Quality Seed and Seed Production Procedures for Cassava and Sweet Potato

C.C. Moyo, N.M. Mahungu, V.S. Sandifolo, A.R.K. Mhone, F. Chipungu, and J. Mkumbira

Introduction

Healthy seed is the basis for obtaining a healthy crop. Cassava and sweet potato are propagated through use of vegetative parts, which entails certain problems, such as low multiplication ratio, bulkiness, short shelf life, and difficult dry season maintenance, in the case of sweet potato. Some diseases, such as cassava mosaic disease, cassava brown streak disease, and sweet potato virus disease, are systemic and can be transmitted through use of vegetative parts.

Farmers have to know what constitutes high quality seed in cassava and sweet potato and how to produce it. Good quality cassava and sweet potato seed sprouts well and grows into a healthy crop, once sown. Such seed should be mature, free of pests and diseases, and true to type.

In most Southern Africa Development Community (SADC) countries, commercial seed companies are not interested in producing cassava or sweet potato seed, as they find it unprofitable. Government institutions, non-governmental organizations (NGOs), religious groups, and smallholder farmers must produce the seed.

Seed Categories

The three categories of seed are:

1. **Breeder seed.** This is produced and maintained by the breeder. It is the source of planting material for basic seed.
2. **Basic seed.** The progeny of breeder seed, this is handled under the supervision of the National Seed Certification Scheme.
3. **Certified seed.** This is the progeny of basic seed.

Seed Multiplication Scheme

Cassava and sweet potato are multiplied at three levels: primary, secondary and tertiary. The scheme has the advantage of facilitating seed distribution. At the primary level, the sites are at or near research stations for easy supervision by scientists. At the secondary level, the sites are established and managed by extension staff, NGOs, religious groups, and some individual farmers. Scientists in root crops programs backstop these sites. Multiplication sites at the tertiary level are mainly farmer managed. They are often smaller in size and more numerous. Extension staff and NGOs usually backstop these.

Cassava

Cassava stems can be multiplied using conventional as well as rapid multiplication techniques. In either case, the primary objective is stem production and not roots.

Conventional method. The conventional cassava multiplication method is the easiest and most widely used. However, it has the disadvantage of having a low multiplication ratio (1:10) unlike the rapid multiplication technique (1:60-100). Ideally, a cassava multiplication site should have the following characteristics:

- Easy access to beneficiaries.
- Must not have been under cassava the previous season, to avoid volunteer plants.
- Well drained soils.
- Protection from livestock damage.
- Away from high-pressure areas for cassava pests and diseases.
- Away from other cassava fields: at least 200 m for breeder seed and 100 m for basic and certified seed.

Variety. The best varieties to multiply are those demanded by farmers. Farmers usually prefer varieties that are:

- High in dry matter content (at least 30 %).
- Mealy (ability of the roots to cook without processing).
- Early bulking.
- Good for in-ground storability—that is, the ability of mature roots to stay in the ground without spoiling. Good storability prolongs the period over which the crop can be harvested.
- Tolerant to pests and diseases.
- Suitable for their cropping systems (e.g., high branching varieties for intercropping).
- Suitable for their mode of consumption. Bitter cassava varieties are preferred where the crop is processed; sweet varieties for the fresh market.

Land preparation and planting. Land for cassava multiplication should be prepared early to enable planting with the first rains. Early planting enables the crop to be established while there is still adequate soil moisture. If the site is in the dambos or low-lying areas flooded during the rainy season, planting should be done soon after the water has receded.

Planting material. Only good quality planting material should be used. The following guidelines can assist in selection to avoid unhealthy stem cuttings.

- Select plants that are mature, about 8 to 18 months old. Such plants will normally have brown-skinned stems. Tender portions can be planted, but these easily dehydrate and get damaged by pests and diseases.
- The plants should be healthy. Healthy plants have robust stems and branches, lush foliage, and minimum damage from pests and diseases.
- Avoid plants with pests and diseases. Many cassava pests and diseases are stem-borne and are spread through distribution and planting of infested or diseased cuttings. The major pests are cassava mealy bug (CM) and cassava green mite (CGM), while the major diseases are cassava mosaic (CMD), cassava bacterial blight (CBB), and cassava brown streak disease (CBSD).
- Avoid bruising/wounding stems. Wounds are potential entry sites for pathogens.

Planting. Cassava for seed multiplication should be planted at 1.0 m by 0.5 m (20,000 plants/ha) or 0.5 m x 0.5 m (40,000 plants/ha). Stem cuttings should be 20-30 cm long, with 6 to 8 nodes per cutting. Shorter cuttings, 15-20 cm, can be used, but the risk of drying is high under poor soil moisture conditions. Care should be taken to avoid bruises and damage to the buds when planting.

Sometimes stem cuttings are slightly infested with CM, CGM and other stem-borne pests. Immersing the stems in heated water (about 60^{o} C) for 5 to 10 minutes or treating with a 1% solution of Rogor (Dimethoate) can control these pests. Fungal diseases, such as anthracnose, can be controlled using Benlate or Decis.

Field management. The major management practices after planting include weeding, fertilizer application and roguing (uprooting disease-infected plants and off-types).

- **Weeding.** The multiplication field should be kept weed free. This is particularly important in the first three months of growth before the canopy fully develops.
- **Fertilizer application.** Where soils are poor, fertilizer should be applied to boost stem growth. In most parts of the region, the best time for application is at or soon after planting so that the crop can make use of the fertilizer before the rains tail off. The amount to be applied depends on soil analysis. However, in Malawi a blanket application of 50 kg N and 40 kg P_2O_5/ha is used, in the absence of soil analysis.
- **Crop hygiene.** Crop hygiene is of paramount importance in the production of cassava planting material. Routine field inspections to uproot and destroy disease-infected plants are a must. These should start soon after sprouting and be repeated every fortnight in the first three months of growth and once every month thereafter, if the disease pressure is not very high. The uprooted plants should be destroyed away from the multiplication field by burning or burying.
- **Roguing.** Good planting material should also be true to type, with no mixtures. In field inspections, off-types must be identified and uprooted. In the early stages of sprouting, gaps from uprooting must be filled to achieve full stand.

Stem harvesting. If the field is well managed, the stems become mature 9 to 12 months after planting. Since the objective is stem production, at harvest the plants are not uprooted but cut 20-25 cm above the ground (ratooned). Several shoots sprout from the stumps after ratooning. These should be thinned to 2 or 3 stems per stump, which will mature into stems.

Post-harvest management. After ratooning, fertilizers should be applied where possible to boost growth, and the field should be kept free of weeds. Another set of stems can be harvested 9 to 12 months after ratooning. This process can be repeated as many times as possible, as long as there is no build up of diseases. The number of sets of stems that can be harvested depends on variety, soil fertility, and management of weeds, pests, and diseases. However, ratooning is not recommended in high CMD pressure areas.

At and after harvesting care should be taken to avoid bruising the stems. Bruised buds may not sprout. The stems should be tied together in bundles. The size of the bundles varies with area but in Nigeria there are usually 50 stems per bundle.

Stem storage. Sometimes it is necessary to store stems. Such cases arise when plants are harvested off-season and planting is to be done later or a farmer acquires stems before the field is ready for planting. However, stems can be stored only for a short time—not more than eight weeks—because they dehydrate easily and can be damaged by pests and diseases.

Cassava stems can be stored by tying them in bundles and keeping them either upright or horizontally under shade in a well-ventilated area. Where stems are stored vertically, the buds should face upwards and the oldest ends of stems should be inserted into the soil and watered at the base.

During storage, avoid exposure to direct sunlight and hot/cold winds. It should be noted that mature and healthy stems store better than immature ones and long stems store better than short ones.

Rapid multiplication. The term ‘multiplication ratio’ refers to the increase in planting material over what is planted. When planted, a 25-30 cm cassava stem cutting yields about 10 cuttings 12 months later, giving a multiplication ratio of 1:10. In contrast, a maize ear may give up to 300 seeds, which is a much higher multiplication ratio (1:300) than that of cassava.

Rapid multiplication overcomes the handicap of low multiplication ratios in vegetatively propagated crops like cassava for the benefit of germplasm evaluation, distribution, and seed multiplication. The technique involves rapid increases in the quantities of planting material from what is available (1:60-100).

Preparation of mini-stem cuttings. Whole stems are cut into mini-stems: hard woods (older parts, 1 or 2 nodes), semi-hard woods (semi-mature parts, 4-6 nodes), and tip shoots (green and tender parts, 6-10 nodes). The number of nodes per mini-stem depends on internode length, stem diameter, and weather at and after planting. Tip shoots should be stripped of all leaves except the youngest and kept in water to prevent dehydration. Care must be taken not to damage the axillary buds. Sharp tools (shears, secatuers, or knives) must be used in cutting the stems.

Sprouting/Planting the mini-stems. Mini-stems can be directly sprouted or planted in nursery beds or strong plastic bags.

Sprouting in the nursery. Nurseries should be near a water source and on well-draining soils. Beds should be 1 to 1.2 m wide, to enable easy working at the center of the beds, and of any length, depending on the amount of seed to be produced. The mini-stems should be planted at 10 cm x 10 cm.

Hard woods should be planted horizontally, 4-5 cm deep to avoid being uncovered during when watering. Plant cuttings so that the nodes are on the left and right sides of the stems and not one on top of the other as shoots from below have difficulties in emerging.

Semi-hard woods and tip-shoots should be planted vertically with two thirds of the older portion firmed in the soil. The shoots are sensitive to low humidity and should be watered lightly, three times a day.

After planting, the nursery should be watered immediately and thereafter every morning and evening, except when it has rained; too much water may cause rotting of the mini-stems. The beds should be provided with labels indicating variety and date of planting. The nursery should be kept weed-free by hand pulling. The mini-stems will take 7-10 days to sprout. After 4-6 weeks in the nursery, the seedlings should be transplanted to the field. One to two weeks before transplanting, the seedlings must be hardened by reducing the amount and frequency of watering. However, a day before transplanting the beds must be heavily watered to enable easy transplanting.

Sprouting in polythene bags. Sprouting in nursery beds, though commonly used, has several disadvantages. It requires 4 to 6 weeks before transplanting, is labor demanding, and soil may contain soil-borne diseases. On the other hand, sprouting the mini-stems in polythene bags without soil is quick, cheap, and convenient. However, the method is suitable only for hardwood and semi-mature mini-stems. Tip shoots, which are tender, do not usually survive the high temperatures in the bags.

Before bagging, the mini-stems should be immersed in a broad-spectrum fungicide such as Benlate (Benomyl). The mini-stems should then be directly placed into the perforated bags, leaving about a third of the space empty for air circulation. The bags should then be kept under shade.

High humidity and temperature in the polythene bags promote rapid and uniform sprouting. Cuttings sprout in 3 to 5 days. Sprouted mini-stem cuttings sprout well in the field.

Transplanting and field management. Care should be taken at transplanting to avoid root damage. The seedlings should be transplanted into a well-prepared field at 1.0 m by 0.5 m or 0.5 x 0.5 m spacing. At this spacing, weeds are suppressed due to early foliage cover. The plots must be labeled indicating variety, date of planting, and area of each variety.

Field management, stem harvesting, and storage. The field management, stem harvesting and storage practices are the same as those of the conventional method.

Sweet Potato

Sweet potato has a multiplication ratio of 1:20, which is much lower than that of maize (1:300). Rapid multiplication overcomes the problem of low multiplication ratio in sweet potato.

Site. Sweet potato rapid multiplication is normally conducted in nurseries. A good site is one that:

- Was not under sweet potato in the previous season to avoid volunteer plants and carry over pests and diseases.
- Is on well draining soils.
- Is fenced off to protect it from animals.
- Is near a perennial source of water.
- Is away from high-pressure areas for sweet potato virus disease (SPVD).
- Is at least 200 m (for breeder seed) and 100 m (for basic and certified seed) from the nearest sweet potato field.

Land preparation and planting. Beds for sweet potato multiplication should be 1.0 m to 1.2 wide to enable easy working of the center while standing in furrows. The beds can be of any length, depending on the amount of seed to be produced. The beds should be 0.5 m apart. Where soils are poor (e.g., sandy) it is recommended to plow in manure at a rate of one wheelbarrow load per square meter of bed space.

Variety. The best varieties to multiply are those demanded by farmers. Farmers usually prefer varieties that are:

- High in dry matter content (at least 30%).
- Mealy (ability of the roots to cook without processing).
- Early bulking.
- Tolerant to pests and diseases.

Vines. Only good quality vines should be planted. The following guidelines can assist in vine selection to avoid planting unhealthy ones:

- Select plants that are healthy, with vigorous and lush growth. In sweet potato, tender and medium (semi-mature) parts are the best for planting, as they sprout better than old portions. Cuttings from bases of vines often carry the sweet potato worm (SPW) and the sweet potato stem borer.
- Avoid plants with pests and diseases, especially the SPW and the SPVD. Many sweet potato pests and diseases are stem-borne and spread through distribution and planting of infested or diseased cuttings.

- Vines for planting should come from actively growing and disease-free plants. The vines can be:
  - Shoot tip cuttings: These are the best parts for propagation as the meristematic cells are still actively dividing and hence grow faster and more vigorously. The tips should be 10-15 cm long. These should be planted vertically with two-thirds of the vines inserted in soil.
  - Three to four node cuttings: These are mostly used when there is inadequate planting material from the shoot tips. These are also planted vertically, with two-thirds of the cutting inserted into the soil.
  - Two-node cuttings: Two-node cuttings usually have 1 or 2 leaves intact. The leaves initiate photosynthetic activity before other leaves are formed. Two-node cuttings are also planted vertically, with one node in soil. However, these require high humidity and this is provided by covering the beds with plastic sheeting subtended 80 cm over the beds. The sheeting is removed once 80% of the cuttings have sprouted.

Water the beds before planting and plant the cuttings vertically, at 10 cm x 10 cm, with leaves outside the soil. After planting, water the plants.

Although tubers can also be planted they are not commonly used as seed as they can also be consumed and take longer to sprout than vine cuttings. Hence, the use of node cuttings is preferred.

Nursery management. The major management practices for sweet potato multiplication nurseries are watering, weeding, fertilizer application and rouging.

Watering is a must. The seedbed should be regularly watered, in the morning and evening, and should not be left to dry, especially in the first five days of planting.

It is important to keep sweet potato nurseries weed free, especially in the first four weeks of growth. Once the crop has grown and covered the ground, weeds may not be a problem and weeding may be limited only to hand pulling. Care should be taken not to damage the roots when weeding.

Where necessary, nitrogen fertilizer (50 kg N /ha) should be applied to boost growth, but too much fertilizer can cause rankness (tenderness of vines), which results in weak vines. Ideally, fertilizer applications should be based on soil analysis.

Crop hygiene is a must in sweet potato vine multiplication. All plants infected with viral diseases must be uprooted and destroyed by burying or burning away from the field. Similarly, all mixtures (off-types) must be uprooted and destroyed to maintain seed purity.

The beds should be marked with labels indicating variety and date of planting.

Harvesting. As soon as the vines are long enough—usually two to three months after planting—harvesting can be done for either further multiplication or commercial production. Harvesting is done by ratooning at 10 to 15 cm above ground. Sharp tools should be used for cutting. Cutting of tips will promote side growth, as the apical dominance will be removed. This will give rise to more vines. With good management, two to three vine harvests can be done within a rainy season, as long as the plants are healthy and free from viral diseases and SPW.

It is important to change the sweet potato nursery sites every two years to avoid build-up of the SPW.

Vine storage. Planting of sweet potato vines should be done preferably soon after cutting the vines. This may not always be possible, as the field may be not ready, but vine cuttings cannot be kept in good condition for more than two weeks.

In storage it is recommended to remove most of the leaves to preserve the food reserves in the vines, leaving only a few at the tip. The cuttings should be tied in bundles with their bases covered with a wet cloth and kept in a cool area under shade.

Common problems in cassava and sweet potato seed multiplication

- *Lack of interest* on the part of commercial seed multipliers.
- *Inadequate isolation.* The isolation distance is rarely respected, especially by farmers, due to land constraints. With cassava varieties susceptible to pests and diseases, this makes it hard to produce good quality planting material.
- *Failure to rogue.* Farmers are usually reluctant to uproot disease-infected plants. This is partly due to ignorance: some view diseased plants as different varieties. Similarly, farmers are not keen to uproot off-types, so the purity of seed is compromised.
- *Lack of financial resources.* Seed multiplication is an expensive exercise, especially in the area of seed, fertilizer, and nursery security.
- *Theft,* especially for sweet cassava varieties.
- *Lack of seed certification.* Until recently, seed certification in some countries did not cover cassava and sweet potato, and this led to led to selling and distributing disease-infected material and off-types.
- *Poor supervision.* This is a common problem in extension and is due to lack of knowledge concerning the management of multiplication nurseries on the part of extension staff, along with a scarcity of resources for supervision.

References

Chitundu, D.C. 1993. Rapid multiplication techniques of root and tuber crops. Paper presented at the Third Root and Tuber In-country Training Seminar, Mansa Hotel, Zambia. 10-24 October 1993.

Chipungu, F.P. 2000. Sweet potato rapid multiplication technique. A paper presented at Commercialization and Enterprise Development for Cassava and Sweet potato Planting Materials Production and Distribution Training Course, Bunda College, Malawi: 24 July-4 August 2000.

IITA. 1990. Cassava in Tropical Africa. A Reference Manual.

Ministry of Agriculture, Malawi. A Guide to Agricultural Production in Malawi (1993-94).

Sauti, R.F.N. The Recommended Cultural Practices of Cassava and Sweet Potatoes. Bvumbwe Research Station, Limbe. Malawi

Wilson, J.E. 1988. Sweet potato planting material. Agro-Facts. IRETA Publications. Apia, Western Samoa.