

SWEETPOTATO VINES (PLANTING MATERIAL) AS A BUSINESS IN AFRICA: Commercializing seed systems in Uganda and Tanzania

Richard Gibson¹, David Phillips¹, Everina Lukonge², Yuventino Obong³, Gration Rwegasira⁴, Stephen Kalule⁵ & Wilfred Mushobozi⁶



¹Natural Resources Institute (NRI), University of Greenwich, Kent, ME4 TB, UK. Email: nosbigrw@yahoo.com

²Lake Zone Agricultural Research & Development Institute (LZARDI)-Ukiriguru, P. O. Box 1433, Mwanza, Tanzania. Email: elukonge@yahoo.com.

³NARO- Ngetta ZARDI, P.O. Box 52, Lira, Uganda. Email: yobong2003@yahoo.com.

⁴Sokoine University of Agriculture, P. O. Box 3000, Morogoro, Tanzania. Email: grwegasira@yahoo.co.uk

⁵Gulu University, Laroo Division, Gulu, Uganda. Email: wamalakalule@gmail.com

⁶Crop Bioscience Solutions Ltd, P.O. Box 15040 Arusha, Tanzania. Email: w.mushobozi@ecoagricsolutions.com

Acronyms

BMGF	Bill and Melinda Gates Foundation
DVM:	Decentralized vine multiplier
ISSD:	Integrated seed sector development
NARS:	National agricultural research station
NGO:	Non-governmental organization
NRI:	Natural Resources Institute
OFSP:	Orange-fleshed sweetpotato
WFSP:	White- (or cream) fleshed sweetpotato
ZARDI:	Zonal agricultural research and development institute
NaCRRI:	National Crops Resources Research Institute

Published in 2016 by: Natural Resources Institute,
University of Greenwich,
Central Avenue,
Chatham Maritime,
KENT.
ME4 4TB, UK

Frontispiece. Vine sellers located strategically at a major road junction in Arua District, northern Uganda.

INTRODUCTION

In the many parts of Africa that have a long dry season, farmers complete the main harvest of sweetpotato roots by the early part of the dry season. This harvest and desiccation during the remaining part of the season destroy the foliage of these crops, so those that supply vines for planting when the rains return are the few grown during the dry season in swampy areas or where they can be irrigated – and most farmers do not have such land. This makes these vines valuable and their production and sale as planting material become businesses. Some get traded long distances, creating roles and jobs within value and supply chains.

This booklet is mostly based on the findings of a project in Tanzania and Uganda (2013 – 2016), funded by the Bill & Melinda Gates Foundation and aiming to strengthen and commercialize multipliers, traders and sellers in vine supply chains. It focuses on:

1. Sweetpotato vine markets and marketing.
2. Business opportunities in informal/ private enterprise seed systems.
3. How multipliers can increase the quantity of vines produced and sold.
4. How multipliers can improve the quality of vines sold.

The main purposes of the booklet are to encourage current and potential multipliers and suggest how they can improve vine businesses. Many of the people using it will be in development and extension; they will then be the route for multipliers to access the information. An underlying aim is to make such people aware that there is a vibrant seed system already supplying smallholders in Africa with planting material. This sustainable foundation provides the base from which a modern seed system able to support a thriving industry will develop.

HOW WE WORKED WITH THE INFORMAL/ PRIVATE ENTERPRISE SECTOR

To improve the private enterprise vine multiplication system, we needed to understand its existing practices. It required several studies conducted over a few years to do this adequately, including capturing prices and flows of vines over a sufficient period of time. We also had rules of engagement with actors and these from the beginning of the project were:

- The choice (of varieties, propagation techniques, fertilizer, markets etc) came from the formal system but actors in the informal system chose what they wanted to use.
- The informal system has a market-driven enterprise culture. To maintain this was a priority so creating cooperatives and using charitable organizations did not occur.
- The multipliers etc were provided with **knowledge** at no cost but they had to purchase **things**. We did pay for labour for small demonstration trials but did not pay to use multipliers' land. The outputs of the trials (vines and roots) belonged to the owners to do with as they wished but we encouraged them to give small quantities to other multipliers.
- Distributing new varieties to farmers was perceived as inefficient because they often lost them in the dry season. Instead variety demonstrations were on multipliers' fields and were the sources of new varieties, directly introducing them into the seed system.
- We used a multiplier's land for a demonstration trial only once, to avoid favouritism and to ensure lessons remained valued and did not become routine.

In addition, previously-established good relationships amongst the project team allowed decisions to be made quickly and allowed the multipliers, traders and sellers to see the ZARDI and university teams (the people working with them) as decision makers. A modest budget meant we were not divorced from the realities of the people we were working with.

THE PRODUCT AND THE MARKET

Vine cuttings, usually about 30cm long and cut from growing crops, are used to plant sweetpotato crops. A few vines can be harvested with little effect on root yield; ‘youngish’ vines harvested at final root harvest are also used. Storage roots are never planted directly though they do sprout. Crops are usually planted on mounds or ridges. Where the aim is to produce only cuttings, crops may be planted ‘on the flat’ in a bed and fertilized: more vines and few roots are then produced and the vines can be harvested several times.

Most farmers in Africa do not have land where they can maintain a crop during the long dry season and need to buy vines in the subsequent rainy season. At 2-3°N or S, crops can survive the dry season in swampy areas; at 4° N or S and higher, the long dry season exceeds 4mths and multipliers usually have to water (Plate 1) to ensure a crop’s survival. Consequently the most important requirement for a seed enterprise is permanently-abundant water. The scarcity of suitable land and the cost of maintaining crops result in the vines being valuable.



Watering is arduous and the seed system cropping cycle is generally timed such that the dry season crop reaches ~3mths old when the rains start. In this way, its final growth, when it needs most water, is completed under natural rainfall. This generally works well for farmers too as most first want to plant their cereals and grain legumes when the rains come.

Plate 1: Women watering a sweetpotato plot manually (Gairo District, Tanzania)

Available markets/ customers: There are three main customers:

1. Smallholders lacking wetlands.
2. Mid- to large-scale farmers lacking wetlands.
3. Projects, mostly led by non-governmental organizations (NGOs) but sometimes by local or national government.

And two ways of marketing:

1. On-farm.
2. Off-farm in local markets in towns or at sites strategically located on main roads.

These different customers and markets have specific characteristics.

Selling on-farm: Buying vines on-farm is generally cheap. To achieve this, smallholders usually harvest the vines themselves (Plate 2). This also allows them to check the quality of what they are buying and to pick and choose. They can afford only small quantities but sales involve few costs and multipliers can do other things whilst the vines are being harvested. It also means the multipliers don't have to hire extra labour to cut the vines or to transport the vines and the vines are not harvested unless sold so there is little waste.



Plate 2. Farmers harvesting and packing vines to buy from a multiplier on-farm (Shinyanga District, Tanzania)



Sales on-farm are mostly to smallholders living within a 30km radius. This is about the maximum distance smallholders can easily travel to and from in a day by pedal cycle (Plate 3).

Plate 3. Farmers taking vines home by pedal cycle they have bought from a multiplier. (Rwanda)

If the smallholders cannot communicate with the multipliers before they come, the latter may not be available when they arrive.

They could also have no vines to sell, lack the right quality or variety, or ask too high a price. An increasingly common improvement is for both customers and multipliers to have mobile phones and for customers to phone ahead to check everything they need will be available when they arrive. With some medium- to large-sized farmers, projects and a few smallholders, the multipliers may harvest the vines before the customer arrives. This may cost extra but payment can then be made by phone and the multiplier forward the vines, saving the customer even more time.

Sales to projects can be lucrative as they often make huge purchases and pay high prices.



Their sales are, however, often infrequent and unpredictable to the multiplier. They may also demand special varieties (e.g., OFSP) and phytosanitary certificates.

Plate 4. Loading a truck with large quantities of vines for a project (Gulu District, Uganda)

Selling off-farm: A few multipliers sell vines at roadsides and local markets rather than wait on-farm for customers. This may achieve more customers and higher prices but it does require the multipliers to harvest the vines, take them to market and stay until they are sold. This can be time-consuming and even unproductive because customers may not come if they are not sure vines will be available to buy. However, in Gulu town, there is a late afternoon/



evening market and for this the multipliers do not have to give up their whole working day. This allows them to attend such a market regularly, so they can develop a clientele of customers who come to the market knowing vines will be available to purchase.

Plate 5. Smallholder multipliers selling vines in an evening market (Gulu Town, Uganda)

Sellers in markets: Enterprising women have realised that customers require confidence that vines will be available to buy at a particular time and location and have created a full-time job for themselves selling vines in the market (Plate 6). Their customers know vines will be available for sale, that there will be a choice of varieties and even sellers – so they can bargain. Selling vines from multiple

sources means the sellers do the selling job of several multipliers and at the same time ensure they have a stable supply of vines.



Plate 6. Vine sellers waiting for customers (Gulu Town, northern Uganda)

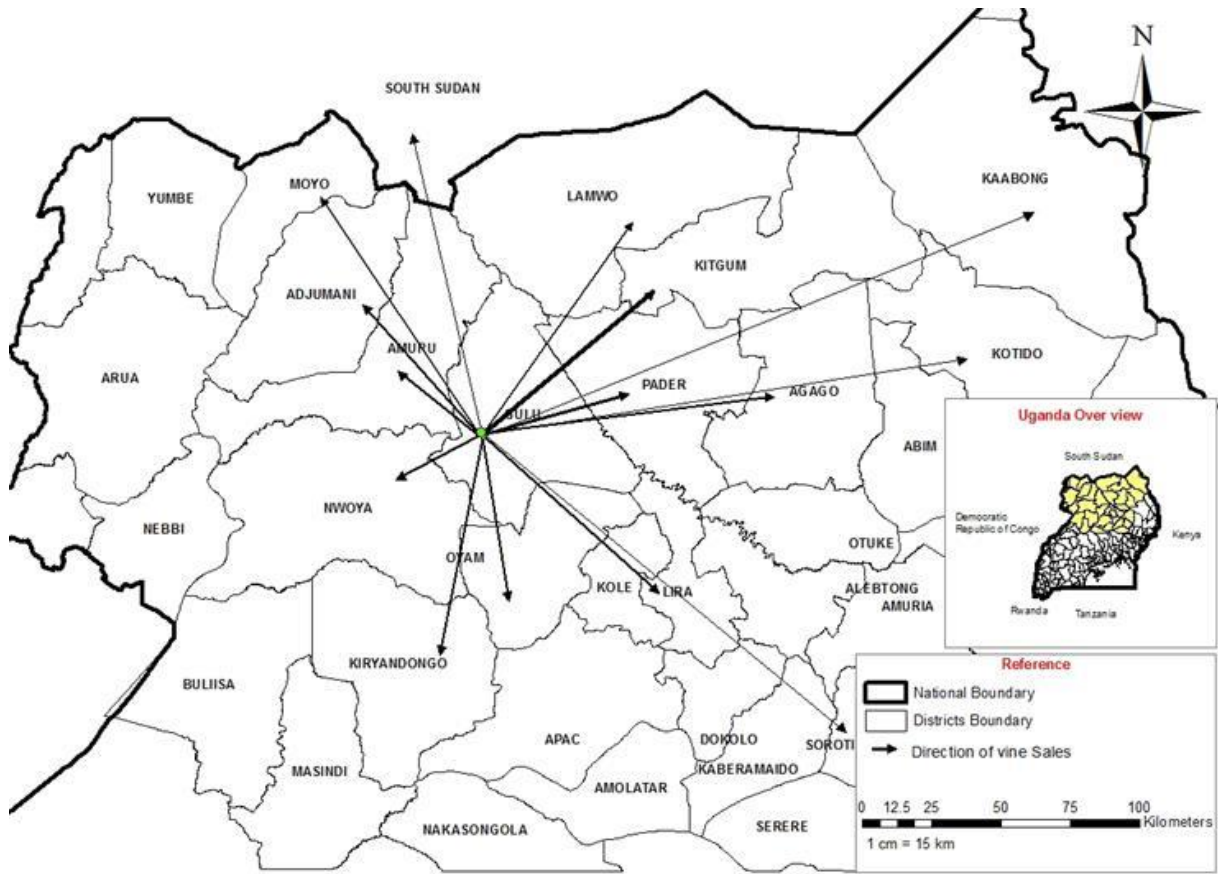


Figure 1. Locations of customers Gulu town sellers outside of Gulu District; the thickness of the arrow indicates a greater quantity of sales.

Gulu town is a hub for people travelling south or north to Kampala and Juba respectively and east to Kitgum and Pader; the sellers are located strategically between the main market and the bus station. As well as selling to local farmers, about 40% of their sales are to customers

from outside Gulu district (Fig 1) using various types of vehicles (Plate 7). Similarly in Arua in West Nile Uganda, vine sellers are located both in the town itself but also a few kilometres outside it at Ombatini Junction, strategically located where the main road north branches east to Rhino Camp. Their market seems to be the whole of northern West Nile region.



Plate 7. Different vehicles used to transport vines long distances. *From the top-left clockwise: a matatu; a communal taxi; the hold of a bus; a truck (Gulu Town, Uganda)*

This long-distance marketing and the willingness of smallholders to cycle up to 30kms for vines is potentially a major asset to the sweetpotato industry. Surprisingly, plant breeders have failed to exploit it to disseminate a new variety to farmers using these hub points and relying on private enterprise to complete the coverage.

Table 1. Characteristics of different markets

Type of market	On-farm to local farmers	Through local markets	Mid- to large-scale farmers	Projects
Location of customer	Local	Local & distant	Local & distant	Mainly distant
Size of purchases	Small	Small	Medium	Large
Number of sales	Few	Many	Few	Very few
Regularity of sales	Regular	Regular	Regular	Unpredictable
Costs of selling	Few	Transport to market & seller	Harvesting & packing	Harvesting & packing
Price of vines	High	Low	High	Very high

The sellers need to make a living and the price paid by the sellers to the multipliers is generally low. Multipliers selling through sellers may also have to harvest, pack and transport the vines to the sellers. Nonetheless they do sell this way, showing that the advantages gained by selling through sellers exceed the disadvantages. As well as saving time, a major advantage to the multipliers of selling through market sellers is access to more customers (Fig 1). This probably also brings gains in market stability. Indeed, in Gulu, only sellers and multipliers working with them seemed to expand their businesses in 2014 and 2015.

Business opportunities:

For multipliers:

- **ADVERTISE:** *It is often particularly difficult to sell on-farm. Customers need to be informed of the opportunity to buy so signboards placed strategically by busy roadsides, in market places or other situations where smallholders might pass are essential for attracting them (Plate 8). Be sure to include:*
 - *Mobile phone number;*
 - *Name & address;*
 - *The varieties for sale.*



Plate 8. A multiplier with his signboard placed by a busy road near a village.

- **COMMUNICATE:** *Invest in a mobile phone so distant customers can telephone to check when the multipliers are available, what are available, prices and so on.*
- **STRATEGY:** *Consider expanding to become also an aggregator of the production of other multipliers, supplying modern varieties to large farmers and NGOs.*
- **MARKETS:** *Each has their own advantages and disadvantages:*
 - *Selling on-farm is easy and cheap but smallholders buy only a few vines.*
 - *Selling in markets is seldom worthwhile unless it is possible to be there regularly.*
 - *Selling to/through sellers can provide access to a very large and wide market but the price of vines for the multiplier is low.*
 - *Selling to projects is lucrative as they can offer large sales at high prices but projects often need specific varieties, large quantities of vines of those varieties*

and maybe the right paperwork (certification). Sales may also be erratic and infrequent.

For sellers:

- **COMMUNICATE:** Invest in a mobile phone so they can telephone multipliers for fresh supplies before they run short of vines. This will result in:
 - Less time when they have no stock to sell.
 - A 'just in time' delivery with improved freshness (quality) of the vines.
 - Fewer cases of vine deterioration because multipliers delivered too many vines.
 - Customers, especially distant ones, being able to place orders by phone.
- **ADVERTISE:** Advertise in local newspapers and radio. Banners in distant market places may also be useful. Make sure your mobile phone number is prominent!
- **LOCATION:** Ensure you sell where many customers pass whilst conducting their normal business. That could be at the main market, at the bus station or between them (Plate 6) or it could be on a busy road, preferably where vehicles can park but also where they slow down such as at a road junction (Frontispiece).

For both multipliers and sellers:

- **SERVICE:** Offer a wide range of cultivars including modern OFSP and WFSP varieties.
- **LABEL:** Include the seller's name, address and phone number on a label on each bundle so customers can remember who they bought from and recommend them to others.
- **INFORM:** Label bundles with the variety name so customers start to associate new varieties with particular qualities and become willing to pay extra for them.



How to present vines to customers

Vines are often sold bundled together in untidy heaps (Plate 8). It is then difficult for customers to judge exactly how many cuttings can be obtained from the heap and to carry them home especially on a bicycle (Plate 2) or motorcycle.

Plate 8. Heaps of uncut and unsorted vines for sale (Arua, northern Uganda)

By contrast, town sellers in Gulu get their multipliers to cut vines to the length of a cutting, strip off the lower leaves (which would otherwise just get buried) and then tie them in neat bundles: first of 50 cuttings and then 20 of these are tied together to form a large bundle of 1,000 cuttings (which plant about 0.03ha, a reasonable start for a household) (Plate 9). This makes it very convenient for customers who can:

- Judge the quality and variety of the vines from the remaining top leaves which are presented at the top of the bundle.

- Easily transport many cuttings home because the waste leaves and vines have been removed and each bundle is neatly and robustly tied together.



Plate 9a & b. A ‘Gulu’ bundle made up of 20 small bundles (left), each of 50 cuttings pre-cut to planting length (right)

As well as looking more attractive, such a bundle of cuttings is likely to persuade customers to buy one or two extra because they can easily carry them – meaning more profit for the multipliers and sellers! Interestingly, this way of selling seems to have originated from the occupation of most sellers in Gulu during the vine off-season: they sell local vegetables, some of which are packed in similar neat bundles.

INTEGRATED SEED SECTOR DEVELOPMENT (ISSD)

Different customers tend to be supplied by specific seed systems. Smallholders are generally served by informal seed systems, mid- to large-scale farmers by either informal or formal systems, whilst projects are served mainly by formal systems. ISSD is a concept that allows the strengths and roles of the formal and the informal/ private enterprise systems to be combined optimally:

- The formal seed system is particularly good at generating quality seedlings.
- Farmers seem particularly good at selecting varieties (Participatory plant breeding).
- The informal seed system is particularly good at delivering planting material.

Sellers in informal systems may have customers >100km distant and, in this sense, are well connected. Nonetheless, actors in it may have little knowledge of who their customers are and what role they have, resulting in an inability to appreciate how useful their systems are. A

strength of the formal system – with its structured reports and meetings – is its ability to transfer concepts. For example, the ideas of trading vines long (>100km) distances and selling extensively in markets, widespread in northern Uganda, had not reached the Lake Zone of Tanzania in 2013. However, it seemed ideally suited to it: it is relatively easy to produce vines during the dry season around the shore of Lake Victoria yet a short distance inland even major rivers are seasonal, water is very scarce during the dry season and vines in huge demand at the start of the rainy season. Ukiriguru ZARDI therefore modified the idea to growing vines by the Lake and taking them inland to sell. In Uganda, bus passengers are an important source of custom because they can put bundles of vines in the storage space beneath buses. Ukiriguru-ZARDI also advised multipliers to try selling vines in markets along the main road inland and near the bus station. So far, it all looks very promising!

Sebastian Maguta is a medium scale but dynamic farmer with land adjoining a gulf from Lake Victoria; he has a petrol water pump and grows high-value horticultural crops throughout the year. He is based in Misungwi, near the B6 tarmac road to Shinyanga and eventually to Dar es Salaam. He takes crops such as tomatoes and watermelons to sell in distant markets including Dar, especially in the dry season.

He always sold small quantities of vines of landraces on-farm each year to local farmers who came to his farm to buy. In 2012, he got modern varieties and ARI Ukiriguru also suggested that he could expand his vine sales by transporting them inland to Shinyanga. He used trucks returning empty to Dar es Salaam via Shinyanga and also filled up his own trucks when they were only part filled with other crops. He also sold vines at local markets.



In 2013, he sold 364.5 bundles, 153 of them to 103 customers in markets along the road to Shinyanga at 5,500/- per bundle (500/- more to cover the extra costs). He has realised this is a lucrative market and has expanding his production from 0.2ha to 0.8ha, based on the extra sales he can make in markets.

He is someone that other people admire and follow. In 2014, one of his labourers also became a multiplier and now in 2015 there are 9 multipliers in Misungwi growing a total of 3.2ha of vines for sale in markets along the road to Shinyanga.

Business opportunities:

- **ISSD:** Multipliers in aid seed systems may supply larger private enterprise farmers to smooth their sales. Other opportunities can be created by switching ideas or mechanisms from one seed system to the other (see above).
- **PULL, NOT PUSH:** Instead of giving farmers vines of new varieties, projects can advertise their qualities and demand for them will make private sector multipliers multiply them – and make a living in the process.

- **ADAPT OR FAIL:** *The formal system is often where big innovation occurs.. Multipliers in the informal system must learn how to become adopters from the formal system and remain competitive or they may fail.*
- **STRATEGIZE:** *Virus cleaned planting material is being multiplied by private sector laboratories but through support of projects in the aid seed system (see later). Nonetheless, their 'natural' home is to be fully in the private sector.*

ECONOMICS AND PROFITABILITY: HOW MULTIPLIERS CAN INCREASE THE QUANTITY OF VINES PRODUCED

There are two main ways of growing vines:

- **Dual purpose method** for both roots and vines. Cuttings usually 30-40cm long are planted ~30cm apart along the top of ridges or mounds ~1m apart as normal for the production of a root crop. Vine cuttings may be taken once or twice and roots harvested piecemeal during crop growth; both roots and vines are taken in the final harvest.
- **Vines-only on-the-flat method.** Cuttings usually ~20cm long are planted at a spacing of 15-20cm in sunken beds 1-2m wide or in small depressions for easy watering. Several harvests of vine cuttings are taken. A few storage roots may grow and be harvested.

Table 2. The productivity and profitability of different methods of growing sweetpotato and of different fertilizer regimes in Tanzania in 2015 (0.1ha; prices in Tanzanian shillings)

Dual purpose								
Fertilizer rates (kg/0.1ha)			Manure (t/0.1ha)	Cutting yield (0.1ha)	Root yield (t/0.1ha)	Production costs (Tz /-)	Profit	
N	P	K					Tz /-	US\$
0	0	0	0	27,306	1.0	178,802	709,631	330
0	0	0	1	28,583	1.1	178,802*	774,248	360
5	2.5	2.5	0	36,028	1.1	214,802	898,331	418
Vines-only								
0	0	0	0	111,667	0	228,067	1,633,050	760
0	0	0	1	143,333	0	228,067*	2,160,822	1,004
5	2.5	2.5	0	163,333	0	264,067	2,458,155	1,142
5	2.5	2.5	0.5	231,667	0	264,067*	3,597,044	1,671
15	7.5	7.5	0	245,833	0	336,067	3,752,882	1,743
25	12.5	12.5	0	247,500	0	468,067	3,656,993	1,699

*The cost of the manure could not be assessed and was considered to be produced on-farm at negligible cost.

Multipliers can improve vine production by (Table 2):

- **On-the-flat vines-only method:** Growing vines intensively in beds on the flat produces ~5x more vines and uses irrigation and fertilizer more efficiently.
- **Using fertilizer and compost:** Balanced compound fertilizer boosts production of vines hugely, especially when growing on-the-flat. Applying 5kg of N (assumed to be the main component of compound fertilizer that the crop is responding to) to 0.1ha of vines gave a US\$400 increase but cost only about US\$15 in 2015: the profit margin is thus massive.

- **Combining fertilizer and manure:** Although manure by itself seemed to give only small benefit, applying 5kg of N/0.1ha of vines with manure gave a US\$800 profit increase but only a US\$400 profit when applied by itself.
- **Irrigation:** Growing crops in beds on the flat allows fairly efficient flood irrigation. Drip irrigation is more efficient but requires clean water to avoid nozzles becoming blocked.

The production costs of growing vines on the flat are similar to those of dual purpose except a vines-only crop requires nearly six times more cuttings; this extra cost depends in practice on whether or not planting material is in ample supply on-farm. The manure similarly is an input which can be supplied by home production but the fertilizer is a 'real' cost. All the activities are assumed to be manual or by ox plough; replacing with machinery is not cost-effective for enterprises of mostly ~0.1ha nor would it be until the enterprise used several hectares. The machine that could replace human labour is a water pump; its use depended on the availability of sufficient water: this was the main constraint on expansion of enterprises.

Lack of pests and diseases can also increase the vigour of the crop (see next section) and so increase the quantity of vines produced; varieties also differ in the length and number of vines produced. It is noteworthy that most landraces produce abundant foliage suggesting it is an important selection trait. A modern variety such as Sowola produces few vines but others such as NASPOT 11 and New Dimbuka many (interestingly, both selected by farmers). Other genotypes such as NASPOT 10 have thick stubby stems: a few cuttings may easily fill a bag of vines but the correct measure is really the number.

Nonetheless, some multipliers may want to produce some roots for home consumption or for sale, because food is often scarce during the dry season and the early part of the proceeding rainy season and so grow a dual purpose crop.

Business opportunities:

VINE PRODUCTION IS PROFITABLE. Multipliers using fertilizer and planting on the flat can make >US\$1,000/0.1ha. They indicated that it was similarly profitable to dry season production of tomatoes, watermelons, etc and far more secure (sweetpotato vines do not quickly 'over-ripen' and smallholders may harvest it and transport it home themselves).

Niche markets, such as selling to projects or selling virus-cleaned material can gain higher prices and so make even greater profit.

CONSTRAINTS: The main constraint on a vine multiplication business is water in the dry season. It determines the size of the enterprise and whether it is worth buying a pump.

INCREASING PROFIT: There are opportunities to increase:

- Profitability by using fertilizer and growing vines-only.
- Scale of operation by using a pump (if sufficient water is available).

HOW MULTIPLIERS CAN IMPROVE THE QUALITY OF VINE SOLD

Three types of improvements to the quality of vines sold are possible – to the:

- Genetic quality of the vines.
- Health (lack of pests and diseases) of the vines.
- Physiological state of the vines.

Individually or in combination, these can lead to increased quality and quantity of roots produced by the planted crop, leading to greater demand for planting material and higher prices.

Improving the genetic quality of the vines: The easiest way to improve vine quality is to grow a new and better variety as its propagation usually doesn't cost more than the old variety. Growing a new variety may also improve the health of the planting material as many locally-selected modern varieties are very resistant to diseases.

The main sources of new cultivars are NARS. Crossing blocks containing selected genotypes are grown together to promote cross-pollination on a vertical framework to promote flowering (Plate 10) or purposeful hand-crosses are made. Large seedling populations can thus be generated, allowing opportunity for rigorous selection. Using farmers to select on their own farms has been extremely effective at developing superior varieties (Participatory plant breeding). The varieties released by the National Crops Resources Research Institute (NaCRRI) at Namulonge Uganda all are resistant to sweet potato virus disease (SPVD), most are resistant to *Alternaria* disease and all have an excellent yield though OFSP varieties may have lower resistances and yields in exchange for their high vitamin A content.



Plate 10. A sweetpotato crossing block at NaCRRI

The main problem associated with new varieties in a largely informal smallholder system is disseminating them. This is unattractive commercially because there is little profit to be gained from selling something that may be propagated essentially forever once a small amount is bought, vegetative propagation ensuring a variety remains identical. It is therefore necessary to do it cheaply. One way of doing so would be to ensure that the multi-location trials required to be done before a variety is released are conducted on multipliers' farms, thus inevitably acting as widespread points of unofficial release. The potential of this can be seen from the fact that about half of the farmers chosen by NaCRRI to host multi-locational trials in Central Uganda have become successful seed businesses – though here we are suggesting that current multipliers should be used, not potential future ones. In addition, multipliers in hub locations such as Gulu and Arua in Uganda should be chosen to enable distribution to far-off locations.

Business opportunities:

- **BEING FIRST** with a new variety creates business opportunities such as a premium on vine sales. A multiplier can achieve this by having good contacts with researchers.
- **OFSP varieties** are being promoted by NGOs etc because of their nutritionally essential pro-vitamin A. Multipliers and sellers can benefit from their free advertising.
- **NGOs and others** are often contracted by their donors to supply farmers with OFSP varieties and they are therefore prepared to pay high prices for these specific varieties.

Peter Omondi is a private enterprise multiplier based in Gulu northern Uganda. Initially he sold to local small-scale subsistence farmers but he appreciated the opportunity of selling to NGOs in 2012 when the NGO World Vision provided him and his neighbours with vines of the OFSP variety Kakamega. He and a neighbouring multiplier made money by retaining the variety during the dry season and then re-supplying the farmers, funded by the NGO. This gave him the idea of selling to NGOs and he got other varieties. He increased annual sales of vines to NGOs to USD22,415, acting as an aggregator for neighbouring multipliers to fulfil large orders. However, he also used his possession of modern varieties to increase his sales to farmers, albeit from a low base, making USD3,663 from these sales alone – in itself an excellent rural income. Most of his sales were of OFSP varieties and were throughout the northwest quadrant of Uganda. He also learnt how to market his business through local radio and newspapers.



Year	Customers	Average number of small bundles in a sale*	Average value of a sale (USD)*	Annual income (USD)	Number of sales
2013	Farmers	72±73	19±20	189	10
	NGOs	785±170	371±25	2,966	8
2014	Farmers	62±50	12±10	742	61
	NGOs	2,986±1,405	626±288	9,390	15
2015	Farmers	465±45	93±9	3,633	77
	NGOs	12,009±2,197	6,724±437	22,415	19

*±Standard error

Improving the health of the vines: Foliar cuttings are used to establish crops and so soil- and root-borne pathogens including nematodes, insects, bacteria or fungi do not usually affect them. Instead, the main diseases affecting the cuttings are viruses because they are often systemic in plants. The viral health of planting material can be improved by the following good husbandry rules:

- Use virus resistant varieties wherever possible;
- Select healthy-looking parents and use the healthiest-looking of these as sources of planting material.
- Reduce the risk of symptomless late infection in crops to be used for planting material by:
 - Removing (roguing out) diseased plants.

- Isolating crops from others, especially older ones.
- Not planting crops where a sweetpotato crop has recently been grown.



Plate 11a & b. Selecting planting material from healthy-looking parental material (left) and SPVD-affected plants (foreground) showing obvious disease symptoms (right).

Selecting planting material from SPVD-free parents can be done easily as the symptoms are usually quite obvious (Plate 11). Generally such selection is combined with removal of SPVD-affected plants from the growing crop – known as roguing (Plate 12). This removes inocula and helps ensure disease-free plants have not recently been infected.



Plate 12. A multiplier removing diseased vines from a crop (roguing)

Ideally, sweetpotato should not be planted where a previous sweetpotato crop has been or near an older crop. This reduces the risk of disease spread and also of weevil infestation as they are poor flyers. However, land used to grow vines during the dry season often becomes flooded during the rainy season and this destroys any sweetpotato plants and the pests and pathogens associated with it. Informal multipliers may use such land repeatedly and succeed in producing vine crops with low incidences of pests and pathogens.



Plate 14. Simple screenhouses used to propagate virus-cleaned planting material

There has recently been considerable promotion of virus-cleaned planting material propagated in simple screenhouses covered with a fine plastic mesh to exclude virus vectors (Plate 14). Such structures protect planting material from re-infection and this may yield 10-30% more than the field planting material selected from healthy-looking parents used by most farmers. However, this yield benefit can disappear within one or a few generations for susceptible varieties, especially in areas where virus diseases spread rapidly. The costs of providing the cleaned planting material to individual multipliers, of maintaining the screenhouses and of the premium multipliers require for new planting material will determine uptake by farmers – and the premium will have to be balanced by the value of extra yield from the initial and subsequent crops. Whether it is really worthwhile for smallholder systems in Africa still remains to be seen.

Business opportunities:

- *Multipliers can gain a reputation as suppliers of good quality planting material and thereby increase their sales and prices.*
- *Some form of certification of planting material is likely to be adopted by governments. Whilst it may be ignored by smallholders, projects and government institutions may (have to) comply with it so sales to them will go only to those who can provide the necessary certificate – allowing multipliers and/ or sellers selling certified crops to increase prices and sales.*
- *Certification may require stocks to be traceable to virus-cleaned material. This should allow such stockists to obtain higher prices for their vines.*

Improving the physiological state of the vines: Cuttings taken from apical portions of vines (Table 3) or from vines from young crops (Table 4) generate greater yields than cuttings taken mid or basal parts of the vine or from old crops respectively. They may also have fewer weevil eggs and larvae.

Table 3. Yield of cuttings derived from the terminal or the basal portion of a vine (adapted from Belehu, 2003)

Source of cutting	Yield of storage roots (g/plant)	Number of storage roots/plant
Terminal portion	151	2.75
Basal portion	77	1.55
Least significant difference	55	0.84

Table 4. Effect of age of vine cuttings used as planting material on the total root yield (Kg/plant) of 4 sweet potato cultivars (Wilson, 1988)

Age of parent crop (Mths)	Cultivar				Mean
	Gem	Miguela	Chipper	Bonara	
2	1.67a ¹	0.51ab	1.08a	1.38a	1.16a
3	1.65a	0.62a	1.10a	1.38a	1.19a
4	1.62a	0.43b	0.66b	1.05b	0.94b

¹ Means in columns followed by the same letter are not significantly different ($P = 0.05$)

Business opportunities:

Farmers realise the benefits of the apical portions of vines. They prefer to buy and may even pay more for them.

Something completely different – Storage of roots in Sand and Sprouting them to produce cuttings (The Triple S method)

In warm temperate regions, it is common for roots to be stored over winter, sprouted in the spring in heated beds and the cuttings generated used as planting material. A similar technique has been developed (Fig 3) for Africa whereby roots are harvested and kept in dry sand during the dry season. They may start to sprout and initially, these sprouts should be removed but, as the end of the dry season approaches, de-sprouting is stopped and the roots are planted in an area where each one can be watered. The sprouts grow profusely using the energy stored in the roots and, when the rains do come, they grow extremely quickly. Such a system can provide abundant, high quality planting material when most farmers really want planting material – shortly after the arrival of the rains, after they have been able to plant most of their slower-maturing seed crops.

Business opportunity:

Using the root-based seed system can provide planting material using very little water as the roots are maintained in a dormant state during most of the dry season. Although it is designed mainly for household use, it would seem to be scalable so that a surplus of planting material could be generated and sold.

Figure 3. The Triple S method: a way of generating large amounts of planting material with very little water

THE TRIPLE S SYSTEM
 (Storage in Sand and Sprouting)
 provides planting material from storage roots in areas with a long dry season

In such areas, farmers often obtain sweetpotato planting material from roots which have been overlooked during harvest and sprout when it rains. However:

1. The roots sprout only when it rains and planting material only becomes available some weeks afterwards
2. The roots may sprout in distant fields, unprotected from grazing animals and thieves.

To solve these problems, researchers and farmers have developed a system of conserving planting material whereby storage roots are stored in sand and then planted out and watered before the arrival of the rains. This way, they have sprouted and produced large amounts of planting material in time for the arrival of the rains.

TRIPLES SYSTEM
 INTERNATIONAL POTATO CENTER (CIP)
 Natural Resources Institute
 University of Greenwich, Central Avenue,
 Chatham Maritime, Kent, ME4 4TB, UK
 International Potato Center (CIP) – UGANDA,
 P.O. Box 22274, Kampala, Uganda
 CIP Sub-Saharan Regional Office, c/o IRI,
 P.O. Box 21171, Nairobi 00601, Kenya

SWEETPOTATO
 planting material

THE TRIPLES SYSTEM
 Storage Sand Sprouting

1 At the end of the rainy season, farmers get small to medium-sized sweetpotato storage roots, carefully selecting roots that are from healthy plants and are undamaged, particularly free from weevil damage.

2 The roots are kept in dry sand [swept from around the house or a road] in a container until 6 – 8 wks from the expected start of the rains. Take care that the sand is cool [not hot from having been in the sun]. Maybe two or more layers of roots can be kept in the same container.

3 The container of sand and roots is kept in a cool dry place, until about 6 – 8 wks before the start of the rains, perhaps in the house or in a roofed hut, but safe from the children or chickens that may like to nest in it. The roots sprout but generally the sprouts remain quite short. [If the dry season is very long, it may be necessary to remove the sprouts midway during the dry season and allow them to re-grow].

4 About 6 – 8 wks 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 ~0.5 x 0.5m and in a slight depression [to help watering]. The soil needs to be fertile and the area fenced against grazing animals. The roots are watered at planting and then every 3 or 4 days.

5 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.

Useful references

- Bashaasha, B., Mwanga, R.O.M., Ocitti p'Obwoya, P. & Ewell, PT. 1995. *Sweetpotato in the farming and food systems of Uganda: a farm survey report*. International Potato Center (CIP)/ Ugandan National Agricultural Research Organisation (NARO). 63pp
- Belehu, T. 2003. Agronomical and physiological factors affecting growth, development and yield of sweet potato in Ethiopia. Ph D thesis. University of Pretoria, South Africa, 213pp.
- Gibson, R.W. 2013. How sweet potato varieties are distributed in Uganda: actors, constraints and opportunities. *Food Security* **5**, 781-791.
- Gibson, R.W., Aritua, V., Byamukama, E., Mpembe, I. & Kayongo, J. 2004. Control strategies for sweet potato virus disease in Africa. *Virus Research* **100**, 115 – 122.
- Gibson, R.W., Byamukama, E., Mpembe, I., Kayongo, J. & Mwanga, R.O.M. 2008. Working with farmer groups in Uganda to develop new sweet potato cultivars: decentralisation and building on traditional approaches. *Euphytica* **159**, 217–228.
- Gibson, R.W., Mwanga, R.O.M., Namanda, S., Jeremiah, S.C. & Barker, I. 2009. *Review of sweetpotato seed systems in East and Southern Africa*. International Potato Center (CIP), Lima, Peru. Integrated Crop Management Working Paper 2009-1. 48 pp.
- Kapinga, R. E., Ewell, P. T., Jeremiah, S. C. & Kileo, R. 1995. Sweetpotato in Tanzanian farming and food systems: implications for research. International Potato Center (CIP)/ Ministry of Agriculture, Tanzania. 47pp.
- Low, J.W., Arimond, M., Osman, N., Cunguara, B., Zano, F. & Tschirley, D. 2007. A food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique. *Journal of Nutrition* **137**, 1320-1327.
- Namanda, S., Gibson, R. W. & Sindi, K. 2011. Sweetpotato seed systems in Uganda, Tanzania, and Rwanda. *Journal of Sustainable Agriculture* **35**, 870-884.
- Stathers, T., Low, J., Mwanga, R., Carey, T., David, S., Gibson, R., Namanda, S., McEwan, M., Bechoff, A., Malinga, J., Benjamin, M., Katcher, H., Blakenship, J., Andrade, M., Agili, S., Njoku, J., Sindi, K., Mulongo, G., Tumwegamire, S., Njoku, A., Abidin, E. & Mbabu, A. 2013. *Everything you ever wanted to know about sweetpotato: reaching agents of change tot manual*. International Potato Center, Nairobi, Kenya. pp390+ x.
- Stathers, T., Namanda, S., Mwanga, R. O. M., Khisa, G., & Kapinga, R. 2005. *Manual for sweetpotato integrated production and pest management farmer field schools in sub-Saharan Africa*. International Potato Center, Kampala, Uganda, pp.168 + xxxi.
- Wilson, J. E. 1988, adapted from F.W. Martin. 1984. Effect of age of planting material on yields of sweet potato from cuttings. *Tropical Root and Tuber Crops Newsletter* **15**, 22 – 25.