# 28 Can Small Still Be Beautiful? Moving Local Sweetpotato Seed Systems to Scale in Sub-Saharan Africa

**M. McEwan,[1]* C. Almekinders,[2] P.E. Abidin,[3] M. Andrade,[4] E.E. Carey,[5] R.W. Gibson,[6] A. Naico,[4] S. Namanda[7] and S. Schulz[8]**

[1]*International Potato Center Sub-Saharan Africa (CIP-SSA), Nairobi, Kenya;* [2]*Wageningen University, Wageningen, The Netherlands;* [3]*CIP, Lilongwe, Malawi;* [4]*CIP, Maputo, Mozambique;* [5]*CIP, Kumasi, Ghana;* [6]*Natural Resources Institute, Chatham Maritime, UK;* [7]*CIP, Kampala, Uganda;* [8]*CIP, Addis Ababa, Ethiopia*

**Abstract**

In sub-Saharan Africa (SSA), a range of farmer-based practices for the conservation and multiplication of sweetpotato planting material has evolved. In bimodal rainfall areas, sequential planting ensures that a ware crop is in the ground for most of the year, and vines are harvested from one crop to plant the next one. In unimodal areas with a long dry season, practices include the use of 'volunteer' planting material from sprouting roots which have been left in the ground from the previous crop. The predominant sources of planting material are from the farmer's own field or from friends or neighbours. However, these practices result in limited amounts of planting material being available at the start of the rains and contribute to the build-up of pests and diseases contributing to suboptimal root crop production. Sweetpotato breeding efforts are leading to the development of new varieties that are preferred by farmers and consumers. However, without strong linkages to seed multiplication and dissemination efforts these varieties may not quickly benefit large numbers of smallholder farmers and consumers. Increasingly there are specialized vine multipliers who have been supported by 'project' interventions. Yet, it is not clear whether and how these interventions have built on the successful elements of existing practices. Our chapter examines the literature on local seed system functioning, and the implications for crops such as sweetpotato. The chapter reviews recent efforts to multiply and disseminate sweetpotato planting material in Mozambique, Uganda, Tanzania, Malawi, Ethiopia and West Africa. New varieties and technologies have been promoted together with interventions to 'engineer' changes in the organization and coordination of the seed system. We review the country cases to gauge the extent to which successful elements of farmer-based practices for managing sweetpotato planting material have been identified and built into the process of redesigning the seed system.

A number of issues are identified for discussion. These include: (i) What are the critical points for interaction between the traditional farmer-based practices and the formal seed system?; (ii) What are the trade-offs between remaining local, and yet achieving scale?; and (iii) How can the quality of planting material be assured as we go to scale? We also assess the different drivers for the seed system, and the implications for the functions of various stakeholders and patterns of

*m.mcewan@cgiar.org

communication and coordination. The chapter concludes by highlighting gaps in our current understanding for getting sweetpotato seed systems not only moving, but working at scale.

**Keywords:** farmer demand, local level specialization, seed systems, sweetpotato

## 28.1 Introduction

After 40 years of seed sector interventions we are still faced with the challenge: Do smallholder farmers in sub-Saharan Africa (SSA) have timely access to sufficient quantities of quality seed? Despite many efforts across public, parastatal, private and civil society sectors, this question about seed provision can still be posed, particularly for vegetatively propagated crops (VPCs). Recently there has been a revival in interest in seed systems including that for sweetpotato. This has in part been driven by: (i) the recognition of the potential contribution that roots and tubers can make to diversified diets; (ii) the price rises in the cost of other staples; and (iii) the realization that increased investments in breeding and the release of improved varieties, will have limited impact on farmers and consumers unless seed multiplication and dissemination strategies can work sustainably and at scale.

As discussed in other chapters, sweetpotato (*Ipomea batatas*) and in particular the orange-fleshed varieties can play a role in strengthening food security, reducing malnutrition and combatting vitamin A deficiency. In SSA sweetpotato is grown as a staple food across a wide range of agroecological regions. Propagation is largely through the use of vine cuttings selected from the previous crop (Gaba and Singer, 2009). The crop is particularly adapted to marginal areas of low or erratic rainfall and low soil fertility; it tolerates high temperatures, is easy to propagate and maintain, and yields well even in adverse conditions. It is friendly to the environment, as chemical inputs are rarely used and it protects soil from erosion, as it closes its canopy in a short time with a well-developed root system (Woolfe, 1992). Sweetpotato requires minimal inputs, making it attractive to resource-poor households, households headed by women or people living with human immunodeficiency virus (HIV). These characteristics make sweetpotato an ideal crop in mitigating disasters and in post-conflict situations. Moreover, its short cropping season, its flexible planting and harvesting schedules, as well as its increasing commercial value, further emphasize the significance of the sweetpotato. While often considered ‘a poor person’s crop’, the area devoted to sweetpotato is increasing throughout the region due to declining cereal yields, the cassava mosaic disease pandemic, the rapid spread of the banana wilt and lately, the threat of cassava brown streak virus.

Realizing the full potential of sweetpotato to increase the food security and nutrition of the poor requires, among others, good functioning seed systems, to effectively distribute new varieties and ensure access to high quality planting material.[1] To date, among VPCs, most attention has been paid to potato (*Solanum tuberosum*) which is a high-input cash crop in many developing countries. Seed systems of other VPCs such as sweetpotato, cassava and banana have received much less attention. These crops have high relevance for food security of the poorest in rural areas but apart from public sector support for breeding, there have been limited efforts to develop formal seed systems for multiplication and dissemination. The existing seed systems for sweetpotato have operated at a local scale, based on diverse farmer practices for selection, multiplication and exchange of planting material. However, until we have a better understanding of the dynamics of farmer demand and how to ensure a consistent supply of planting material at scale, we will be unable to address bottlenecks and take advantage of the opportunities to contribute to the transformation of food security and nutrition in SSA.

This chapter seeks to re-examine what we know about seed systems in general and the implications for sweetpotato. We will look at the specificities of a seed system for a VPC, and in particular how the characteristics of sweetpotato influence the objective and functions of seed system interventions, the types of stakeholders involved, and what this means for the end users (i.e. smallholder farmers in SSA). We take farmer demand for planting material as an entry point. The chapter first reflects on a series of demand characteristics that are of importance in crops in general, and assesses these in relation to sweetpotato seed systems. The second part reviews some of the strategies which have been used to strengthen and expand the multiplication and dissemination of sweetpotato planting material. In the final section we briefly assess some factors to consider when getting sweetpotato seed systems moving.

## 28.2 Reflections on the Literature: What is Relevant for Sweetpotato Systems?

A vital change in seed system thinking over the last four decades relates to the increased awareness of the importance of local seed systems. This has been partly a result of the unsuccessful efforts to get seed systems in place in developing countries using blueprints based on models for formal seed systems in developed northern countries such as the USA, The Netherlands and the UK. Such approaches (as expounded by Douglas, 1980) yielded temporary successes, but in most cases were not sustainable. Large-scale centralized government or parastatal multiplication programmes, often with the technical support of the Food and Agriculture Organization of the United Nations (FAO) and international donor finance (e.g. the FAO Seed Improvement and Development Programme; FAO, 1973) had the objective of 'meeting farmers' demand' and providing quality seed of improved varieties. However, there were various reasons why these programmes were not economically sustainable and consequently resulted in poor performance. A major argument was that in many countries the smallholder farming sector is characterized by diversity and complexity. This implied the need for formal seed programmes to deal with a large portfolio of varieties that were adapted to a range of farmers' socio-economic and agroecological conditions (Almekinders and Louwaars, 2002; Tripp, 2002). These programmes had difficulty in effectively catering for this with the result that: (i) seed was distributed for varieties which were not locally adapted; (ii) seed production was expensive; (iii) seed quality was unsatisfactory; and (iv) seed delivery was untimely.

The structural adjustment policies in the 1990s reduced national and international investment in the agriculture sector. This contributed to the closure of loss-making state or parastatal seed companies, with the expectation that the private sector would be both willing to fill the gap and lead to more competitive seed marketing and distribution practices (Cromwell *et al.*, 1992). As it became clear that a parastatal-based approach for breeding, seed multiplication and distribution was inappropriate, local seed systems came onto the radar of researchers and policy makers. At this point the focus was provision of seed for grain crops and limited consideration (if any at all) was given to VPCs, with the exception of potato.

The comparative advantages of local seed systems compared with formal seed systems have been extensively commented on, stressing in particular: (i) the local adaptation of varieties and practices; (ii) the valuable diversity which local seed systems harbour; and (iii) their ability to diffuse materials among farmers via alternative social networks and channels (Almekinders *et al.*, 1994). Since then research and development actors have been trying to find ways to build on local seed systems, link with them and integrate them into or with the formal system (Louwaars and de Boef, 2012).

From the 1990s onwards, using more integrated perspectives, seed-sector development strategies considered that the national and local private sector, specialized farmers or farmer groups supported by nongovernmental organizations (NGOs), all have an important role to play in seed multiplication and distribution (e.g. Camargo *et al.*, 1989).

Most developing countries have tried this approach for one or more crops and many of these strategies included elements of participatory plant breeding or participatory varietal selection. Models that involved farmer groups or cooperatives often had the vision that these would become entrepreneurial actors. There are examples of successful entrepreneurs, in particular specialized traders (Tripp, 2002; Van Mele and Bentley, 2011), but the majority of these efforts have still not been considered as sustained successes. The participation of multinational corporations in these efforts is limited, particularly in the food-crop seed sector, with exceptions for the maize and vegetable seed sectors.

For VPCs it is only potato which has seen major seed system efforts (Devaux *et al*., 2011; Manrique, 2013), but these have also borne few sustainable successes. Important bottlenecks which affect seed systems of VPCs are:

- bulky and perishable planting material – with implications for transport requirements, storage and for the maintenance of the planting material in the off season;
- seed contamination and degeneration which takes place through soil-borne diseases and vegetative multiplication;
- low multiplication rates, which therefore increase the amount of time needed to bulk up sufficient supply; and
- ease of propagation and common property nature of the planting material means that there is little profit incentive for commercial seed enterprises.

With renewed attention for agricultural productivity, seed systems and concern for underutilized or 'orphan' crops such as sweetpotato, what can we learn from the experiences so far? After so many failures, are the successful seed enterprises the forerunners heralding more positive developments or are they just outliers? Has the tide turned and have the bottlenecks to seed system development been overcome? Are the past failures no longer relevant? If so, what has changed: the type of initiatives or the overall context? We think that some underlying questions still merit re-examination in order to be as well prepared as we can for the new initiatives that we support, design and implement. We also need to think through how these lessons apply to sweetpotato seed systems, in particular those that priortitize food security and nutrition. This may bring in additional and different goals together with non-conventional actors, and thus alternative thinking about integrating local and formal seed systems.

## 28.3 Seed Demand

Ordinarily, smallholder farmers use seed from their previous harvest, seed from neighbours and relatives, or in some circumstances seed from the market or local agrochemical-input supply shops. Even for regular seed lot replacement, these sources are often sufficient or the most rational seed sources for farmers. Therefore our analysis starts out from the viewpoint that farmer demand for planting material is the most decisive driver for the development of a viable 'seed' supply system. However, 'actual' demand for seed can only be assessed when there is a sufficient supply of quality seed, which is not the case for most crops and in most countries in Africa. 'Farmers' demand' for seed is usually estimated by research and development actors on the basis of area planted with the crop and an 'expert guess' of a replacement rate. Therefore we might ask: Would a better supply of quality seed stimulate demand? Yet, from the perspective of the seed producer there is limited incentive in ensuring a stable seed supply if the seed demand is not stable. This is part of the conundrum of the interdependence between seed demand and seed supply which we need to unravel.

For sweetpotato, surveys frequently report 'shortage of planting material' as a key production constraint. For example, surveys in Lake Zone, Tanzania found that shortage of planting material was ranked third in sweetpotato production constraints (after weevil and drought), with 66% of farmers reporting this constraint (Kapinga *et al*., 1995). Shortages of planting material are more common in areas with unimodal rainfall systems and a long dry season where there is higher risk of loss of planting material. In bimodal areas or areas where there is a longer rainy season, there is always a crop in the ground to provide planting material, but there may be higher build-up of pests and diseases thus contributing to suboptimal root production. The Programme Régional d'Amélioration de la Pomme de Terre et de la Patate Douce en Afrique Centrale et de l'Est (PRAPACE) priority setting exercise in 2003 and an International Potato Center (CIP) survey of the National Agricultural Research Institutes (NARIs) both ranked 'virus management, seed quality and supply systems' as high priority for future research and development against all other listed sweetpotato technologies (PRAPACE, 2005; Fuglie, 2006; Barker *et al.*, 2009). So, ensuring that farmers can have timely access to adequate quantities of quality planting material remains a challenge. Therefore, we consider that farmers' rationale and incentives for purchasing seed are still not fully understood.

Which then are the situations where farmers are actively seeking seed from external sources? Table 28.1 summarizes our understanding of the incentives which influence farmers' seed-purchasing behaviour, which we then discuss in more detail below.

### New varieties

An obvious reason to acquire seed from formal seed sources is to get seed of new varieties. Experts usually asssume that when a succesful new variety is around, farmers are willing to pay a premium price for the seed. There is, however, limited research data to confirm this and the assumption ignores the social context and interactions among different types of farmers when sourcing seed. In any case, for farmers to be attracted to new germplasm, it needs to respond to their needs, preferences and be adapted to their agroecological conditions.

For sweetpotato, breeding work in and for SSA has only gained momentum in the last 5–10 years. While the relative importance of different varietal characteristics differs across countries, yield, root size, drought tolerance and pest and disease resistance are consistently prioritized (Table 28.2).

**Table 28.1.** Relative importance[a] of incentives for farmers to purchase planting material of different crop types.

| | Seed-based crops | | |
|---|---|---|---|
| Incentive | Varieties based on pure lines | Hybrid varieties | VPCs[b] |
| New varieties: genetic superiority of germplasm | + | +++ | + |
| High seed health degeneration rates which affect crop yield | + | – | +++ |
| Specialized practices required for seed production (e.g. this applies to many vegetable seeds where seed is not the harvested product; hybrid seed) | + | +++ | +/– |
| Difficulty to store/perishability of planting material | + | +/– | ++ |
| Small volume and weight (easy to transport) | + | ++ | –– |
| Low multiplication rate | ++ | ++ | ++ |
| A stable profitable market for the crop product | +/– | ++ | ++ |
| Demand in the consumer market for high quality (examples: (i) vegetables; and (ii) demand for grain lot purity, e.g. rice, groundnut) | ++ | +++ | + |
| Poor growing season/crop failure (including disaster contexts) | +++ | – | +++ |

[a]Relative importance is indicated as: +++ higher importance; --lesser importance.
[b]VPCs, vegetatively propagated crops.

**Table 28.2.** Seed demand: sweetpotato attributes preferred by farmers in Ethiopia, Ghana, Malawi, Mozambique, Nigeria, Tanzania and Uganda. (From country Sweetpotato Seed Systems Case Studies prepared for African Potato Association presentation.)

| Varietal characteristics preferred by farmers[a] | Case study countries | Comments |
|---|---|---|
| **Yield, production, pest and disease characteristics** | | |
| High yielding roots | Ethiopia, Malawi, Tanzania, Mozambique | |
| Large roots | Kagera | |
| Drought tolerance | Tanzania, Mozambique, Malawi | Particularly important in unimodal rainfall areas and areas with unpredictable climate patterns |
| Persistent vines | Ghana, Mozambique | |
| High vine yield | Ethiopia | Important in livestock systems |
| Resistance to diseases | Uganda, Tanzania, Mozambique | In many areas of these countries, sweetpotato virus diseases are devastating and resistance is an absolute requirement |
| Alternaria disease tolerant | Lake Zone, Tanzania, Uganda | This disease tends to be a problem in highland areas |
| Weevil resistant | Ethiopia | |
| Sweetpotato butterfly resistant | Ethiopia | |
| **Root flesh colour** | | |
| White and cream | Ethiopia, Mozambique | OFSP varieties: demand increasing where varieties have been introduced |
| Yellow | Ghana and Nigeria | |
| Orange | Malawi, Burkina Faso | |
| **Texture** | | |
| Firmness | Lake Zone, Tanzania | |
| Low fibre | Lake Zone, Tanzania | |
| Mealiness | Kagera, Tanzania | |
| **Other organoleptic features** | | |
| High dry matter | Lake Zone, Tanzania, Ethiopia, Ghana, Nigeria, Burkina Faso, Mozambique | |
| Sweetness | Ethiopia, Malawi | |
| Moderate sweetness | Tanzania | |
| Leaf shape | Malawi, Mozambique | Important where leaves are used as a vegetable |
| **Harvest and postharvest characteristics** | | |
| In-ground storability | Ethiopia, Lake Zone, Tanzania, Malawi | |
| Non-perishable roots | Ghana, Nigeria, Burkina Faso | |
| Early maturity | Ethiopia | |
| High market demand | Lake Zone, Tanzania | |

[a]Farmer preferences are not ranked in order of importance.

Breeding efforts have taken into account these preferences and since 2005, a range of new varieties have been released in SSA, with high levels of beta-carotene, reduced virus susceptibility and improved drought tolerance. Few studies, however, with the exception of work in Tanzania (Kapinga *et al.*, 2003) for traders and in western Kenya for pregnant women and young children (SASHA, 2012), have looked at trait preferences from the perspective of other end users and products (e.g. different types of consumers, fresh root traders, processors, institutional buyers, livestock keepers). If new varieties are a key element of farmers' demand for seed, then as sweetpotato shifts from being not only a food security crop for home consumption but is also marketed and used for processing, new end users and their preferences for additional or different traits will need to be considered (e.g. shelf life, long-term storability, leaf and vine characteristics). When improved varieties are being distributed with the objective of improving food security for poorer farmers, some subsidy may be needed (e.g. through the use of targeted vouchers) to encourage risk-averse farmers to try the new varieties. This also means that when targeting particular vulnerable groups, different entry points and distribution channels may have to be considered.

### Seed quality and degeneration

Decreasing yield is another important driver for farmers to purchase new seed. Decreasing yields are associated with different types of quality loss in seed, which can be related to genetic, health and physiological factors. In crops with well-developed hybrid-variety technology such as maize, sorghum and vegetables, genetic decline (or rather 'disintegration') strongly drives farmers' seed purchasing behaviour. In these crops yearly seed replacement with seed purchased from specialized sources is considered the only logical option by research and development professionals: it is as if farmers have to buy the variety 'new' every season. In grain crops such as wheat, barley, rice and grain legumes such as beans, genetic degeneration has less importance because pure line varieties prevail. However, in situations where there is market demand for consistent quality of the grain product, genetic mixtures become problematic and therefore farmers make an effort to acquire 'pure' seed lots, for example the case of sorghum in West Africa (Tripp, 2002).

Variety mixtures in the field might be considered another form of degeneration or loss of quality. For farmers, however, variety mixtures may not be problematic. On the contrary, mixtures in the field can offer advantages in variable climate conditions and disease pressure (De Haan, 2009). Various researchers have also found that farmers have remarkable knowledge and skill in varietal differentiation, on the basis of morphological characteristics of the plants and tubers. For sweetpotato, variety mixtures in the field are common, either by choice or if volunteer plants emerge from the previous crop. Variety mixtures also occur when planting is done sequentially, from whatever varieties are currently available (Badstue and Adam, 2011). Where grown for food security purposes, sweetpotato is normally harvested piecemeal and so having varieties with different maturity periods in the same field is not a disadvantage, and in terms of mitigating potential climatic, disease and pest risk is beneficial. However, if the crop is grown for commercialization and harvesting is done at one time for a specific end user (e.g. a processor), then varietal mixtures are more problematic and require sorting after harvest.

In VPCs, while genetic degeneration is not usually an important factor due to their clonally propagated character, phytosanitary and physiological considerations are of paramount importance for quality and yield decline. In SSA the most important diseases which contribute to degeneration in sweetpotato planting material are sweetpotato virus diseases, which infect either individually or in mixed infections. Sweetpotato virus diseases are spread through white fly and aphids. *Sweet potato feathery mottle virus* (SPFMV) is the most common, but is largely asymptomatic as a single infection. In mixed infections, *sweet potato chlorotic stunt virus* (SPCSV) and SPFMV combine to present as sweet potato virus disease (SPVD) with stunting, feathery vein clearing and yellowing observed (Carey *et al.*, 1999; Gaba and Singer, 2009). These diseases occur throughout SSA, albeit with differences in prevalence and strain (Gibson *et al.*, 2009).

Reduction in root yield from the complex SPVD infection is estimated at 50% or more (Loebenstein and Thottappilly, 2009). A study in China showed that the use of virus-free material (from sprouted roots) yielded 30% greater than normal planting material – with the yield reducing to the same level after five generations (Fuglie *et al*., 1999). The evidence for reduction in root yield from the impact of single infection (e.g. SPFMV) is more ambiguous, and varies dependent on the susceptibility of the cultivar and which viruses are involved. While severity of symptoms is thought to be correlated with viral load, some viruses are symptomless or latent. The presence of a mild symptomless virus, while occurring singly may not cause significant yield decline, however, once able to combine with another virus may lead to severe visual symptoms. Landraces bred and grown by farmers in Africa together with some researcher-bred varieties (with breeding carried out in East Africa) are said to show little evidence of degeneration (Gibson *et al*., 2009). However, local farmers' cultivars with high levels of resistance tend to be low yielding and late maturing compared with earlier maturing, high yielding, yet susceptible local cultivars or exotic introductions (Carey *et al*., 1999).

In general, sweetpotato farmers are aware of signs that show that the planting material is poor quality, but often link the symptoms to drought rather than to pests and diseases (Gibson *et al*., 2009). In situations where material is in scarce supply, farmers may use what they would otherwise reject. In Malawi, the existing practice was for farmers to select varieties with a strong vine so that the crop would continue growing in the early dry season (Abidin, 2013) (i.e. a varietal characteristic rather than a health characteristic).

Research and development actors and a number of projects have introduced practices to improve the health, genetic and physiological quality of sweetpotato planting material in SSA. These have included: (i) negative selection of symptomless planting material together with roguing of plants with symptoms as they appear; (ii) use of pathogen-tested tissue culture plantlets as the 'foundation' material for further multiplication, limiting the distribution of virus-susceptible varieties to low virus pressure areas; and (iii) continuing breeding work on virus resistance. The use of low-cost screen net tunnels to keep out insect vectors has proved to be very effective in maintaining virus-free planting material for at least 3 years in a virus pressure hot-spot in western Kenya. While the principal objective of root-based vine multiplication systems (e.g. the 'Triple S' or sand storage and sprouting; Namanda *et al*., 2012) is to address the challenge of maintenance of planting material in areas with long dry seasons, this technology may also contribute to improving the health quality of planting material as the roots are only sprouted 2 months before the planting season and the subsequent planting material is not exposed to disease vectors for as long as in conventional practices.

Other diseases and pests which are soil-borne (e.g. bacterial wilts, nematodes, weevil and millipedes) are also of greater importance in VPCs than in seed for grain crops as the roots, tubers (and in the case of sweetpotato vines) are in direct contact with the soil. Planting material of VPCs is living fresh tissue; so any storage period (in the field or once harvested) provides additional opportunities for pests and diseases to proliferate and affect the quality of the planting material as compared to the seed-phase of sexually propagated crops.

Physiological factors also influence quality and degeneration. For sweetpotato the physiological vigour of the planting material is influenced by the age of the mother plant and the section of the vine which is cut and used for planting material. Generally, the older the mother plant (e.g. more than one season) the more opportunity there is for both pest and disease build up and reduced sprouting and vigour of the material selected from it. The older 'woody' part of the vine close to the ground will take longer to sprout. On the other hand plants which are too young (e.g. 2 months or less) are not physiologically mature, and the planting material will not sprout well.

Therefore, a number of questions still need to be addressed around seed quality. Currently, plant health may be more of a preoccupation of research and development practitioners, and we need a more in-depth understanding of farmers' rationale and practices for quality planting material. If there are yield benefits to using disease- and pest-free planting material, under what circumstances will farmers pay a premium for improved quality? When would the use of 'cleaned-up' planting material be economically viable (i.e. which varieties benefit from 'clean-up' and for how many seasons do they continue to produce higher yields than farmers' own selected material)? Moreover, as plant health and seed control bodies become more involved in the certification and inspection process for VPCs we should be aware that inappropriate regulation might act as a disincentive for improving seed quality.

### Need for specialized seed production practices

The need for specialized conditions and practices to produce quality seed provides the basis for an ongoing demand from farmers who are not willing nor able to apply these conditons. These can include specific growing conditions, equipment, storage and packing facilities, as well as specialized practices. This creates opportunities for specialization in seed production for those who have the expertise, growing/storage conditions and are willing to invest in a seed crop. Many vegetable crops need specialized production practices in order to produce and harvest seed. Hybrid seed production similarly asks highly advanced knowledge and practices. In other situations farmer-seed producers have clear advantages to produce quality seed, for example those producing potatoes at higher altitudes where disease pressure and temperatures are more favourable or when being able to produce in the off-season (Thiele, 1999) and those that have access to cold-store facilities in warmer climates.

For sweetpotato and most other VPCs, the simplicity of vegetative multiplication means that every farmer is able to produce his or her own planting material. However, in areas with a long dry season, there is increased likelihood of loss of planting material, or farmers need to wait 2 months after the rains so that roots left deliberately or accidently sprout and produce sufficient vines to be used for planting material. In these contexts, many farmers will purchase planting material. This provides the opportunity for farmer-multipliers who have access to swamps or are able to invest in irrigation equipment and pest-and-disease management practices to maintain and multiply material for sale in time for the next rains.

### Perishability and bulkiness

Unlike seed for grain crops, for most VPCs the planting material is living. For example, sweetpotato can be propagated from botanical seed, or from root slips, but most commonly in SSA it is from stem or vine cuttings from live plants. This makes the maintenance of planting material from the root harvest to the next planting season more challenging than in most seed crops. Living material (approx. 20% dry matter) is also more subject to pathogens and infection compared with dried seeds (80% dry matter). The perishability of the planting material is thus associated with the need for some degree of specialized conditions and/or practices (see previous section). For sweetpotato, specialized conservation or maintenance methods (i.e. for vines only) are predominately used in the unimodal rainfall systems, where there is an extended dry season, or where there is a significant market demand for vines.

Table 28.3 shows these vine conservation and maintenance practices in local sweetpotato seed systems. While these practices are diverse and take advantage of different localized agroecologies, it might be argued that they do not ask for highly sophisticated practices or conditions.

Living material also tends to be more bulky planting material (see Table 28.4). One to two tons of seed potatoes are needed to plant 1 ha for the ware crop. Cassava stem cutting and sweetpotato vines are less bulky than potato seed tubers or the suckers for banana, but still represent heavy and voluminous loads that farmers may need to transport from where they acquire the planting material to where they store and/or plant. For example, for sweetpotato around 34 sacks (with an estimated 1000 cuttings each) are needed per hectare, and transportation needs to be done quickly (to allow planting within 3 days of harvesting the material) in ventilated

**Table 28.3.** Vine conservation and maintenance practices in local sweetpotato seed systems. (Based on Abidin, 2013; Andrade and Naico, 2013; Aragaw *et al*., 2013; Carey *et al*., 2013; McEwan and Namanda, 2013.)

| Conservation method | Case study countries | Comments (e.g. period) |
|---|---|---|
| **Specialized vine conservation practices** | | |
| Planting of vines under enset trees. These vines have been detached from the ware crop planted in October | Ethiopia | Vines are planted during the short rains between January and March for harvesting the roots between June and August. The vines are then replanted August–October for the main rainy season and harvested again in January–March |
| Planting of vines under banana plantation | Kagera, Tanzania, Mozambique (banana and coconut plantations) | Central Mozambique: sweetpotato is harvested to give space for rice in the period October–January, and then sweetpotato is conserved under the banana and coconut plantations |
| Nursery/seed beds mulched with dry grass or maize stalks | Malawi | Watering can or treadle pump is used for irrigation |
| Seed beds located along river beds or wet spots | Lake Zone, Tanzania | Women are responsible for conserving planting material. Small amounts of material from the nurseries are then planted out at the beginning of the rains to generate more material during the season |
| Irrigated gardens | Nigeria, Ghana, Burkina Faso (northern regions) | Raised or sunken beds, or planting on the flat. Planting material is further multiplied during the latter part of the dry season using standard cuttings and spacing to obtain roots and vines |
| Vines planted in fertile back yards | Ethiopia | January–March |
| | Malawi | During winter/dry season: June–October |
| Use of lowlands to conserve vines | South Mozambique | Farmers use the lowlands from August to December to conserve the vines in small plots or plant around the maize, cassava or vegetable plots |
| **Maintenance of a small area of root crop to also produce vines** | | |
| Mulching of ware crop planted in October to maintain vines until June–July the following year | Ethiopia | |
| Roots (accidentally or deliberately) left in soil until rains start to regenerate crop from roots | Ethiopia: January/ February–April | |
| | Lake Zone Tanzania | Areas deliberately left unharvested are protected from livestock |
| | Mozambique: roots left in the field from May to August sprout in October–January | |
| Piecemeal harvesting, leaving the plant in place so the vines survive | Lake Zone, Tanzania | |

*Continued*

**Table 28.3.** Continued.

| Conservation method | Case study countries | Comments (e.g. period) |
|---|---|---|
| Sequential planting for roots so vines are always available | Lake Zone, Tanzania | In bimodal rainfall areas |
| Existing crops and ratoons | Nigeria, Ghana, Burkina Faso (southern regions) | Areas with shorter dry season |
| Leaving sweetpotato plants in between cassava, maize or other crops – the shade helps prevent drying out | Lake Zone, Tanzania, Malawi | In Tanzania: bye-laws compensate for cassava plots damaged by free-ranging livestock, but not for sweetpotato plots. So women plant their sweetpotato in with the cassava to provide some protection from animals |
| **Rotation of root crop between upland and lowland areas with vines as by-product** | | |
| Production of ware crop in wetland areas also produces vines for the following season's planting in upland areas for root production | Malawi | Most farmers are doing this in groups/clubs related to the irrigation scheme. Clubs are promoted by the government |
| Transfer of crop from rain-fed upland to paddies after rice is harvested | Lake Zone, Tanzania | Considerable work is needed to prepare mounds in the paddies before planting sweetpotato (for roots and vines) |
| Shift between upland and low-lying areas for both root and vines | Lake Zone, Tanzania | |
| **Vine 'storage' practices** | | |
| Leaving a bundle in a hole, termite mound or laying in a shallow trench covered lightly in soil | Lake Zone, Tanzania and Malawi | |
| Harvesting roots and re-planting vines in the same field before transferring to another field | Lake Zone, Malawi | |

**Table 28.4.** Multiplication rates and bulkiness of planting material. (Based on Purseglove, 1977.)

| Crop | Multiplication rate | Planting material (per ha) |
|---|---|---|
| Potato | 6–15 | 1500–2000 kg |
| Cassava | 3–4 | 20,000[a] |
| Sweetpotato | 3–15 | 35,000[a] |
| Soybean | 8–38 | 40–60 kg |
| Sorghum | 47–60 | 4–12 kg |
| Maize | 70–200 | 15–25 kg |

[a]Number of cuttings.

sacks and in medium-size open trucks so that the material does not begin to rot. These factors make buying of planting material less attractive and highlights one of the advantages of using decentralized approaches for the multiplication and dissemination of sweetpotato planting material.

### A stable and profitable market for the product

Although there have been no systematic market studies, experiences for different crops and in different situations indicate that a profitable market with stable prices for the product stimulates farmers to invest more in that crop. In Zimbabwe cash income from common beans leads farmers to invest cash in seeds and inputs whereas they do not do the same for cowpea, which has no market and is only used for home consumption (C.J.M. Almekinders, 2014, unpublished data). It seems likely that this situation would be the same for VCPs. (See also Box 28.2 Nigeria sweetpotato case study.)

There are increasing sweetpotato markets both for fresh root markets and for processing in SSA. With their development, it is likely that one-time harvesting of larger areas of sweetpotato will become more common. This may create opportunities for the specialized vine multiplier or for the use of a root-based method for vine production (see previous section).

#### Bad harvests and crop failure

Farmer demand for seed fluctuates considerably, not only between regions but also within a region over time. An important factor is the average yield level of the preceding growing season. After seasons with low yields or crop failures for example, farmer seed demand may be higher because more farmers were unable to save seed for the next season. In contrast, when the production conditions are favourable and the seed producers have a good seed crop, farmers also have good yields and are in a better position to save seed for the next season. This creates a situation of counter-cyclical seed demand. This forms an important challenge for the building of an economically sustainable quality seed supply.

After disasters, seed stocks in an entire region may have been lost. This then requires seed provision interventions of a different nature (i.e. which do not represent regular farmer demand for planting material). In the cases where sweetpotato plays a role in post-disaster relief, institutional buyers may tender for large amounts of planting material. It has been argued that this leads to a distortion of both supply and demand. There are examples – for example Ethiopia where cyclical drought leads to regular distributions of free planting material. Multipliers may have large institutional buyers one year and the following year there is no 'disaster' and since there is no local market for planting material their enterprise collapses (Aragaw *et al*., 2013). Disaster relief contexts can also negatively affect farmer demand. Normally, in these situations the distribution of planting material to farmers is 'free'. Farmers have little choice about the variety, quality or timing of delivery (Sperling and Longley, 2002). This leads to a situation where farmers have little incentive to try to maintain the materials which they have received or do not consider that sweetpotato planting material has a 'value' which they should pay for. We reflect on this type of intervention in a later section.

## 28.4 Seed Sources and Seed Supply

Having examined some of the factors which influence farmer demand for planting material and how this plays out in the case of sweetpotato in SSA, we turn to seed supply, looking at seed sources, affordability, and how these interact with the factors which influence demand.

To date, studies indicate that different seed sources are not equally available, accessible or suitable for smallholders (Almekinders *et al*., 1994). While we can characterize different formal and local seed sources in general terms, farmers use the seed source which suits them best when they need it. For farmers, a local informal source is sometimes superior to distant formal sources; sometimes it is the other way around. It depends on the crop, growing conditions, type of varieties, cost of the seed and the social context; and it can vary from year to year or even between seasons. The use of seeds purchased from traders at local markets may point to a bottleneck in local social relations making seed which might be available from better-off farmers in the community a less preferred option for some community members (e.g. poorer farmers) because other obligations may be bound up in the seed transaction. Most studies on farmers' acquisition or use of seed from different sources relates to seed for grain crops. It is only for potato in its centre of domestication that substantial work of this type has been done (Thiele, 1999; Almekinders *et al*., 2009; De Haan, 2009). For other VPCs much less information is available.

Over time, sweetpotato farmers have developed their own seed practices which to a large extent reflect the influence of unimodal and bimodal rainfall patterns. Farmers source planting material from their own fields or neighbours, friends or kin (Barker *et al*., 2009; Namanda *et al*., 2011). Different sources may be used depending on: (i) whether cultivation is for home consumption, sale or processing; (ii) whether the farmer is seeking new varieties or requires additional or replacement material of existing varieties; (iii) seasonal conditions; (iv) the time in the season when material is being sourced; and (v) the presence of ad hoc opportunities to obtain planting material (e.g. social visits, funerals). In many societies planting material is considered a common good, and farmers can ask for or take seed freely from the fields of neighbours. Planting material is also sold; the price depending on the geographical or social proximity of the source, time in the season and presence of strong markets for roots. Where the crop is considered a woman's crop, there are strong social and kin networks for sourcing vines which may be resistant to commercialization (Badstue and Adam, 2011). In areas where the crop has become commercialized, men become more involved and there may be a greater willingness to pay because men have access to, and/or the decision-making authority over, financial resources. In parts of Ghana (Bawku), Burkina Faso (Leo, Po, Bobo) and Nigeria (Kano, Kaduna and elsewhere), where sweetpotato roots are commercialized, there is an actual commercial market for planting material with significant off-season production, integrated with dry season vegetable production (Carey *et al*., 2013).

## Seed availability and multiplication

A factor which is related to the bulky character of VPCs is the relatively low multiplication rate as compared with grain crops (Table 28.4). Multiplication rates of sweetpotato vary according to the technique used, the variety, the agroecological conditions and management practices but can range from a low multiplication rate (e.g. 1:12) using conventional multiplication to 1:50 using rapid multiplication techniques (Stathers *et al*., 2012). This affects the quantities of planting material which are available when needed for planting the ware crop.

For sweetpotato, new multiplication methods using both vines and roots are being tried out in different countries and conditions (McEwan, 2013). Some promising methods which have been promoted include the use of rapid multiplication techniques in specially prepared seed beds. This has included testing two or three node cuttings and different plant spacing for vine multiplication (CIP, 2012). Closer spacing is more suited to contexts where high management is possible and there is access to irrigation. Adjusted conventional spacing (e.g. a 30 cm cutting with 15 cm between plants × 75 cm between ridges) has been used with farmer multipliers in Malawi, with the objective of producing both planting material and roots during the November–April hunger period (Abidin, 2013).

Sweetpotato multiplication techniques have also been tested which build on existing farmer practices to be able to maintain the planting material after the harvest until the next planting. This method is appropriate in areas with an extended dry season and has been trialled in parts of Uganda and Tanzania. Farmers can make a careful selection of small (unmarketable but undamaged) roots, which they then store in dry sand in a container during the early part of the dry season, in the home or a store. About 5–7 weeks before the expected start of the rains the roots are planted out in a protected bed, which is then watered on a regular basis. The roots sprout and can provide planting material at the start of the rains, successfully producing 40–60 cuttings per root (CIP and NRI, 2011; Namanda *et al*., 2012). Women in particular have reported that it gives them more control over the source of their planting material, so avoiding having to expend time 'looking for vines'. The technology is also being tested in Malawi.

### Seed price and affordability

Seed quality and seed price are often presented as trade-offs for farmers, and it is frequently suggested that in many situations farmers cannot afford to buy seed from formal sector sources. For sweetpotato, there is no regular supply from a formal seed source in SSA with the possible exception of the Republic of South Africa. Sweetpotato planting material is often considered a common good (i.e. freely available to whoever wants it) and is therefore 'affordable'. In some situations, while local varieties continue to be made available freely, planting material of improved varieties is bought and sold. However, for specialized multipliers there are costs involved, in particular: (i) hire of land; (ii) use of irrigation; and (iii) additional labour for bed preparation, weeding, disease management and harvesting. Therefore, a continuing challenge in many countries is how to maintain emergent vine multipliers in an environment where the commercialization of the vines is incipient, and traditional practices of vine sharing coexist. This underlines the need to appreciate that specialization may be possible only on a small scale, and to consider mixed enterprise and social models for increasing the availability of planting material.

## 28.5 Strategies and Approaches for Dissemination of Sweetpotato Planting Material

We now turn to review and discuss some of the different strategies which have been used to scale the dissemination of sweetpotato planting material (i.e. ensuring adequate and timely quantities of quality planting material) and the factors which have influenced the type of approach used. Three broad approaches have been used depending on the challenge being addressed, the context, and goal of the seed intervention. These are: (i) post-disaster mass multiplication and mass distribution; (ii) decentralized multiplication and distribution; and (iii) a sweetpotato seed enterprise as part of the sweetpotato value chain.

### Post-disaster mass multiplication and mass distribution

Sweetpotato planting material has often been distributed with the objective of contributing to improved food security in post-disaster or post-conflict situations. The advantage of the crop is that it requires minimum inputs, matures in around 4 months and can fit into different cropping systems. The approach which has been used most in these situations is mass multiplication and mass dissemination. Under this scenario, planting material is multiplied at centralized sites, harvested and transported to central points for distribution on a predetermined day. This approach has often been used in post-disaster and post-conflict situations such as:

- after the 2001 floods in Mozambique (Andrade and Naico, 2013);
- post-conflict resettlement programmes in northern Uganda in the mid- to late 2000s (Potts, 2006); and
- in Ethiopia after recurrent cycles of drought (Aragaw *et al*., 2013).

Some of the criticisms of this approach include: (i) the wastage and loss of material; (ii) the undetermined quality of the planting material; and (iii) that it provide farmers with limited choice (of varieties and timing for collection) and information. Distribution is normally 'free' to farmers, raising concerns as to whether farmers will value the material and make an effort to maintain it. Yet, this 'campaign' or single-shot type of dissemination may be appropriate when replacement material is needed quickly, and in bimodal rainfall areas it may be suitable for injecting new varieties into a system such that once the replacement material is in the system it will then flow from farmer to farmer and is more easily conserved or maintained than in areas with a long dry season (Stathers *et al*., 2012).

### Decentralized multiplication and distribution

The challenge of the bulky and perishable nature of sweetpotato planting material has influenced efforts to extend availability by decentralizing farmer access to planting material with general developmental objectives. This approach has been used to disseminate new varieties or cleaned up material from formal breeding programmes through the use of variations on the '1-2-3' multiplication approach (Abidin, 2013; McEwan and Namanda, 2013). This involves:

- 'primary multiplication' at research stations or on an experienced farmer's plot under researcher supervision;
- 'secondary multiplication' to bulk up the planting material, which can be under the management of experienced farmer groups or entrepreneurial individual farmers, with supervision from research or extension service providers from the public sector or NGOs; and
- 'tertiary multiplication' under farmer groups or individual farmers (decentralized vine multipliers) who normally produce both roots and vines.

The catchment area for the tertiary decentralized level depends on population density, but is usually based around a 9–12 km radius. Since the mid-2000s decentralized multiplication and distribution approaches have been used in Ethiopia, Mozambique, Kenya, Uganda, Malawi and Tanzania to target specific vulnerable groups (resource-poor farmers and farming households with pregnant women and children under 5 years old) in particular, with biofortified crops. This has required novel entry points and a different group of stakeholders to be involved to support demand creation and information education and communication activities. This has been done in collaboration with health facilities, community-based health workers, and using a partially or fully subsidized voucher system. This approach is implemented within a project time frame, through international NGOs (INGOs), NGOs and community-based organizations (CBOs), with technical support from the national research system and CIP. In Ethiopia, decentralized vine multiplication is being implemented with state-managed farmer training centres and model farmers. An example from Malawi is shown in Box 28.1 where there has been a deliberate effort to re-engineer the seed system, include non-conventional

**Box 28.1.** Malawi: decentralized vine multiplication (from Abidin, 2013)

In Malawi, government policy has supported agricultural diversification, and yet at the same time malnutrition remains among the highest in SSA with vitamin A deficiency rates among children less than 5 years old at nearly 60%. Sweetpotato is becoming a major food source (third after maize and cassava) and increasingly contributes to the food basket, especially in the months where maize is scarce or the price is too high for poor people. The crop is also becoming a source of cash and employment to many farmers. Dry spells are increasingly common, so there is great interest in sweetpotato. Access to clean planting material, however, remains a challenge in sweetpotato production, due to build-up of virus diseases and subsequent yield reduction; some varieties (e.g. the orange-fleshed cultivar, Kamchiputu) might have disappeared due to this. Land pressure is causing cultivation by smallholders to extend into marginal and less fertile areas thereby negatively affecting sweetpotato production and availability of clean planting material at the onset of the rainy season. Some farmers, particularly in the central and southern regions, practise intercropping and relay cropping to resolve the problem of land pressure and to secure food during the prolonged dry spells. These cultural practices also contribute to reducing the problem of shortage of sweetpotato planting material at the start of the rainy season. Maize and sweetpotato, maize and pumpkins or maize and groundnut or sweetpotato and soybeans are commonly planted together in one row/ridge. The first rains generally appear in the month of November. Short duration crops intercropped with the sweetpotato are chosen with a life cycle of 3–4months. When the first crop is harvested in February, the vines of sweetpotato are available on a relatively large scale to plant for the production of storage roots. CIP and partners through the Rooting out Hunger in Malawi with Nutritious Orange-fleshed Sweetpotato (OFSP) project have taken an integrated (seed system, demand creation and postharvest interventions) approach to the promotion of OFSP. In Malawi, the '1-2-3' seed system model comprises research, extension and trained farmers. A strong enabling policy environment promoting dietary adequacy and improvement in dietary quality among the most vulnerable groups has also supported the expansion of OFSP. Effective partnerships have contributed to the integration of OFSP interventions into the Scaling Up Nutrition (SUN) initiative.

stakeholders to achieve food security and nutrition goals and to institutionalize linkages for the flow of material through the different tiers of multiplication.

In this Malawi case, careful planning has ensured that a project intervention builds upon existing vine conservation and multiplication practices such as shifting between upland and lowland areas and using inter- and relay cropping practices to address limitations in land and climatic conditions. In Malawi an integrated agriculture-nutrition-marketing approach was used to promote: (i) increased production of sweetpotato; (ii) increased awareness of the nutritional benefits of the OFSP varieties; and (iii) a value addition component. The Malawi model has also been successful in linking into national and international policy initiatives (e.g. the SUN movement) through showing that food-based approaches are both feasible and appropriate for contributing to reduction in micronutrient deficiencies and improving nutritional well-being.

The example from Malawi also illustrates how nutritional considerations have influenced the strategy adopted. In order to stimulate demand for the vitamin-A-rich orange-fleshed varieties, this decentralized approach has been combined with a subsidized voucher system to be able to target particular vulnerable groups such as pregnant women, children under 5 years old, school children and people living with HIV. In some cases, for example Sweetpotato Action for Security and Health in Africa (SASHA) and DONATA (Dissemination of New Agricultural Technologies in Africa) project interventions in western Kenya and Rwanda, novel entry points for sweetpotato vine multiplication and dissemination have been used such as health facilities, schools, churches and mosques (SASHA, 2011, 2012; CIP, 2012). To a certain extent these development-orientated interventions have built upon existing practices of farmer-to-farmer dissemination and social networks through supporting farmer-group multiplication plots to provide vines to members, either free on a pay-back or pass-on basis; and in addition sell on a small scale to other farmers for group income generation.

## Sweetpotato seed enterprise as part of the sweetpotato value chain

In many countries there are farmers who have been multiplying sweetpotato which they sell for cash or distribute by gift or barter. There are examples of where this practice has become increasingly specialized and commercialized. In parts of Ghana (Bawku), Burkina Faso (Leo, Po, Bobo) and Nigeria (Kano, Kaduna and elsewhere), where sweetpotato roots are commercialized and there is market demand for planting material, there is significant off-season production, integrated with dry season vegetable production. A short case study of commercialized informal sweetpotato vine multipliers in Nigeria is presented in Box 28.2.

In a number of countries project-based interventions have tried to support incipient commercialization in different ways. Seed is only one segment of the overall sweetpotato value chain, and as the example of local vine multipliers in Nigeria shows, where there is a large urban market demand for roots, commercialized vine multiplication is possible. In Ethiopia as shown in Box 28.3 there is the example of integrating the vine enterprise with other farm enterprises such as root production, and vines for livestock fodder. In western Kenya, a community-based organization, the Siwongo Drainage and Irrigation Group, initially supported through project funds, has transformed its status into a limited company and extended its activities from vine multiplication and processing to contracting farmers for root production. Now the Siwongo Processing Company works across the whole value chain from vine multiplication, root production and processing, with linkages to a distributor agent. Each segment provides an element of risk diversification. The company currently contracts farmers (incipient seed out-grower system) to produce planting material and or roots (Makokha, 2012). A critical factor in the growth of the company was the ability to access credit so that farmers could be paid cash for roots even when there was delayed payment for the processed flour from the distributor. In Rwanda we have seen a similar evolution and growth

**Box 28.2.** Nigeria: commercialized informal sweetpotato vine multipliers (from Carey *et al*., 2013)

Until recently, sweetpotato has received little consideration in agricultural policies of most West African countries. As a result, crop production statistics have not been systematically tracked and reported and reliable information is scarce. Striking increases in production, led by a doubling of yield to 20 t/ha are reported for Burkina Faso, while yields of 2–3 t/ha are reported for Ghana and Nigeria. Even with such low production, Nigeria is reported to have the second largest production of sweetpotato in SSA, after Tanzania (FAOSTAT, 2013).

The extended rainy season in the southern regions is weakly bimodal; in these areas with a shorter dry season, planting material is selected from existing or ratoon crops. In areas where sweetpotato can be grown in three seasons (i.e. farmers have access to fadamas (low-lying irrigable plains)), vines are sourced from their own farms especially for the second and third season or from friends/neighbours. The northern regions are characterized by an increasingly short rainy season as one goes farther north, and a long, harsh dry season. Highly weathered, sandy soils and high temperatures (due to low elevation and latitude) exacerbate stresses and restrict dry season farming to irrigated areas. In dry, livestock-system-dominated areas farmers are unable to conserve their own vines due to lack of water or damage by free-grazing cattle.

Studies by Peters (2013) and others (Anyimah-Ackah, 2012; Bidzakin and Acheremu, 2012; Onumah *et al.*, 2012) indicate that sweetpotato is an increasingly important cash crop with considerable unmet demand in both urban and rural markets where it is typically consumed boiled or fried. Planting material is either produced for own use or sale in each of the countries, particularly in areas where the crop is commercially important (Peters, 2013). Vine conservation is carried out in irrigated gardens and may be in raised beds, sunken beds or on the flat; sweetpotato planting material is produced in these areas so as to be available at the onset of the rains. There are specialist vine multipliers in wetland areas or along the banks of rivers.

Examples of this are around Kano and Kaduna where there is a strong market for roots and there is also significant specialized vine production. Farmers, who are predominantly male, combine high-value horticultural crops and vine multiplication in wetland areas or along the banks of rivers. The farmers have identified a narrow window in the season when sweetpotato vines can command a high price. Their customers are local or regional farmers who come to buy vines direct from source, using private or public means of transport. The multipliers ensure that the planting material is ready on time or otherwise they risk missing the market. The quality of the planting material is unknown.

**Box 28.3.** Ethiopia: commercial vine multiplication as part of an integrated business model (from Woldegiorgis, 2012)

In Tigray, northern Ethiopia, sweetpotato is a newly introduced crop, and one interesting example is where a commercial agricultural enterprise (Minora Agricultural Investment Share Company) have used an integrated crop and livestock business model to support a vine multiplication enterprise. The company earns income from crops (including sweetpotato roots), horticulture, livestock and poultry; and existing irrigation facilities are used for sweetpotato vine multiplication. CIP has provided starter material for orange-fleshed varieties and in an effort to support the emergence of a sweetpotato seed system also buys vines from the company for distribution to other multipliers. Additional value from sweetpotato is derived from: (i) sale of planting material; (ii) sale of vines for livestock fodder; and (iii) utilizing sweetpotato as a rotation crop and for erosion control. The company's business model also incorporates social values through extending knowledge and practices to the community as farm employees take practices onto their own land, families and communities. Other farmers in the community have also started to grow and use vines for livestock fattening and poultry in addition to consumption of the orange-fleshed varieties by the family members, especially children.

from a CBO to a limited company and diversification into all segments of the sweetpotato value chain (Habumuremyi, 2012). Ibyiwacu Company Ltd was able to access sizeable bank loans. However, in both examples accessing formal markets (e.g. urban supermarkets with processed products) requires national Bureau of Standards Certification.

These examples of vine multiplication enterprises associated with other value chain segments show that diversification of products allows a spread of risk and vertical integration can strengthen coordination in the chain. In a mixed enterprise there can be both economic and environmental benefits. However, the enterprises need to be business driven with strong market linkages.

We have reviewed three broad sweetpotato seed system approaches from the perspective of what is working where and for who: (i) mass multiplication and mass distribution; (ii) decentralized multiplication and distribution with elements of social enterprise built in; and (iii) the seed system as part of the sweetpotato value chain. A strong profit rationale is often presented as the basis for a sustainable sweetpotato seed system, and this route has potential in areas with access to well-developed markets for roots and vines. In such areas there is a consistent demand for quality roots; root producers can be linked to the commercial supply of quality seed. Medium- to large-scale multipliers or farmer groups can have the infrastructure and organizational capacity to plan and supply seed to root producers. There may be a high demand for seed, but during a very short window. In this scenario multipliers are integrated into and operating within a market economy. However, we still need to ask the following questions:

- Are there barriers to market entry for would-be specialized multipliers?
- What happens when an intervention is targeting non-conventional seed demand and and in areas where there is limited market penetration?

## 28.6 Discussion

We started the chapter with a discussion around the characteristics of farmers' demand for seed, the interactions between different drivers of a seed system and how this played out for sweetpotato. As we return to discuss the question of how to get sweetpotato seed systems moving in SSA, we note the key constraints which have been identified in existing seed practices: (i) low multiplication rates; and (ii) perishability. Together these lead to limited availability of planting material. In unimodal rainfall systems with a long dry season the challenge is to maintain planting material from the root harvest period to the next planting time; in bimodal rainfall systems the challenge is disease and pest build up which can be transferred through planting material from one crop to the next. In combination these factors contribute to late planting, limited areas planted to sweetpotato, and low productivity. This in turn reduces the potential of sweetpotato to provide a source of food and income to bridge the chronic hunger period experienced by many households before cereal crops are ready for harvest.

We have seen that the complexity and diversity of existing seed practices allows for local specificity and flexibility to respond to dynamic agroclimatic conditions. Currently efforts to multiply and distribute planting material (whether based on informal farmer-based systems or project interventions) are mostly on a local and relatively small scale. Farmer demand for seed is uncertain and the quality of planting material is generally unknown – neither to farmers nor researchers.

Although in many countries sweetpotato has been regarded as a 'subsistence' food security crop there are increasing opportunities for commercialization, which will also broaden the recognition of the role which sweetpotato can play to contribute to the food security and nutritional well-being of vulnerable groups. The commercialization of the crop has a range of implications for its seed systems, for example different end users, different traits, different varieties and different types of harvesting. In turn this provides opportunities for specialist multipliers. This review of the literature, analysis of some of the experiences with VPCs and sweetpotato and reflection on some of the issues around scale leads us to three conclusions.

First, we have identified three broad approaches which are associated with the way sweetpotato is currently promoted in SSA. These types of interventions for sweetpotato seed systems are not necessarily or exclusively pursuing the objective of 'seed sector development' with the goal of improving agricultural productivity. Instead the reasons for intervention are much broader, with objectives related to improved food security, nutrition and post-disaster recovery, in particular for the most vulnerable households in rural areas. This means that we need to be more careful in assuming we understand farmers' demand for seed and we need to be more considerate in the design of interventions. Designing interventions to support the availability of sufficient quantities of sweetpotato planting material requires an understanding of the locally specific drivers (i.e. agroclimatic, market, social context and varietal preferences) and their implications for the way in which we work to support seed systems. We also need to consider how to balance economic, environmental and social sustainability.

Secondly, we have seen that a diversity of farmer practices to multiply and maintain sweetpotato planting material exists and are well adapted to local conditions. There are many examples of situations in which farmers have developed a degree of specialization and commercialization of planting material. In comparison to a VPC such as potato, the production of sweetpotato planting material requires relatively less expertise – in the sense that all sweetpotato farmers can produce their own planting material without much extra training and investment in infrastructure compared with, for example, the rapid multiplication techniques for potato. The opportunity for specialization seems to relate more to the conditions needed for the maintenance, multiplication and marketing of vines (i.e. access to different land types, access to water in the off-season, ability to invest in appropriate irrigation or to integrate into irrigated vegetable production systems, and closeness to a profitable market for sweetpotato roots). In order to protect the planting material against phytosanitary degeneration, specialized structures and practices (screenhouses, net tunnels, extra application of fungicides and pesticides) will also become increasingly relevant. These do require investment, but are not of such high capital and capacity level that they would be beyond the reach of smallholder farmers. Specialization can be local and small scale to take advantage of different agroecologies and address end-user preferences. This creates space for farmers who would otherwise not be the logical actors to engage with in seed sector development, to engage in the multiplication of sweetpotato planting materials, for example less-privileged smallholder women farmers. They may find a profitable niche from which they can reap benefits, without high levels of investment in capacity or infrastructure. The material characteristics of the root crop and its seed – its perishability, bulkiness and the common property nature of vines (i.e. they are the common property of everyone so anyone can take vines from a field) – further also underlines the economic rationale for 'staying local' and ensuring that seed production and root production areas are in close proximity.

Finally, If we allow ourselves to think along alternative lines, we see opportunities in SSA for the emergence of a seed provision system for sweetpotato that is aligned with the interventions that do not pursue seed-sector-development objectives only, but which also importantly strive to strengthen the food and nutrition security of the poorest and most vulnerable households in locally appropriate and sustainable ways. Thus we consider it unlikely that 'conventional' economically sustainable seed systems will emerge for sweetpotato. An alternative is to seek to build a large-scale pattern of small-scale enterprises, where small (and local) can still be beautiful.

For small and local to work at scale, however, we need to fix the current disconnection between breeding efforts in the 'formal' sector and 'informal' farmer-to-farmer dissemination. This will require a much better understanding of how to make linkages and partnering mechanisms across a range of stakeholders who have different objectives and are coming from different sectoral and disciplinary viewpoints.

## Acknowledgements

The authors would like to thank Elias Urage of Hawassa Agricultural Research Centre, Hawassa, Ethiopia and Abiyot Aragaw of CIP, Hawassa, Ethiopia for additional contributions.

## Note

[1] Throughout this chapter planting material and seed are used interchangeably.

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