Everything You Ever Wanted to Know about Sweetpotato

Reaching Agents of Change ToT training manual

VOLUME 3

Topic 5: Sweetpotato Seed Systems

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Reaching Agents of Change ToT Training Manual

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Foreword

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

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

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

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

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

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

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

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Acronyms and abbreviations

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

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

Contents

How to use this manual

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

TOPIC 5: SWEETPOTATO SEED SYSTEMS

IN

EVERYTHING YOU EVER WANTED TO KNOW ABOUT SWEETPOTATO

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Topic 5: Sweetpotato Seed Systems

5.1 What do we mean by the term "seed"

There is often confusion regarding how different people use the term 'seed'. Throughout this manual, when we refer to sweetpotato seed, we are referring to cuttings from vines (often also referred to as planting material) which are used vegetatively (or clonally) to produce (or propagate) another sweetpotato plant. 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 but they are typically at least 3 nodes (≥20 cm) long.

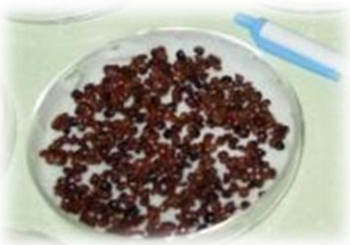
There are two broad methods currently used for obtaining these planting materials. One is to obtain vines from growing plants, for example, from an existing field crop or a crop grown especially for the production of planting materials/ vines. The other is to obtain them from sprouts growing from storage roots; these sprouts are then used as planting material.

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 in order to supply cuttings at the start of the rains. Alternatively, volunteer plants which grow from roots left over in the field after the previous harvest provide a late crop of cuttings some weeks after the rains begin. Farmers normally obtain vines for use as planting materials from their own or their neighbours' fields, purchase of planting materials occurs most frequently in drought prone areas or when there is a market for roots.

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. However, true seedlings are not commonly found in the field for several reasons: many varieties rarely flower, most varieties need to be cross pollinated yet crops may be just one variety, and seeds may remain dormant for many years, during which time they are subject to mortality. 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

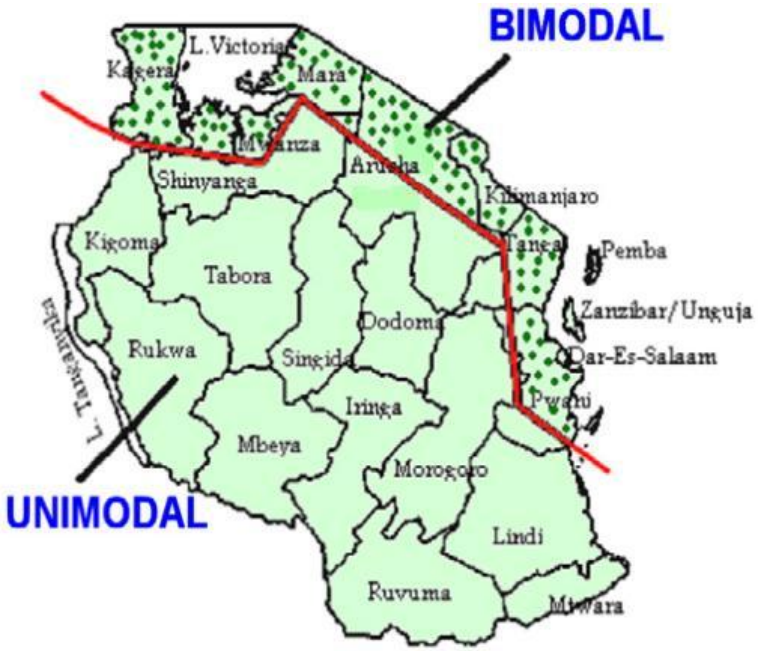


Botanical or 'true seeds' of the sweetpotato plant

5.2 Seed systems

Seed systems are required for all crops. If effective they provide farmers with sufficient quantities of vigorous disease-free planting material of the required varieties at an affordable price and in time for the planting season. 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. There needs to be capacity within the seed system to securely maintain pure disease free seed, to generate new varieties with attractive characteristics, and to multiply and disseminate seed. In societies where sweetpotato is considered a "woman's crop", seed management practices and knowledge are normally in the "women's realm". The gender context and dynamics of existing seed practices need to be understood to determine who we work with and how.

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. Temperature can also be important in the production of planting materials as sweetpotato grows between 15°C and 33°C, with optimum growth between 20°C and 25°C. It is not productive below 10°C, while warm temperatures combined with good soil moisture may encourage vine growth. Highest root yields are obtained when day time temperatures are 25°C to 30°C and night temperatures are 15°C to 20°C.



Bimodal and unimodal rainfall areas of Tanzania

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. 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 foliage. Other 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 areas farmers purchase planting material from those male and female farmers who have good access to water and who specialise in the supply of planting materials as a business. There is typically competition for use of these wetlands for other horticultural enterprises. Little is known about the details and scale of supply of sweetpotato planting materials of these existing specialist farmer multipliers. The cost of this planting material can often be quite high making it difficult for most farmers to purchase large amounts of it. In situations where farmers are unable to access planting materials from their

previous field crop, women face gender related constraints in accessing seed from off-farm sources. Compared to men, women farmers have more limited time and less access to labour and cash which influences their vine sourcing strategies. In addition, women are less mobile than men and tend to have to rely on their husbands or other male family members to access vines from further away distances, 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, in particular, may be forced to reduce their planned field size and to plant planting materials which they consider sub-standard. Therefore, timely access to planting material and distribution of improved sweetpotato varieties are major constraints to sweetpotato productivity in Sub-Saharan Africa.

Few, if any, projects and organisations working on improving sweetpotato seed systems in areas with a prolonged dry season have involved the existing farmer multipliers of planting materials, although there are clearly opportunities to better understand, build on or improve their current practice. Instead most tend to organise their own seed systems to supply clean, vigorous planting materials of particular varieties to their target communities. This can be done in a number of ways: from supporting an existing or setting up a new planting material mass multiplication and dissemination unit, to training several farmer groups or individuals located across a wider geographical area and in local communities to multiply and locally disseminate planting materials. A range of different multiplication and dissemination strategies with various degrees of commercialisation and decentralisation are discussed in detail in section 5.6. 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.

In 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 ensuring: that cuttings are obtained from disease-free plants and ensuring any clearly virus infected plants are rogued out (pulled out) of the supply materials; varieties are available that meet farmers' and consumers' needs; cuttings are only taken from the apical (tip end) of the vines to avoid the chances of them containing weevil eggs. In areas with a prolonged dry season, in addition to the above improvements the seed systems has to 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.

5.3 How to identify 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 very short shelf-life. Further, sweetpotato planting materials are seldom subject to any formal quality standard checks, often exchanged directly from farmer to farmer, and may be infected with viruses or infested with pests.

As already discussed in Topic 2, sweetpotato plants in Sub-Saharan Africa may be infected by virus diseases which can seriously reduce their yields. When planting a field of sweetpotato you want to start with clean healthy planting material, in order to give your sweetpotato crop the best chance of remaining healthy and producing a high yielding crop of sweetpotato roots and leaves.

So how can we select clean planting materials? We can use positive and/or negative selection methods which are used by potato seed producers. The idea is as follows:

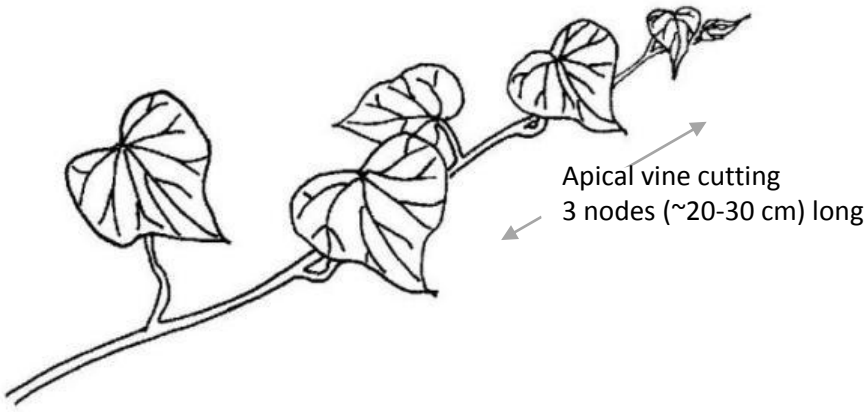
1. Positive selection is only practiced occasionally by seed multipliers since it requires growing the crop for production, and monitoring performance during the season and at harvest. It is done by selecting plants which appear healthy, true-to-type (both roots and foliage have the shapes and colours expected of the variety) and which produce good yields of storage roots at harvest. At harvest time of a field used for positive selection planting material may be taken by saving storage roots for sprouting (Triple-S method – see section 5.5.2) or vine cuttings (if these are still vigorous).
2. Negative selection is practiced routinely during vine multiplication by roguing out (removing) plants showing virus symptoms so as to leave only healthy, vigorous plants in the multiplication plot. Roguing of virus-infected plants helps prevent the disease from spreading to the other plants. (Note: details of how to recognize virus and pest infected plants are given in Topic 7)

Planting materials from vines

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 node long (~20-30 cm) portion of vines of healthy looking plants as planting material

When selecting the planting materials, use the top/ apical 3 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.



Planting materials from starter roots

When selecting roots to use to produce sprouts, you can use positive selection by selecting roots from healthy, high yielding, true-to-type plants. In addition a further selection phase is needed. Lay the harvested sweetpotato roots outs and carefully select small to medium-sized roots which are undamaged. Be particularly careful that they are free from sweetpotato weevil damage, as if the weevil has laid eggs in them the eggs can develop into larvae, pupae and adults during storage and destroy the stored roots and next season's planting materials!

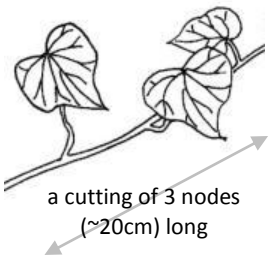
5.4 How to rapidly multiply your planting materials

The amount of planting material you require depends on the size of the area you wish to plant with sweetpotato. However, many farmers do not manage to plant their planned area of sweetpotato as they do not have and cannot access enough planting materials. Some farmers sequentially plant small parts of the planned area depending on availability of vines and labour for land preparation and planting, and the pattern of rainfall.

If you set up a nursery to conserve sweetpotato vine planting materials during the dry season, it is likely that you will still need to further multiply these vine planting materials so that you have enough cuttings to cover your planned sweetpotato crop area. If you are planning to sell planting materials at the start of the rainy season, this rapid multiplication process can be very useful.

However, it should be noted that whilst a few farmer multipliers may focus solely on vine production in order to sell the planting materials, most prefer to have a dual purpose system where they produce enough planting materials to sell but also are able to harvest a few roots (albeit small ones) from the same plot. For a successful dual purpose system the farmer multipliers have to use a different (slightly wider) spacing than those who are just interested in producing vines only.

Farmers have found that for rapid vine multiplication, cuttings of at least 3 nodes (~20cm length) are preferred to shorter ones of ~10cm length. The longer cuttings have a higher survival rate and their management requirements are lower than for the very short 10cm cuttings.



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 production plot can greatly increase your vine production.

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. However it must be remembered, that excessive vine production causes reduced root formation, so there is a trade-off. Beware of applying too much nitrogen if you want to harvest roots.

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.

Make sure the soil is wet before applying any fertiliser.

Urea: Making sure the soil is already wet, apply the 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: as urea contains only nitrogen it will not help increase your root yield at all. It is worth experimenting with different application rates.

NPK: 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. Some of the pre-planting rates which have been used successfully by farmers include: 25g of NPK 25:5:5 per square metre, or 42g of NPK: 23:21:0 +4S per square metre (note: 42g is a full matchbox). It is worth experimenting with different application rates.

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.

Well decomposed manure or compost: Pre-planting incorporation of an organic manure or compost can also be effective in increasing vine production.

5.4.1 Rapid multiplication of planting materials

Rapid multiplication is a technique used for overcoming the problem of otherwise low multiplication rates of vegetatively propagated crops such as sweetpotato and cassava. Through this technique, planting materials that are in short supply are increased rapidly, to ensure sufficient planting materials for timely planting in the field.

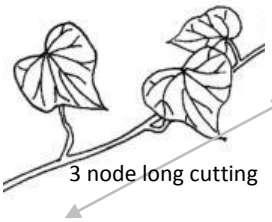
Preparing and managing a rapid multiplication nursery

Bed size: A standard rapid multiplication bed is 1m wide by 5m long, with 50cm space between beds. Use 50 cuttings per square metre, so in a 1m x 5m bed you will plant 250 cuttings.

Site selection and preparation: Choose a site for the rapid multiplication nursery bed that is close to a water source to make the irrigation easier. Sandy loam soils are generally good for vine multiplication. Prepare a rapid multiplication nursery bed using loose soil mixed with fertiliser, compost or manure (see Fertiliser recommendations in Box 5.1 above for details). If you are using mature farmyard manure, make sure 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. The nursery bed should be raised about 20cm above ground level, and sited across the field slope so it will not be affected by run-off and soil erosion. Long, narrow beds of 1m width allow for easy management. Light irrigation should be applied prior to planting.

Cuttings: Only cuttings taken from healthy, disease and pest-free vines of two to three month old plants should be used. Avoid using vines from older plants as they are more likely to be infested with viruses or insect pests. The vine is cut into pieces/ cuttings of 3 nodes (~20cm) in length. Each cutting should be three nodes long (a node is the bump at which the leaves branch off). The leaves can be removed from the cutting so that just the stem is planted; removing the leaves helps to reduce the surface area through which water may be lost from the cutting, and remove the apical dominance of tip cuttings which leads to more sprouting and vine production.

Do NOT take cuttings from diseased plants



Planting: The 3 node (~20cm) long cuttings should be planted upright or at a slant at a spacing of 10cm x 20 cm, with at least two of the nodes buried under the soil, to encourage faster plant growth. This planting layout uses about 50 cuttings per m^2. 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). Protect the nursery bed from livestock damage.

Recently planted planting material multiplication bed

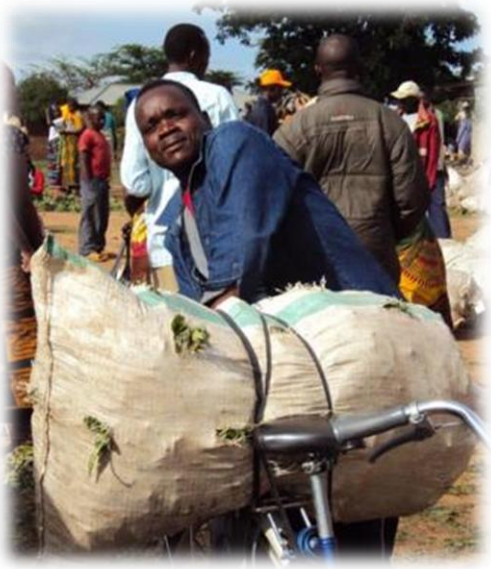
Management: Periodically remove any weeds by hand. Check carefully for any diseased plants and rogue (pull out) any that you find. Fill any gaps with new cuttings to try and maintain the optimum plant population density of 50 plants per square metre. Check the cuttings are well covered with soil,

and cover over any that have become exposed during the watering. If you have used cuttings of several different varieties make waterproof labels and put them next to the correct bed to show which variety is in it and the date it was planted.

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 3 nodes (~20-30cm) long. Do not cut right the way down to ground level, leave at least 15cm 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.

If the nursery bed is well maintained, a second set of cuttings can be taken from it a few weeks later. This practice is called rattooning, and may be done up to 3 times. Often at the first harvest, the cuttings taken are then planted out in an adjacent rapid multiplication bed, so that the quantity of planting material eventually obtained after a further 6 to 8 weeks is much greater. For example, if after 6 to 8 weeks, the original cutting has produced a vine long enough to cut into 3 cuttings, and these 3 new cuttings are then planted out, after a further 6 to 8 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.



Packing vines: Jute sacks are better than the grain (polypropylene) sacks as they allow more air movement. If using grain (polypropylene) sacks, pierce them to increase air flow. Do not overfill the sacks or you will damage the vines. **50 cuttings typically weigh about 1kg**, and cuttings are often distributed in 4kg / 200 cuttings lots. There will be some variation between different varieties. 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.

Transport of vines: Take care when loading sacks 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 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. 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 vine cuttings needing to be transported, or the field not being ready yet, then the vine cuttings can be kept, but only for a maximum of 2-3 days. It is best to remove most of the leaves on the cuttings leaving just a few at the tips. 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 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 (e.g. Imidacloprid) before planting.

5.4.2 Quality Declared Planting Materials (QDPM)

Most countries have a legally based seed certification system for cereal crops such as maize and wheat. 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 can be 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 commercialized 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. This is called Quality Declared Planting Material or QDPM.

What are the QDPM standards for sweetpotato? In 2010 FAO published protocols and standards for vegetatively propagated crops including sweetpotato. These FAO standards proposed tolerance levels for different pests and diseases affecting sweetpotato planting material. These FAO standards 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 quality farmers want and are willing to pay for. The Marando Bora project adapted the FAO proposed standards to their own context as shown in Table 5.1. To be successfully introduced "standards" need to be accompanied by an increased awareness among farmers as to the benefits of better quality planting materials. Any system of standards, where the "quality" may not be immediately visible is also built on trust. In some countries QDPM labels are issued to match the quantity of quality planting material produced. These labels have the

following information: name of multiplier and contact number; variety and date of harvest; number of cuttings in the bundle or sack.

Table 5.1 FAO's sweetpotato QDPM pest and disease tolerance levels adapted to the Marando Bora, Laze Zone, Tanzania project context

Parameter	FAO's QDPM (G4) tolerance level	Marando Bora project's – QDPM tolerance levels*		
		Very good	Acceptable	Not acceptable
Mosaic and stunting	1 %	≤1 %	1.1-5 %	>5 %
Leaf Curl	5 %	≤5 %	5.1-10 %	>10 %
Purpling	5 %	≤5 %	5.1- 10 %	>10 %
Other varieties	2 %	≤2 %	≤2 %	>2 %
Any signs of weevils	0 %	≤0 %	≤10 %	>10 %

**Note:* Three out of every 10 beds of each variety are randomly sampled, and in those beds two complete rows of plants are inspected to determine the % of plants showing symptoms for each parameter

Source: SASHA Marando Bora Draft Protocol for Inspection of Sweetpotato QDPM, 2011c

QDPM 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 crop health regulatory body, the research system, or delegated to a decentralized level for example a district crop protection officer, or a trained village extension officer. 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 5.1) the plot is rejected. During this second visit, the estimated quantities of planting materials which can be harvested from the plot are also calculated.

Farmer-multipliers can also be trained to inspect their own plots to determine whether the material reaches the quality standards. The production of QDPM and associated inspection system has costs and someone has to 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. In some countries 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. QDPM standards need to be appropriate to the specific context. Overly stringent standards may be by-passed, promote corrupt practices or end up closing down multipliers so that farmers are left in a worse-off situation.

5.4.3 Tissue cultured planting materials

As discussed earlier in this topic, 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 can be used to produce large quantities of cleaned-up planting materials of these varieties, enabling their yields and nutritional benefits to become available to farmers again.

Tissue cultured sweetpotato plantlet

Plant tissue culture is a process undertaken in a laboratory which produces small plantlets from the cells, tissues or organs of a mother plant on a solid or liquid medium under aseptic and controlled environmental conditions. For example, these cells, tissues or organs are taken from a mother plant, such as a sweetpotato plant which has been cleaned and tested to check it is virus-free, and then grown in a carefully managed screen house to prevent it becoming infected with virus. Small pieces (such as nodes or buds - which are then called 'explants'), are carefully cut out of this mother plant in a laboratory. Then inside a special cabinet which is used to reduce the chances of bacterial or fungal contamination, these explants are surface sterilised and placed onto a sterilised nutrient medium in a tube. These tubes are then stored on shelves in the laboratory growth room which is kept at temperature of 26-28°C, and within 4 days tiny shoots start to emerge from the explant. When a small plantlet with several nodes has formed from the explant, the plantlet can be cut into node pieces using a sterile scalpel and the nodes can then be transferred to a new sterile jar of culture medium, which must then be sealed. After 3-4 weeks the plantlets will typically each have at least 5 nodes and be ready for hardening and transporting to the reception site.

Sweetpotato plantlets starting hardening-off at receiving point

Planting sweetpotato plantlets into polytubes

Planting materials produced from tissue cultured plantlets

Plant 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 access as they require a careful hardening-off process to enable them to adjust to and survive ambient field conditions. Intermediaries such as primary seed multiplication sites (see section 5.6.1) can play an important role in successfully hardening-off and transplanting the tiny plantlets. These primary multipliers can then use the plantlets to produce large quantities of clean planting materials which farmers can access and afford and which are less risky. Details of the hardening-off process for tissue cultured sweetpotato plantlets are given in Appendix 5.1.

5.5 How to 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 have to 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:

1. 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
2. Dry season preservation of *sweetpotato roots in dry sand, followed b*y forced sprouting in time for the onset of the rains. This is known as the Triple S system – *Storage, Sand, Sprouting*

In order 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.

5.5.1 Dry season conservation and multiplication of vines for cuttings

In order to ensure availability of planting materials 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, which will then be carefully preserved and multiplied 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 dry season plot 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) (see Table 5.2).

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 becoming water-logged once the rains start or before the farmer has shifted the material to the site for further multiplication or root production
- 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 them 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

Table 5.2 Common planting material conservation practices in areas with short and areas with prolonged dry seasons

Planting material conservation method	Application in areas with a: short dry season (1-2 months)	Application in areas with a: prolonged dry season (3.5-5 m)	Comments/ constraints
1. Old surviving fields and stems	******		In prolonged dry season areas, the few plants in old surviving fields were available at the start of the rains, but the vines had lost vigour due to their age and the harsh dry period.
2. Sprouting groundkeeper roots	*	******	Cuttings from sprouting roots are a good source of planting material, but unless protected these cuttings are vulnerable to attack by grazing animals and pests. If shoot growth starts only after the rains have begun, mature vines will be available late.
3. Plants under shade or in backyard		**** *(but small area covered)*	Generally provides mature, good-quality planting material at the onset of the rains. But the quantities were very limited as the area for production under shade was normally very small.
4. Purchasing vines from others	**	****	
5. Vine multiplication and/or root production in the swamp/ valley bottoms, especially during the dry season	**	~~ *(if residual moisture available in valley bottoms)*	Provides good planting material at the beginning of the rains, but this material is also vulnerable to attack by grazing animals and pests during the dry season.

*Key: ****** = Most common; **** = Common; ** = Not common; * = Rarely applied; ~~ = Applicable under certain circumstances; = Not applied.*

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 (see section 5.2).

A net tunnel method of protecting planting materials from virus infection has been developed. Further details about the net tunnel and how to construct it are given in Appendix 5.2.

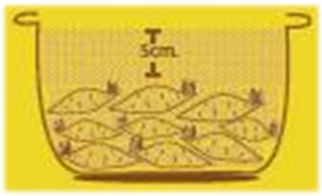
Net tunnels for protecting planting materials from virus infection

5.5.2 Dry season preservation of starter roots for the production of planting materials – the Triple S system: Storage, Sand, Sprouting

Following the careful selection of undamaged, uninfested small/ medium sized sweetpotato roots:

- Place the dry roots carefully in a container (such as a plastic basin) along with dry sand (this can be swept from around the house or a road). The roots can be kept dry like this in this container until 6-8 weeks from the expected start of the rains.
- Take care that the sand is cool; if it has been in the hot sun, let it cool completely before you use it.
- Two or more layers of roots can be kept in the same container.

  Make sure there is a 5cm layer of sand above the top layer of roots.



- 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 children who might like to eat the roots or chickens that might like to nest in the container.

- The roots will sprout during this storage period, but the sprouts generally remain quite short. If the dry season is very long (e.g. >4months), it may be necessary to remove the sprouts midway during the dry season and allow them to re-grow. The early sprouts are removed as otherwise they will use up the water reserves in the root.
- About 6-8 weeks before the start of the rains, the sprouting roots are planted in a garden near the home. The whole of the root and sprouts are buried, unless they are very long. They are planted at a spacing of about 0.5 x 0.5m and in a slight depression at a depth of about 5cm (to help watering). The soil needs to be fertile and the area fenced against grazing animals.

- The roots should be watered at planting, and after every 3 or 4 days.
- By the time the rains come, the roots will have sprouted vigorously and it is possible to cut large amounts of planting material. Just 40 roots can generate about 1,500 cuttings.

  (*see the Triple S System handout in your folder*)

Farmers wanting to produce larger amounts of planting materials, should set up several small Triple S containers, or use larger containers.

5.6 Choosing your planting material multiplication and dissemination strategy

In order to have a large scale impact on a target aspect (e.g. improved yields or reduced vitamin A deficiency in under 5 year olds) and area, a clear planting material multiplication and dissemination strategy needs to be developed.

There is no one-size-fits-all option and very careful thought and planning is required before deciding on which dissemination strategy or strategies would be most suitable for your specific situation. You also need to consider why you are distributing planting material; is it to distribute a new variety, 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 that you can adjust the strategy as conditions (e.g. climatic, institutional) on the ground change.

5.6.1 Different planting material multiplication levels

CIP and partners have found it helpful to distinguish between several distinct planting material multiplication levels: the foundation level, the primary multiplication site (PMS), the secondary multiplication site (SMS) and the tertiary multiplication site (TMS). However, sweetpotato is mostly a low input crop, and many varieties are maintained completely outside such a formal structure. Such a structure is likely to be relevant to project interventions although not all the levels will be necessary in every situation (the secondary level is sometimes missed out), and they do not need to be introduced in a sequential manner, secondary and tertiary levels may be set up simultaneously to save time. As with any multi-layered system, the importance of communication and coordination between and among layers needs to recognised and supported with the necessary resources if the system is to function efficiently.

- Foundation level is found only at agricultural institutes. These are primarily public sector but could be private sector. They often possess tissue culture laboratories and/ or other means of maintaining stocks of virus-free planting material.
- Primary multiplication sites (PMS) are heavily supervised by researchers and are usually on a research stations, however if the research station is a virus hot spot, then researchers may instead work closely with experienced farmers as the PMS. The PMS form the first level of field multiplication of vines which may arise from cuttings from foundation seed vines or *in vitro* tissue culture plantlets. These sites have irrigation access and generate the planting materials for the secondary multiplication sites/level.
- Secondary medium scale multiplication sites (SMS) are established to form decentralised points for planting material access by farmer multipliers. Thus the geographical location of the SMS is important. The SMS sites are usually established and/or managed by extension staff, NGOs, individuals/entrepreneur farmer/private sector. They may use rapid multiplication techniques and will need irrigation. These sites need to be physically easy to access, especially in the rain season.
- Tertiary decentralized community level multiplication sites (TMS) are the further decentralised farmer or farmer group managed sites, and are often known as DVMs (decentralized vine multipliers). They may be existing farmer vine multipliers whose skills and range of varieties have been boosted through training by the 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. TMS 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.

While ideally, it is the tertiary level DVMs who interface with farmers providing them with planting materials either at commercial or subsidised value. In practice, the primary, secondary and tertiary levels all provide farmers with planting materials. However, if the primary level provides planting

materials free or at a cheaper price than the tertiary level, this will undercut commercialisation of secondary and tertiary levels.

5.6.2 Key actors and their responsibilities in the seed system

Researchers, extension agents from public, private and NGOs, farmers/farmer groups vine multipliers, plant health regulatory bodies, traders and transporters are among the key players in sweetpotato seed vine multiplication systems.

- *Researchers* have the key role of supplying new varieties at foundation site level and multiplying sweetpotato vines at primary multiplication level. Researchers also have the responsibility of building the capacity of NGOs or government staff or farmer representatives as ToTs on quality vine multiplication. Researchers may also make inspection and certification visits to the PMS, SMS and possibly the TMS as well (although this should be done by the seed certification authority).
- *Public extension and/or NGOs* are responsible for building the capacity of farmers/ farmer groups vine multipliers in managing multiplication at secondary and tertiary level. They provide:
    - training to farmers/ private sector on quality vine multiplication techniques; the training and site visits should be designed and implemented taking into account any gender based constraints which male and female multipliers might have,
    - access to sources of clean planting materials for the trained farmer multipliers,
    - technical guidance and supervision of the initial establishment of SMS and TMS,
    - 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 at SMS or TMS level,
    - facilitation of linkage between the vine multipliers and market and other services such as credit facilities (e.g. to obtain irrigation equipment), and business development services to provide support in enterprise development,
    - 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,
    - regular visits to the SMS and TMS to obtain feedback from the multipliers on any challenges they have and encourage the use of recommended practices. These visits back up those of the research inspections of SMS.
- *Farmer vine multipliers'* key role is to establish and manage their SMS or TMS. They are expected to undertake the recommended practices for quality vine multiplication and conservation:
    - 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,
    - pre-planting practices,
    - practices for planting and management of multiplication fields (including the roguing of infected plants),
    - recommended harvesting and post-harvest handling practices for quality vine multiplication,
    - dissemination of planting materials to nearby farmers, and acting as a source of information and advice on sweetpotato vine and root production,
    - conservation of planting material during the dry season,
    - feedback to extension service providers and researchers on any disease and pest outbreaks in their multiplication plots and the performance of different varieties during multiplication.
- *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.

5.6.3. Decision-making factors for planting material multiplication and dissemination strategies

Key factors to take into consideration when deciding on your planting material multiplication and dissemination strategy include:

- *Agro-ecological and climatic factors* – e.g. how long is the dry season in the target area, are water sources permanent? What is the sweetpotato vine multiplication and root production calendar?
- *Varietal factors* – e.g. 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 which are more popular for men, women and children or for different end-users (e.g. fresh root consumption, processing, livestock fodder)? Are the varieties you want to promote virus resistant and therefore likely to remain virus free once farmers start to grow and multiply them themselves even if the target area is a virus hot spot, or will clean virus free planting materials need to be regularly re-introduced?
- *Socio-economic and demographic factors* – e.g. what is the population density, 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? 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?
- *Institutional factors* – e.g. are there government policies 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? Is there any one organisation or entity which has responsibility for coordination of seed systems and how is this done?
- *Existing seed system factors* – e.g. what is the existing seed system? Who is involved? What multiplication practices are used, how do they differ between male and female farmers, gender analysis of division of labour, resource allocation, and decision-making? How commercial is it, what prices are charged? What varieties are multiplied? What scale does it operate at? What are its strengths and weaknesses? What are male and female 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 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 existing multipliers need to reach more clients?
- *Project specific factors* – e.g. 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 worked with, 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 the long term sustainability of the seed system an important criterion?

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

It should be noted that by a single shot approach, we are not advocating for a 'truck and chuck' approach. In any situation where there is to be a delivery of planting materials, it is vital that there is a well-organised system to:

- ensure that the arrival of the planting material is when the farmers want it, e.g. at the start of the 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 are likely to 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.

Box 5.2 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.

Box 5.3 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: This approach 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 varieties being introduced 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 in order to target a particular group (e.g. targeting orange-fleshed sweetpotato for 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). In this way, the project provides the targeted vulnerable households with vouchers,

which they can use to obtain planting material; the planting material supplier is then reimbursed by the project for each voucher used. However, use of a voucher system prevents an accurate analysis of willingness to pay by consumers and may act as a disincentive to careful preservation of planting materials.

In areas with sufficient purchasing power and where there is 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).

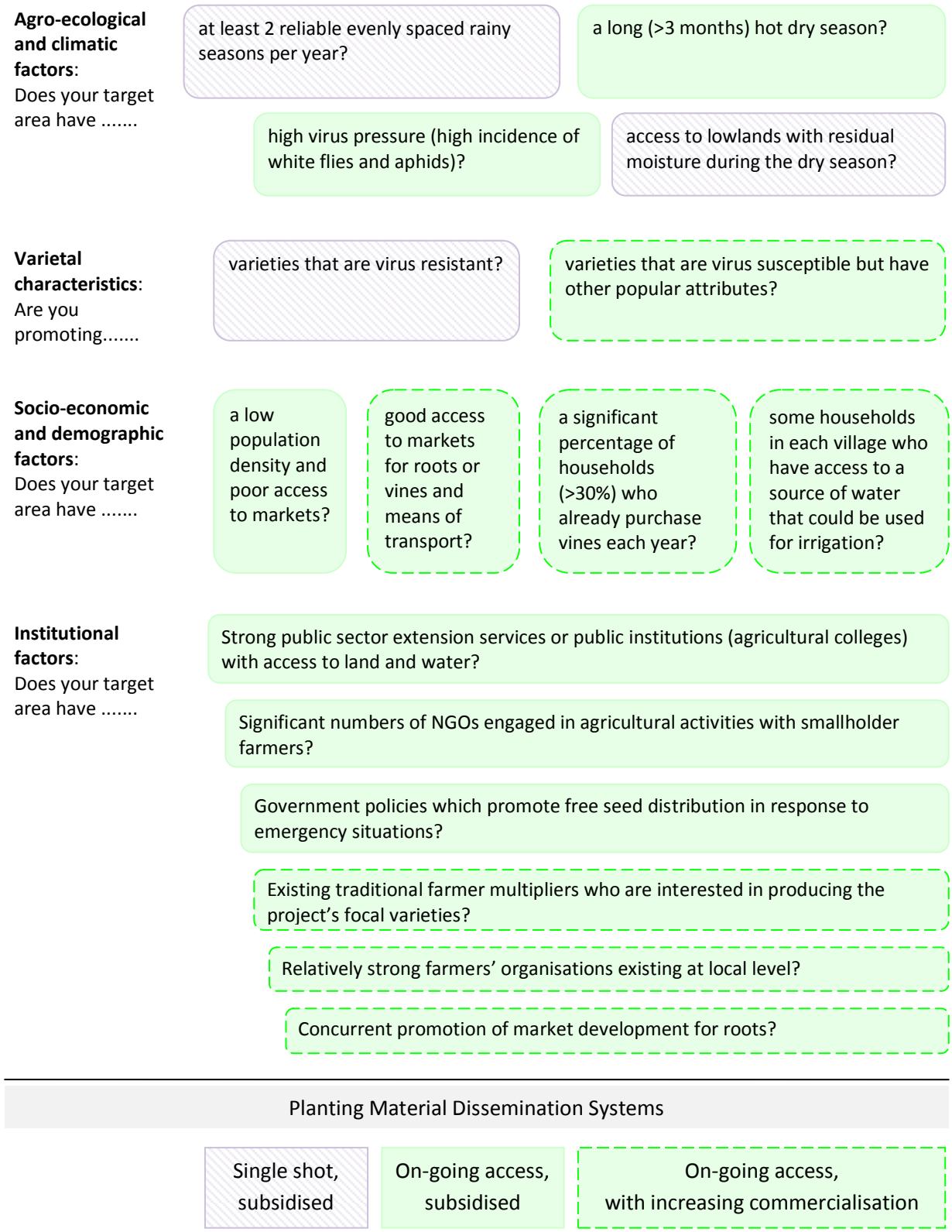
Extent of decentralisation: An ongoing access approach can also range from being completely centralised to very decentralised. Training of DVMs in vine multiplication and dissemination can enable a sustainable source of high quality planting materials to be available to the community each year without 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 presented in Table 5.3.

So how do you decide which planting material dissemination strategy would be most suitable for your situation? The following diagram (Figure 5.1) 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.

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 in order 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.

The different dissemination strategies are described in detail in section 5.6.4:

Figure 5.1 Factors influencing which sweetpotato planting material dissemination strategy to use?



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.

5.6.4 Centralised and decentralised planting material dissemination strategies

A comparison of the pros and cons of centralised mass multiplication of planting materials and decentralised vine multiplication by local multipliers is given in Table 5.3. 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.

Table 5.3 Pros and cons of centralised and decentralised planting material dissemination strategies

	Pros	Cons
CENTRALISED mass multiplication and dissemination	• 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	• 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)	• 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	• 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

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 have not yet seen or experienced the yield difference between 'clean' planting material and their normal planting material and therefore do not fully grasp the association between virus infection and reduced yields. An understanding of this concept is important if farmers are going to increase their sweetpotato yields and 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 long-term sustainability sense to boost their skills as necessary and work with them as opposed to starting the operations from scratch with a new farmers group. However, introducing a new variety, in particular OFSP varieties, may be risky for the existing multiplier so they may need to be subsidised at first before the market value of the new variety becomes established.

A recent project in Tanzania used the following criteria to select the DVMs it partnered with:

a. 10 kms minimum distance between multipliers
b. Willingness to have 750 sq meters of vine multiplication
c. Resident in target areas
d. Prior experience growing sweetpotato; and as sweetpotato is recognized as a female crop want $^{1}/_{3}$ 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 & 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.

One challenge with strengthening existing farmer-based seed systems is how to achieve greater scale. This includes both "scaling out" i.e. reaching more farmers, or achieving greater geographical coverage and "scaling up". The latter implies influencing the policy context. This needs to provide an "enabling environment" to support the following dimensions which are necessary to contribute to a sustainable sweetpotato seed system. These are:

a. technical (e.g. ensuring clean planting material and good agricultural practices),
b. social (e.g. acceptable varietal traits and multiplication and dissemination models which are appropriate to the socio-economic and gender context),
c. financial (e.g. market context and willingness-to-pay) and,
d. institutional (e.g. rules and norms related to coordination and communication across a multi-actor and multi-layered seed system) conditions,

It should be re-iterated that there is no "blue print" model for "going-to-scale", but that there is the need to find a mechanism whereby all sweetpotato seed system actors can come together to identify and address the constraints in a specific context. 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.

5.6.5 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 likely to be more sustainable if they are run commercially, but for this to work farmers need to be willing to pay for sweetpotato planting materials. Some of the main factors helping to contribute towards farmers' willingness to pay for sweetpotato vines are shown in Table 5.4, along with those factors that contribute against it. 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.

Table 5.4 Factors contributing towards and against farmers' willingness to pay for vines

Factors **CONTRIBUTING TOWARDS** farmers' willingness to pay (WTP) for sweetpotato vines	Factors **CONTRIBUTING AGAINST** farmers' willingness to pay (WTP) for sweetpotato vines
• 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	• 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

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 varieties' nutritional values and market values 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.

Box 5.4 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

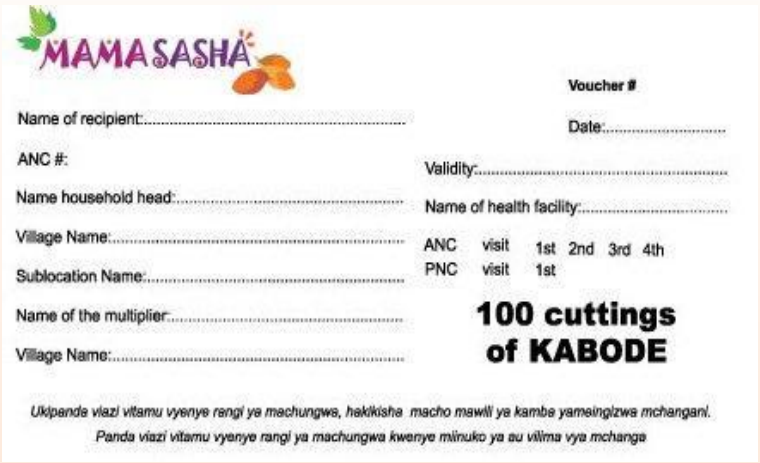


Figure b. More complex voucher: Obtaining additional information on who received and who provided the vines.

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) Be able to 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.

5.7 Constructing your multiplication and dissemination plan

Your dissemination plan needs to be realistic and aligned 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 dissemination area. You can use the calendar to also find out about: 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.

Simple agricultural calendar

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. As mentioned earlier, 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.

Remember 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 (Table 5.5) before you can decide how to construct your initial multiplication and dissemination plan.

Table 5.5 Questions you need to think about to help determine your planting material multiplication and dissemination plan

Question	Why do you need to know this?
1. When do farmers in the target area want to plant their sweetpotato fields?	So that you can work backwards from the farmers' planting date, to calculate when each of your multiplication plots need to be prepared and planted. If the vines are needed within five to six months so as not to miss a season, more labour-intensive rapid multiplication techniques will need to be used, fertilizer applied, and good water and pest management employed.
2. How many households in our target area do we want to distribute sweetpotato planting materials to?	To help calculate the amount of sweetpotato cuttings you are aiming to produce.
3. How many cuttings or kgs of each variety does each household need to receive?	To help calculate the amount of sweetpotato cuttings you are aiming to produce (e.g. X cuttings for each of Y households).

4. Which varieties do we want to promote in the target area, and what are their multiplication rates?	So that you can calculate how many cuttings of each variety you need to produce (e.g. X cuttings of variety A and variety B for each of Y households) AND so that you can calculate whether the multiplication rates of the different varieties vary significantly, and will then require you to set up multiplication plots at different times and of different sizes to ensure you can produce the same amount 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). Varieties can differ significantly in ease of establishment, growth rates, and the number of nodes per 30cm length (each node can be a future plant). Obtaining accurate multiplication rates for each variety allows for better planning. If your varieties have very different multiplication rates you will need to do a multiplication plan for each variety. *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 all perspectives are covered.*
5. Is virus-free primary planting material available for the desired varieties?	Primary planting material is the first generation of material produced from disease-free *in vitro* plantlets maintained by national research programs. If such material is not available, it can take six months to a year 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.
6. Are we doing a centralized mass multiplication at just a primary multiplication site level, OR are we also using secondary and tertiary multiplication levels and if so how many do we have, and what training needs do they have?	So that you can calculate whether all the planting materials will be produced at one centralised location or not. If secondary or tertiary multiplication sites are being used, this information will help you plan when and what quantity of cuttings from the primary site will be required at each secondary site, and then subsequently when and what quantity of cuttings will be required at each tertiary site. 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. 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. 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).
7. 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. Primary planting material is usually maintained on research stations; hence secondary and sometime tertiary sites are located closer to the target areas to reduce the distance between the source and the target area. 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.
8. How far apart are the different target areas, and how many households in each target area will receive what amount of cuttings?	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. 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. However, if your dissemination strategy is very decentralised, farmers may be able to make their own way to the multiplication sites to obtain their planting materials. Although it is likely 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.
9. 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.
10. How much would you need 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 the 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 is much 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 Vine multiplication rates:

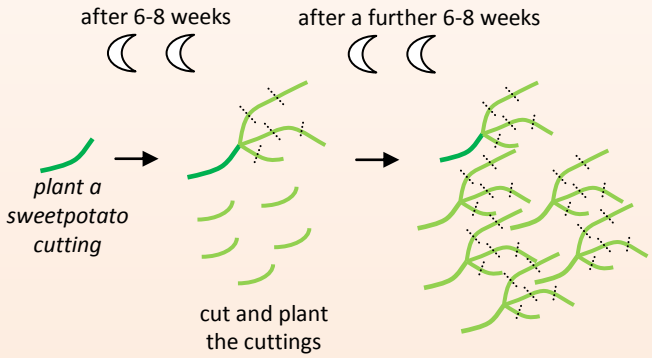
For example:

Under conventional management (spacing of 30cm between plants, 1m between ridges):

- 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.
- Roots will be harvested as well as vines. Note: cutting vines before 3 months may affect root yield.

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

- 1 sweetpotato cutting can produce 30-50 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 250-300 cuttings from that sq m after 2 months, and plant those new cuttings you will then reach 1500 – 2100 cuttings (3 nodes long) after 4 months in your now expanded area (6-7 sq m)

Note: Multiplication rates vary by variety (especially spreading vs. erect types), management scheme, seasonal temperatures (growth is slower when it is cooler) 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 Table 5.6 (which works backwards from November 2013 to July 2012 when the specified number of cuttings need to be planted in order to reach your target).

Table 5.6 Example of multiplication calculations working backwards from the number of cuttings required by a certain time, using two different multiplication rates

	Example 1			Example 2 - higher multiplication rate		
Months working backwards	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 4 month period
November 2013	2,000	400,000		2,000	400,000	
October 2013						
September 2013						
August 2013						
July 2013		26,667	15		10,000	40
June 2013						
May 2013						
April 2013						
March 2013		1,778	15		250	40
February 2013						
January 2013						
December 2012						
November 2012		119	15		6	40
October 2012						
September 2012						
August 2012						
July 2012						

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, 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 1m between ridges and 30cm 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 Table 5.7), 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 TMS multiplication plot (sq m)
- Proposed size of each SMS multiplication plot (sq m)
- Multiplication rate in a 4 month period at TMS level, at SMS level and at PMS level

Table 5.7 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 Step 1. = total no. of cuttings needed = target no. hh x no. cuttings per hh =D4xD1			
5								
6			Oct-13					
7			Sep-13					
8			Aug-13					
9	TMS	100	Jul-13		1,000,000 Step 2. =no. of cuttings reqd at TMS level = no. cuttings reqd by farmers / multiplication rate at TMS level =E4/H9	20,000 Step 3. = area reqd at TMS level = no. of cuttings required/ planting density of cuttings =E9/D2	200 Step 4. = no. of multipliers needed = total TMS area reqd/ size of each TMS plot =F9/B9	20
10								
11			Jun-13					
12			May-13					
13			Apr-13					
14	SMS	750	Mar-13		33,333 Step 5. =no. of cuttings reqd at SMS level =no. cuttings reqd by TMS level / multiplication rate at SMS level =E9/H14	667 Step 6. =area reqd at SMS level=no. of cuttings reqd at SMS level/ planting density of cuttings =E14/D2	0.9 Step 7. = no. of multipliers needed =total SMS area reqd/ size of each SMS plots =F14/B14	30
15								
16			Feb-13					
17			Jan-13					
18			Dec-12					
19	PMS		Nov-12		833 Step 8. =no. of cuttings reqd at PMS level =no. cuttings reqd by SMS level / multiplication rate at PMS level =E14/H19	16.7 Step 9. =area reqd at PMS level =no. of cuttings reqd at PMS level/ planting density of cuttings =E19/D2		40
20								

Note this worksheet: does not account for any wastage factor; assumes that all PMS goes to SMS which goes to TMS; assumes a multiplication rate of 20 at TMS level in 4 months (2 cycles but lower RMT as under farmer conditions)

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 have calculated your planting material multiplication numbers and stages, to match with the farmers' planned planting time. You can create a full work plan of the activities which need to be done at each stage in preparation for the final dissemination to all your target households. Make this activity work plan as detailed as possible to help ensure you have covered everything. You might find the template (Table 5.8) below useful in creating this plan, guidelines for calculating the multiplication and dissemination costs are given in section 5.8. An example calendar of decentralised multiplication and dissemination activities is shown in Table 5.9. 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.

Table 5.8 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 • 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 5.9 below*) showing when and where the multiplication activities are needed				
4. Multiplication implementation phase • 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 (see Tables 5.5, 5.6 and 5.9)				
5. Pre-distribution activities • 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				

Table 5.9 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																			
PRIMARY 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 secondary multipliers						X													
Distribution of cuttings to Secondary multiplication sites							X												
SECONDARY 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								
Training of Tertiary multipliers										X									
Distribution of cuttings to Tertiary multiplication sites											X								
TERTIARY MULTIPLICATION																			
- *Planning*		X					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				
Preparation for next seasons multiplication and dissemination													X						
Planning for dissemination of cuttings*													X						
Awareness raising on varieties and crop management, with target households														X	X				
Distribution of cuttings to target households															X				
Monitoring of farmer and market perspectives on the new varieties																		X	

**(Note: little input beyond awareness raising may be required if local farmers are to collect them from their local multipliers)*

5.8 Guidelines for calculating the cost of multiplication and dissemination activities

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

For a project the activities 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*)
- QDPM inspection of the multiplication sites to assess the quantity and quality of the planting materials (*at 1.5 months after planting and 2 wks 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 of planting material performance in communities, awareness levels, demand for, spread of planting materials
- 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 Table 5.10, 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, but below is an example showing the 2009 costs of production of a Ugandan farmer vine multiplier (Example A). Costs are often higher for research station managed multiplication plots due to higher labour and supervision costs and distance to the researcher managed multiplication site.

Example A. Ugandan farmer multiplier's 2009 costs of vine production per acre, with final column showing conversion to USD$/ha

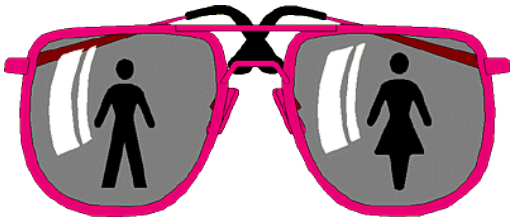
Item/activity	Quantity per acre	Unit cost (Ug Shs.)	Total amount/ acre (Ug Shs.)	Cost per ha (USD$)
Ox- ploughing	x 2 times	50,000	100,000	124
Cost of conserving and harvesting seed vines	100 bags	2,000	200,000	248
Planting	50 people	5,000	250,000	309
Fertilizer (NPK 25:5:5)	300 kgs	1,600	480,000	594
Irrigation fuel	100 litres	3,000	300,000	371
Irrigation labour	4 people x 14 wks	5,000	280,000	347
Weeding	40 people x 1	2,500	100,000	124
Pesticides	750 mls	20	15,000	19
Blanket spray labour	1 x 3mths x 4 people	5,000	60,000	74
Other costs			100,000	124
Total			**1,885,000**	**2,334**

Exchange rate 2009 Dec: 1 USD = 2020 Ug Shs.

Table 5.10 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
Setup Steps	**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 *& tracking*	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					

5.9 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. 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, 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).

5.10 Ideas for sweetpotato seed systems learning-by-doing activities

These learning-by-doing activities have been designed to provide hands-on discovery learning opportunities for the participants of the 10 day ToT course on '*Everything you ever wanted to know about sweetpotato*'. We hope by learning about sweetpotato in a hands-on way, these trainers will then train others using a practical learning-by-doing approach.

The full 10 day ToT course programme is described in Topic 13 of this manual. The following activities occur on days 4 and 7 of the 10 day ToT course, an overview summary of those two days is given below, and the detailed step by step learning-by-doing activities are described in the pages that follow. However, we hope these activities will also be used by trainers as stand-alone learning activities and as part of other training courses.

Day	Topics	Intended Learning Outcomes	Activities
4	Selecting, preserving and multiplying sweetpotato planting materials	*Participants will:* - Be able to identify, select and conserve clean sweetpotato planting materials - Know about the principles of positive and negative selection and preservation of sweetpotato planting materials - Understand how to calculate vine multiplication rates and how varieties rates' differ	- *Activity 5.10.1: Vines for planting: clean and multiplied.* Field activity 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, calculate vine multiplication rates. [2.5 hours] - *Presentation 5a.* Sweetpotato planting materials, traditional vine conservation practices, water management of vines (drip irrigation), Triple S system, and net tunnels. - *Discussion.* Existing SP seed systems. - *Activity 5.10.2: The Triple S system.* Practicing the triple S method, from the root selection stage, to loading and placement in cool dry area. [1.5 hours] - *Additional activities:* If time - construct a net tunnel (Appendix 5.2) or practice hardening off tissue culture plantlets (Appendix 5.1)
7	Planning a planting material dissemination program	*Participants will:* - Understand all of the key steps, and bottlenecks that may emerge in planning a mass multiplication or DVM approach dissemination exercise - Practice designing a dissemination program for their area to reach 5,000 households - Understand why it is important to monitor and evaluate activities - Practice monitoring the dissemination of planting materials	- *Presentation 5b.* Key principles of sweetpotato planting material multiplication and dissemination [30 mins] - *Activity 5.10.3: Planning your multiplication and dissemination strategy.* Practical [3 hrs] - *Group discussion*: comparing the strategies for different scenarios - *Activity 5.10.4: Working with DVMs.* Practical exercise. [2.5 hrs] - *Presentation 5c.* Costing out the dissemination exercise [10 mins] - *Presentation 12.* Introducing M&E [20 mins] - *Activity 12.3.1: Where did it go?* Practice in monitoring planting material dissemination [30 mins] - *Homework problem:* to figure out costs of dissemination strategy

5.10.1 Vines for planting: clean and multiplied

Intended Learning Outcome: Participants will be able to identify, select, conserve and multiply clean sweetpotato vine planting materials, and understand how the multiplication rates of varieties differ

Timing: 2.5 hours plus travel time to the field and back – this activity should be done in the morning.

Materials: Nearby planted sweetpotato field with some virus infected plants. Half completed nursery bed. 5 cutting knives. 2 watering cans with water in. 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.

Advanced arrangements required:

- 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 to the participants that today they are going to collect planting materials to set up a rapid multiplication plot, as though it was close to the on-set of the rains. They need to make their way to the field. [Travel time (? mins)]
2. On reaching the field, ask the participants to get themselves 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. [10mins]
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)). [10 mins]
4. Give each group of 5 people a knife and ask each group to carefully cut a total of 20 cuttings each of 3 nodes long (~20cm lengths) from healthy sweetpotato plants, and then to bring them to the site of the half prepared rapid multiplication nursery bed. [15 mins]
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 piercing polypropylene sacks to increase ventilation; not squashing the vines by overloading the sacks or the truck; labelling the sacks with variety name, harvest date and multipliers contact details; 50 cuttings typically weighing 1kg etc.). [10 mins]

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 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. [50 mins]
7. 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. [20 mins]
8. 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. [15 mins]
9. 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. [15 mins]

5.10.2 The Triple S system: Sand, Storage, Sprouting

Intended Learning Outcome: Participants will have experience in setting up the Triple S system.

Timing: 90 mins

Materials: About 200 sweetpotato roots – some damaged and a range of sizes, 6 plastic basins, newspaper, 5 buckets, and 5 brooms. Set up one Triple S system about 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 a few months in advance of the ToT course, so that the students can uncover the roots and find them sprouting, and can then use them to practice planting them out.

Suggested steps:

1. Ask the participants to get themselves into 5 groups. Explain that they are going to 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 carefully 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 show the rest of the participants some examples of damaged roots, and to explain why they would not use those ones. [10 mins]
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 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 5cms of sand. [30 mins]
3. Ask one person from each of the 5 groups to come to a table where all the others can see them, and ask them to together explain and again do the process of setting up the Triple S system as though they were demonstrating it to a group of farmers. The facilitator should watch them 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*). [20 mins]
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 (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 mins]
5. Ask another two of the participants to explain what the next steps are before the rains e.g.
   - About 6-8 weeks before the start of the rains, plant the sprouting roots in a garden or 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 ~0.5 * 0.5m and in a slight depression at a depth of about 5cm (to help watering).
   - The roots should be watered at planting and every 3 or 4 days.
   - By the time the rains come, the roots will have sprouted vigorously and it is possible to cut large amounts of planting material. Just 40 roots can generate about 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. [15 mins]

5.10.3 Planning your multiplication and dissemination strategy

Intended Learning Outcome: 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 4kgs of planting materials to each of 5,000 households (HHs) before the next rainy 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 households (HHs) with children under 5 years old across 3 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 2kgs of 2 different varieties of OFSP to test. Plan.

Timing: 3 hrs

Materials: flip chart and markers; 35 copies of blank template of sweetpotato activity calendar (Handout 5.10.3a); 35 copies of the blank worksheet for calculating your sweetpotato multiplication strategy (Handout 5.10.3b); 35 copies of template of sweetpotato dissemination plan (Handout 5.10.3c);

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. [5 mins]
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? [20 mins]
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 5.10.3a Calendar). [25 mins]

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 5.10.3b) to help with the calculations. They need to complete all the highlighted cells first, and then work step by step through the calculations. A worked example is presented in Table 5.7.

   The groups should start by working on answering the questions in the Handout 5.10.3c 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 [40 minutes per plan = 80 mins].

5. Presentation of plans. Each group has 10 minutes to present their plans (5 min per plan) to the rest of the participants. This should then be followed by discussion of 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 the different groups had worked on the exercise. [40 mins]

6. 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 people cost each activity in advance to enable you to plan timely availability of funds. [10 mins]*

Handout 5.10.3a 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 (1st, 2nd, 3rd)													
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 (see Table 5.6)

Months working backwards									
	Target no. of HH & timing	No. of cuttings of variety ...	Multiplication rate in a 4 month period	Target no. of HHs & timing	No. of cuttings of variety	Multiplica-tion rate in a 4 month period	Target no. of HHs & timing	No. of cuttings of variety ..	Multiplica-tion rate in a 4 month period

Handout 5.10.3b Worksheet for calculating multiplication strategy figures

(see Table 5.7 for a worked example)

	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		Step 1. = total no. of cuttings needed = target no. hh x no. cuttings per hh =D4xD1			
5								
6			Oct-13					
7			Sep-13					
8			Aug-13					
9	TMS		Jul-13		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	
10								
11			Jun-13					
12			May-13					
13			Apr-13					
14	SMS		Mar-13		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	
15								
16			Feb-13					
17			Jan-13					
18			Dec-12					
19	PMS		Nov-12		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		
20								

Handout 5.10.3c 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 • No. of districts, • No. of households, • No. of varieties, • Quantities of planting materials/ household • Monitoring data requirements • Available budget				
3. Make a calendar (*see Table 5.8 in manual*) showing when and where the multiplication activities are needed				
4. Multiplication implementation phase • Calculate for variety A and/or B - 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 (see Tables 5.6 and 5.8)				
5. Pre-distribution activities • 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				

5.10.4 Working with DVMs

Intended Learning Outcome: Participants will understand the benefits of and training requirements for a successful DVM strategy

Timing: 2.5 hrs

Materials: A nearby sweetpotato demo plot with two distinct varieties separated, labelled and containing clean planting material and a 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 Handouts 5.10.4a and 5.10.3b.

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 [10 mins]
2. Use the pictures in Handout 5.10.4a (or similar pictures) to stimulate discussion on some of the challenges associated with vine dissemination. The facilitator must try and ensure all participants contribute to the discussion. [10 mins]
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 group's to present their observations and thoughts about the nursery plots and the planting materials in them. The facilitator should use probing questions if necessary to ensure that planting material health, the importance of separating different varieties, and roguing are mentioned. [30 minutes including visit to nearby plots]
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 ideally work in the same groups that they used for Activity 5.10.3 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. [15 mins]

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

5. 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 section 5.6.4).

   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 in order to identify and select DVMs during a project, or to rank different DVMs in order to decide 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 it should 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. [30 mins]

6. In their small 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 to meet the requirements. Give the groups 10 minutes to discuss this and make notes on a flip chart. Then go round the groups, asking the first one to present all their ideas, and the subsequent groups to only present any new ideas they had 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. [20 mins]

7. Referring to the previous activity on multiplication and dissemination calculations (section 5.10.3) 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 5.10.3b and Table 5.7 might assist them). [10 minutes]

8. Ask the groups to summarise and share the results of their calculations (3 mins per group), highlight any key issues or mistakes that arise. Then use random questions to find out what the participants feel the key aspects of working with DVMs are. The facilitator can probe to ensure the following points are covered in the discussion.

   - *Selection of vine multipliers should be objective and include those who have the capacity and some relevant training or experience on how to produce, maintain and market vines as this is an investment*
   - *Vine multipliers should be close to required clients (i.e. tertiary multipliers (DVMs) should be close to farmers)*
   - *It is important to calculate how many multipliers you will need at each level using the multiplication rates of the focal varieties. This calculation needs to be done as early as possible, or you may find you don't have enough time to build up sufficient materials to reach your target number of beneficiaries.* [30 mins]

Handout 5.10.4a.

5.11 References used

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Notes on: ***Sweetpotato Seed Systems***