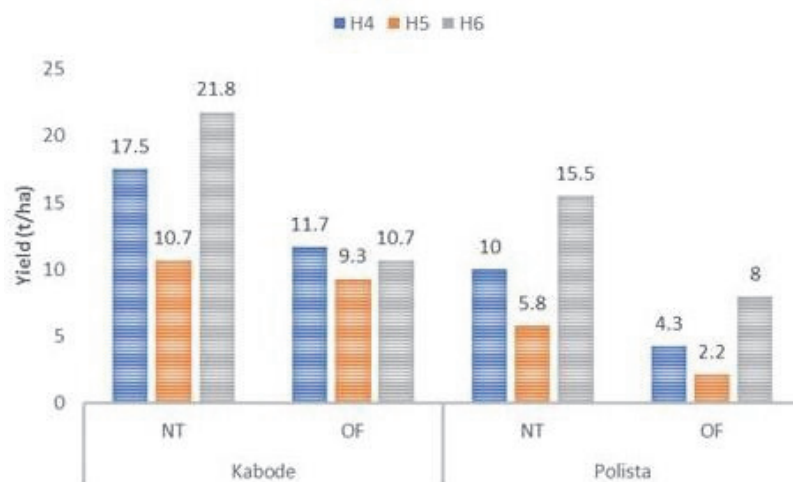


Figure A5.18. Storage root yield comparison between cuttings from net tunnel (NT) versus open-field planting materials in a high-virus pressure area of Tanzania (Mwasonge) for different generations (H4- H6) for Kabode and Polista varieties

Significant yield increases were seen in Tanzania even after six generations (H6) between root yields from net-tunnel (NT) versus open-field (OF) sourced sweetpotato planting materials (Fig. A5.18⁶).

In Nigeria, after two seasons, yields were still 100-200 % higher in net tunnel sourced planting material versus open-field materials (Figure A5.19).

Yield difference benefits are greatest for virus-susceptible varieties.

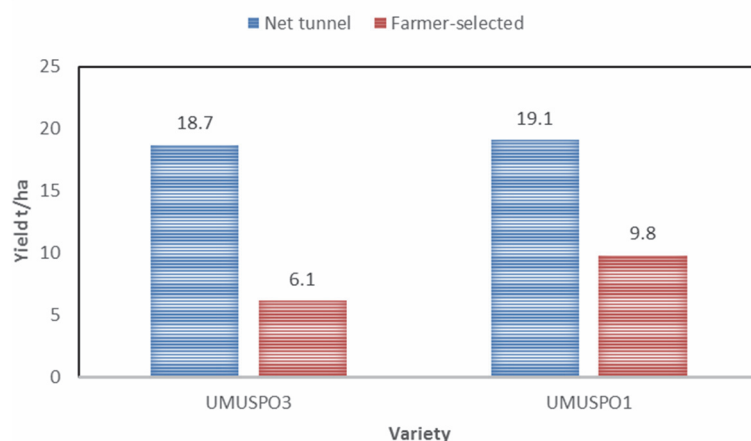


Figure A5.19. Storage root yield comparison between planting materials from net tunnel (NT) cuttings versus open-field in a high-virus pressure area of Nigeria (Umudike)

In Tanzania, due to the high cost of pre-basic starter material and irrigation, it is recommended to multiply the net tunnel seed twice using rapid multiplication in the open-field before selling. By that time, the multiplier will have 31,500 cuttings (30 cm each). In Nigeria, one multiplication after harvesting the net tunnel was sufficient for generating profits.

⁶ Data presented was from the last three generations (H4 – H6) of a study that was conducted over six generations. The aim was to compare yield performance of planting material sourced from the net tunnel and multiplied in the open-field once with that maintained in the open-field throughout.

Appendix 5.3. Status of Sweetpotato Seed Standards Across Sub-Saharan Africa

In some countries a similar system to QDS is being piloted for vegetatively propagated crops. This was initially referred to as Quality Declared Planting Material (QDPM) by the FAO but is also referred to as QDS⁷. An overview of the status of sweetpotato seed standards in selected SSA countries is shown below.

Table 5.2 Status of sweetpotato seed standards across sub-Saharan Africa (as of June 2017) *

County	Status
Ethiopia	Approved 2015. Under implementation.
Kenya	Recently included under schedule two in the Kenyan law (Cap 326) which warrants mandatory certification of vines (seed). Yet to be circulated for use. N.B. Kenya does not recognise quality declared seed as a class or category of seed.
Malawi	Draft certification standards and protocols for root and tuber crops reviewed in June 2016. The recommendations were included in the country's Seed Act and Policy and are awaiting government approval.
Mozambique	Protocol for seed quality control and genetic purity of sweetpotato varieties finalized. To be submitted to the Ministry of Agriculture for approval.
Nigeria	Undergoing stakeholder consultation. Burkina Faso Inspection protocol was validated in April 2017 and sent to the National Seed Service for approval.
Rwanda	Stakeholder consultations completed. The Rwanda Standards Board (RSB) has submitted the proposed standards for approval.
Tanzania	Approved in January 2017. Ready for implementation.
Uganda	Technical guidelines for inspection and certification of sweetpotato planting material in Uganda completed in consultation with Makerere University, National Agricultural Research Organization (NARO), International Potato Center (CIP), HarvestPlus and Ministry of Agriculture, Animal Industry and Fisheries (MAAIF). The guidelines have been tested by the Crop Inspectors from MAAIF.

**Contact the Ministry of Agriculture and national seed regulatory body (National Plant Protection Organisation) in your country to obtain a copy of the sweetpotato seed standards and inspection procedures; and information about how to register as a seed producer.*

⁷The use of the terms QDPM and QDS differs between countries, but in this manual, they are used interchangeably

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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