

A comprehensive training module on competitive cassava production

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1

Introduction

Results from a yield gap analysis shows that cassava yields on the farmers' fields is about 10 t/ha while the yields attained in research stations stand at about 45 t/ha. Ironically these higher yields are attained with minimal marginal increase in costs of production vis-à-vis the production cost by the smallholder farmer. This is partly because the farmers lack the resources and knowledge to practice profitable and sustainable farming. Our producers must therefore be exposed to competitive cassava production techniques such as improved soil management practices; adoption of zero-input technologies; better stem handling techniques for increased yield; integrated weed control practices; cost-efficient mechanization practices; better harvesting and post-harvest handling methods in cassava production. This publication is therefore, produced to highlight the possible areas of cassava production that will enhance on-farm productivity. It is expected to be a training guide for farmers, extension workers, government agencies, NGOs, researchers, students, and all partners in the cassava production industry.

2

Soil management practices for sustainable cassava production

Crops continually remove large amounts of nutrients from the soil. Soil destruction (erosion) and the removal of nutrients from top soil (leaching) reduce soil fertility more quickly. Therefore, we need to put back nutrient supplies naturally or by chemical methods through sound soil and crop management practices.

What makes a soil fertile?

- Large amounts of topsoil (Fig. 1).
- Rich in macronutrients (nitrogen, phosphorus, magnesium, sulphur, and potassium) and micronutrients (boron, cobalt, copper, iron, manganese, molybdenum, zinc, etc.).
- Soil acidity/alkalinity between pH of 6.0 and 7.5.
- Large amounts of organic matter which improve soil structure and nutrient and moisture retention.
- Good drainage and aeration.
- Presence of soil organisms that enhance availability of nutrient for plant growth.



Figure 1. A typical soil pit with rich topsoil.

How can you identify a fertile soil?

1. Vegetative growth – a fertile soil supports good crop growth (Fig. 2); plant growth is stunted in a poor soil (Fig. 3) and the result is low yield.
2. Results of soil analysis.
3. Visual symptoms or signs of active biological activities on the soil surface (e.g., worm casts).



Figure 2. Luxuriant cassava crop supported by fertile soil.



Figure 3. Stunted cassava crop growing on poor soil.

What makes a soil lose its fertility?

- Deforestation (cutting down trees) – exposes the soil to the harsh effects of rainfall and sunshine leading to soil erosion and removal of nutrients.
- Excessive tillage or cultivation – damages soil structure leading to increased erosion and leaching or removal of nutrients.
- Continuous cultivation – removes large quantities of nutrients from the soil within a short time.
- Bush burning – kills soil organisms, destroys soil structure, and enhances loss of nutrients from the soil.
- Wrong use of heavy machinery – leads to soil compaction or damage.

- Improper use of inputs (fertilizers and herbicides) leaves residues, which inhibit activities of soil organisms and can make a soil poor.
- Ploughing along the slope enhances erosion and removal of nutrients.

How do you restore soil fertility?

a. Recommended fertilizers

- Apply fertilizer to replace or supplement what crops will remove. Unless your soil analysis indicates otherwise, adding 400 kg or 8 bags of N:P:K 15:15:15 per ha is good, based on national soil mapping and testing.
- A combination of 200 kg NPK plus 2 t/ha of poultry manure.
- Apply fertilizer at the recommended period, e.g., 4–8 weeks after planting.
- For small-scale farmers, apply fertilizer in rings around the cassava stand or band on both sides of the stand (Fig. 4). One match-box full of fertilizer is enough for one stand. This is approximately 32 g/stand at the rate of 400 kg/ha or 8 bags/ha.



Figure 4. Ring application of fertilizer on young cassava plants.



Figure 5. Pile of manure usually available in many homes.

- However, for commercial farmers (above 5 ha), broadcasting after harrowing (before ridging) seems to be a good practice. The method has a potential risk in high rainfall areas where the nutrients could be leached before crop establishment.
- If soil is very acidic, apply lime (500–1000 kg/ha). Most soil nutrients required by crops are optimally available when soil alkalinity/acidity is between pH of 6.0 and 7.5.
- Add organic matter, example manure (Fig. 5) to the soil (at 8–10 t/ha).

Pointers when using fertilizers

1. Soils rich in organic matter make more nutrients in fertilizers available to crops.
2. Sandy soils retain less of the elements in fertilizers for crop use than clay soils.
3. The higher the soil fertility, the lower a crop's response to fertilizers. Do not apply fertilizers when there is no need.
4. Under low soil moisture content, fertilizers do not reach the rooting zone where they are most needed by crops. Do not apply when the soil is dry.

5. Under high temperatures, nitrogen in fertilizers breaks down quickly (nitrification) and volatilizes from the soil before crops can use it. Apply fertilizer when the temperature is low.
6. For small-scale farmers, fertilizer should be placed round the plant where it is needed, not broadcast.

b. Recommended cultural practices

- Leave land to fallow, if depleted, for 3 or more years and manage it thereafter for long-term use.
- Plant fast-growing leafy leguminous crops such as *Mucuna* (Fig. 6) as live mulch to cover a degraded soil. It is a form of fallow which achieves good results in 1–2 years. This also adds nitrogen to soil and suppresses weeds.
- Rotate crops on your land. Do not plant maize after maize or cassava after cassava on the same piece of land. Instead, plant cowpea after cassava or maize after yam the following year.



Figure 6. *Mucuna* fallow for soil replenishment (improvement).

3

Zero input technologies to increase yields

You can grow cassava using zero input technology. This does not need chemicals, such as fertilizers and herbicides, or organic compost. The zero input method encourages biological activity in the soil and provides natural protection from diseases. It can guarantee good yields, provided that farmers prepare the land well, use the right varieties, plant at the right spacing and time, and ensure a weed-free farm. This section of the training manual provides a guide to extension officers, NGOs, and farmers on how this environmentally-friendly farming practice can be carried out.

What does zero input technology mean?

- Zero input technology is meant to inform resource-poor farmers about what they can do to get a good yield when they lack capital to purchase inputs.
- It focuses on how farmers can use their agronomic skills to achieve high yields.
- It proves that the use of chemical inputs is not the only way to promote a good yield.

How do I use zero input technology for a good yield?

- Choose a good soil with medium fertility and good drainage (Fig. 7).
- Avoid stony, clayey or water-logged soils.
- Use a site that has been well maintained.
- Practice minimum tillage in sandy soils to conserve organic matter, and moisture, and to reduce soil erosion.

- Avoid shallow and hard soils or alternatively, make ridges (Fig. 8) or mounds to increase the topsoil volume per plant for a better establishment.



Figure 7. Example of a good soil.



Figure 8. Example of good ridges.

- Choose improved varieties with the highest and most stable performance in different locations (Fig. 9).
- Select planting materials from healthy cassava plants (10-12 months old) without stem and leaf damage from pests and diseases (Fig. 10).



Figure 9. Selected examples of improved varieties.



Figure 10. Healthy stems for planting.

- Handle the stems carefully to avoid bruising or damaging the nodes and to improve sprouting. For example:
 - Do not use force when tying the stems in bundles and when loading into vehicles.
 - Cut the middle stems into 25cm lengths with 5–7 nodes; middle portions establish better than the tips and basal parts.
- Plant at the right time to ensure healthy sprouting and good crop establishment. Dry season planting is not recommended when the rains stop early or where the water table is low. There will not be enough moisture to allow sprouting and the stems to survive. In general, cassava should be planted when 2 months of soil moisture is expected after planting.
- Plant at the correct spacing. The recommended planting space is 1 m × 0.8 m for non-branching types (Fig. 11) and 1 m × 1 m for branching types (Fig. 12).



Figure 11. 1 m × 0.8 m plant spacing.



Figure 12. 1 m x 1 m plant spacing.

- Weed the farm early. Early weeding is easier, and prevents weeds from competing with the crop for nutrients, water, light, and space at that important period. If planting early in the rainy season, weed at 4, 8 or 12 weeks after planting. If the rainy season ends before this schedule can be completed, continue weeding during the following rainy season at 6–10 weeks after the rains begin.

What qualities do improved cassava varieties have?

- Grow fast.
- Tolerate major diseases and pests.
- Mature early.
- Give high root yields (fresh and dry).
- Meet end-users' quality needs.
- Store well in the ground for 12–15 months.

Where can I find high yielding and healthy planting materials?

- International Institute of Tropical Agriculture, Ibadan, Oyo State.
- National Root Crops Research Institute, Abia State.
- State offices of the National Seed Council of Nigeria.
- State offices of Agricultural Development Programs.
- State offices of the Cassava Growers Association.
- Roots and Tubers Expansion Programme (RTEP), Ogun State.

Can I intercrop cassava under zero input?

- Cassava/maize and cassava/legume intercrops have been found to make better use of the land, reduce soil erosion and the risk of crop loss.
- Cassava can also be intercropped with yam, cocoyam, sweetpotato, melon, okra, and leafy vegetables (Fig. 13).
- For sole crop cassava, plant on the top of the ridge or heap. If you must intercrop with maize, plant cassava on the top and maize on the side of the ridge or mound.



Figure 13. Cassava intercrop with melon.

- Where cassava is grown as an intercrop, adjust the spacing from 1 m × 0.8 m to 1 m × 1 m to suit the branching habits of cassava and the other crop(s).

What else can I do to increase yield without inputs?

- Plant leguminous crops such as soybean (Fig. 14) in rotations or intercrops, or *Mucuna* (Fig. 15) in fallows. This helps to sustain soil fertility and quality, and to manage water, noxious weeds (spear grass), pests and diseases.



Figure 14. Soybean in rotation.



Figure 15. *Mucuna* as fallow.

- Mulch cassava seedbeds: This means covering the soil surface with plant materials. It is especially valuable when growing cassava in dry areas and on slopes. It has these advantages:

- Improving the fertility of the soil.
- Increasing the ability of the soil to hold water for plant growth.
- Reducing erosion and weed problems.

Sources of good mulching material include dead leaves from alley crops, rice husks, coffee hulls, crop/weed residues (Fig. 16), and leguminous plants (live mulch) (Fig. 17).

Cover crops such as *Mucuna*, *Centrosema*, and *Aeschynomene*, when used as live mulch are usually incorporated into the soil before the crop is planted.



Figure 16. Dead mulch of straw between rows.



Figure 17. Live mulch.

4

Stem handling techniques for increased yield

Cassava is propagated by stem cuttings. These cuttings must be handled properly for good sprouting, establishment, and vegetative growth (Fig. 18). This training manual provides a guide for extension officers, NGOs, and farmers on the best practices of stem handling for increased yield.

What makes cassava stems healthy for planting?

- Stems for planting should be obtained from plants 10–12 months old (Fig. 19).
- Cassava stems should be stored under the shade for 2–5 days (never more than 2 weeks) before being cut and planted. This makes the stems sprout faster than when they are planted freshly cut from the field.



Figure 18. Good growth of cassava.



Figure 19. Mature cassava plants.

- Cassava stems can be stored vertically on the soil under shade (Fig. 20). The distal end of the stems should touch the soil, and moistened regularly, with the surroundings kept free from weeds. Mishandling by destroying nodes, making jagged cut surfaces, and keeping stems in the open (leading to drying), may result in losses.
- The stems should be cut with sharp tools, preferably secateurs or cutlasses (Fig. 21), into 25 cm lengths with 5–7 nodes (Fig. 22).



Figure 20. Stems under shade.



Figure 21. Sharp tools for cutting stem.



Figure 22. 5-7 node piec of stem.

How do you plant your cassava cuttings?

- Cassava cuttings can be planted in a slanting or angular position in which case, the cuttings are buried in the soil with one-third above the soil surface. Ensure that the buds point upwards (Fig. 23). This is from where the cutting sprouts.

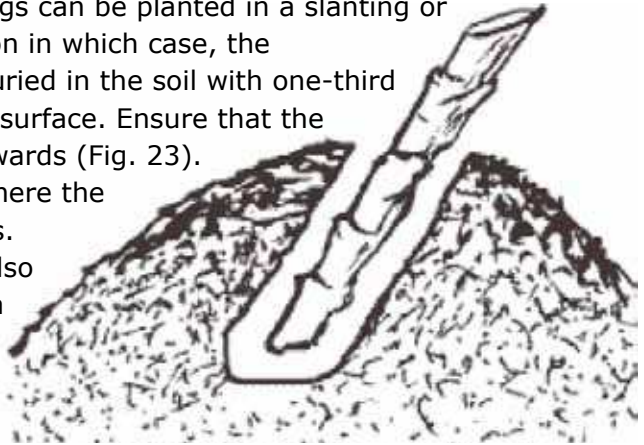


Figure 23. Planting at angular position.

- Cuttings can also be planted in a horizontal position in which case, the cuttings are completely

buried in the soil to a depth of 5 cm. Plant cassava cuttings at a spacing of 1 m × 0.8 m on the crest of ridges or mounds (Fig. 24 and Fig. 25) as conventionally recommended. This will give a plant population of 12,500 stands/ha.

- In areas of high rainfall or on very heavy soils, vertical or angular planting should be practiced while horizontal planting is better in dry areas.



Figure 24. Stand-by for planting.



Figure 25. Planting on ridges (crest).

Rapid multiplication of cassava stems

To produce large quantities of cassava stems as planting materials for subsequent seasons, cassava growers can use the rapid multiplication technique. Mature cassava stems are cut into several pieces and cared for until they become individual mature cassava stems. The first step is to acquire land and make a skeletal layout/ demarcation of the farm for good management.

How can you multiply cassava stems in a nursery using 2-node cuttings?

- Select and use improved, healthy, and pest/disease-free cassava stems from the farm.
- Cut selected cassava stems into 2-node pieces (Fig. 26) using a secateur, sharp knife/matchete or stake cutting machine for pre-sprouting in transparent polybags.



Figure 26. 2-node piece of stem.

- Treat the stakes with available insecticides or fungicides using recommended rates; cultural method can also be used e.g., Neem leaf powder: 1 kg in 5 litres of water.
 - Measure out the required quantity into a container.
 - Add water and mix thoroughly.
 - Put the stakes into the solution for 10 minutes (Fig. 27).



Figure 27. Stakes in insecticide.



Figure 28. Stakes in polybags.



Figure 29. Bags under a shady tree



Figure 30. Sprouted stakes.

- Remove the treated stakes from the solution and place them in perforated transparent polybags (Fig. 28).
- Store the transparent polybags under a shady tree (Fig. 29) or under the cassava canopy or in a farm shed for 7 to 10 days to sprout.
- Transplant the sprouted stakes into the field after exposing the polybags for 20 minutes in the field. Transplant sprouted 2-node stakes (Fig. 30) on ridges and mounds, or on the flat. Handle the stakes carefully to avoid breakage. Plant at 2–4 cm depth and at a spacing of 100 cm × 50 cm or 50 cm × 50 cm in a well prepared field. Transplant only when there is enough moisture in the soil.

- Harvest cassava stems at 9–12 months after planting. To harvest, cut the stems at a height of 20–25 cm above the ground level with a sharp machete (Fig. 31). Avoid bruising the harvested stems during the dry season (Fig. 32).



Figure 31. Cutting heights.



Figure 32. Handle harvested stems carefully.

How can you multiply cassava stems from 3-node cuttings for direct field planting?

- Select and use healthy stems from improved cassava varieties.
- Cut selected cassava stems into 3-node pieces (Fig. 33) using a secateur or sharp matchete or a stake cutting machine.
- Treat with fungicides, plant using the appropriate spacing, and harvest as in the 2-node cuttings method.



Figure 33. 3-node piece of stem.

5

Weed control practices

Controlling weeds in sub-Saharan Africa takes up to 60% of the labor in crop production and more than 40% of the total cost of growing cassava. This training manual provides a guide for extension officers, NGOs, and farmers on the effective and cost-efficient weed control practices in cassava production.

What common weeds are found on cassava farms?

There are two broad categories: annual and perennial weeds. Weeds can further be grouped into broadleaved weeds, grasses, and sedges

Broadleaved weeds – *Chromolaena odorata*, *Commelina benghalensis*, *Euphorbia heterophylla*, *Aspilia africana* (Fig. 34) and *Mimosa* spp.

Grasses – *Imperata cylindrica* (Fig. 35), *Cynodon dactylon*, *Panicum maximum*, and *Pennisetum polystachion*.

Sedges – *Cyperus rotundus* (Fig. 36), *Cyperus esculentus*, *Mariscus alternifolius*, and *Mariscus flabelliformis*



Figure 34. *Aspilia africana*.



Figure 35. *Imperata cylindrica*.



Figure 36. *Cyperus rotundus*.

Weed control: when and how?

Control weeds in the first 3-4 months after planting (MAP). There are different weed control methods.

Cultural method: Good crop husbandry minimizes weed interference. Included here are:

- Hand/hoe weeding (Fig. 37).
- Mechanical weeding (Fig. 38).



Figure 37. Hand weeding.



Figure 38. Mechanical weeding.



Figure 39. Good land preparation (Tillage).

- Tillage (Fig. 39).
- Mulching
- Burning
- Cropping system
- Ideal spacing (1 m × 0.8 m)
- Preventing the spread of weed seeds

Biological method: This means suppressing weeds by natural means, so that cassava grows and develops well. This includes:

- Fallowing
- Cropping systems i.e use of cover crops

Chemical method: Herbicides kill or impair weed growth. Herbicides should be applied before land preparation (pre- tillage) (Fig. 40); immediately after land preparation (pre-emergence) (Fig. 41), and 4–8 MAP (post-emergence) (Fig. 42).



Figure 40. Pre-tillage application.



Figure 41. Pre-emergence application.



Figure 42. Post-emergence application.

Why use chemical control?

- To control hard-to-kill perennial weeds that hand-pulling cannot remove.
- To avoid damage to cassava roots.
- To control annual weeds that grow quickly and produce many seeds.
- To increase yield, reduce labor and weed interference
- To make it easier to cultivate large farms.

Applying chemicals: when and how?

- Preplanting: Use herbicides containing glyphosate at (3–4 L/ha), 10 days before land preparation.
- Preemergence: depending on availability, use (Atrazine + Metolachlor) at 4 L/ha, or Atrazine + Pendimethalin at 4-6 L/ha, or Fluometuron + Metolachlor at 5 L/ha, or Fluometuron + Pendimethalin at 4 L/ha.
- Postemergence: Use Fusilade Forte 150EC recommended at 5–6 L/ha at 12 weeks after planting, specifically for grasses. Apply Diuron + Paraquat at 7 L/ha (directed spray) 4–8 weeks after planting (early post-emergence) for broadleaved weeds.
- Avoid direct spray or chemical drift to the crop as this will cause damage.

Tips for successful chemical weed control

- Choose the right herbicide for the job.
- Check and calibrate the sprayer.
- Know the spray volume needed. A standard spray volume is 200 L/ha, speed and walking is 1 m/sec or 3.6 km/h.
- Wear the right protective clothing (Figs. 40 and 41).

- READ THE LABEL AND HEED THE LABEL (Five times: 1. before purchase, 2. before mixing, 3. before application, 4. at storage, and 5. before disposing of the excess herbicide).
- Dilute the herbicide correctly: too much is dangerous, too little does not work.
- Watch the weather: do not spray on windy days or in very dry weather or when heavy rain is likely.
- Buy the amount needed for one spraying or for one growing season.
- Store herbicides correctly.
- Maintain the sprayer in good condition.

6

Cost-efficient mechanization

Small-scale cassava production in Nigeria mostly depends on manual labor and millions of Nigerian farmers are now less able to employ workers. One solution will be to replace human labor which is also becoming scarce with the use of machines. Full benefits of using improved inputs, such as stems, fertilizers, and herbicides in cassava production cannot be achieved without the use of improved tools or machines.

What are cost-efficient mechanization practices and farm operations?

- Cost-efficient mechanization means that all costs are covered and the farmer enjoys a good profit.
- Mechanization covers land clearing, tillage, planting, fertilizer application, weed control, and harvesting.
- The level of mechanization can be small, medium, or large, depending on the land area.
- Careful planning is required because buying machinery requires a huge amount of capital. Unfortunately, some of these machines (especially planters and harvesters) are not commonly available for hire. The right machines and a suitable schedule for field operations are needed.
- Terrain, soil type, and rainfall have to be considered when the farmer is choosing machines.

What machines are available?

1. Land clearing

- For land clearing, 50 to 75 people are needed to remove trees and stumps by hand from 1 ha in 1 day; usually farmers are unable to clear more than 1 ha in a season.



Figure 43. Bulldozer in operation.



Figure 44. Monkey winch felling trees.

- Land clearing can be mechanized using light bulldozers, monkey winches, and chain saws.
- Light bulldozers (Fig. 43), such as D6, can clear 2 or more ha in 1 day, depending on the vegetation. The machines push down the trees and shrubs and the blade should not be allowed to touch the topsoil.
- Bulldozers should be used only on dry soils, preferably during the dry season, to avoid compaction.
- Whenever bulldozers are not necessary or not available, the monkey winch (Fig. 44) is the next most efficient machine for land clearing.
- It can clear 1 ha in half the time that would be taken to do the work by hand.
- The chain saw (Fig. 45) is portable and very useful for felling trees and cutting down shrubs but it cannot be used to uproot stumps. For higher efficiency, it is usually combined with the monkey winch, or else the stumps are removed by hand.
- The brush-cutter (Fig. 46) is designed to clear grasses, small bushes, and shrubs. With a medium powered brush-cutter, a woman farmer can clear 1 ha of fallow in less than 2 hours.



Figure 45. Chain saw.



Figure 46. Woman farmer using brush-cutter.



Figure 47. A tractor-mounted plough.



Figure 48. A power tiller.

2. Tillage

- Tillage loosens and aerates the soil, and mixes organic matter and nutrients fairly evenly; roots can penetrate more deeply and plants are established better.
- In fallow land in Southern Nigeria, it takes 40 to 50 people to till 1 ha by hand in 1 day and make mounds. In the savannas, it takes 25% less labor to do the same work.
- Soil tillage can be mechanized using tractor-mounted plows (Fig. 47) or power tillers (Fig. 48).

- The most common plows in Nigeria are the disc type. They are designed to break, turn, mix, and raise soil.
- A trained operator can plow 4 ha in 1 day. A disc plow is cheaper and faster than tillage by hand.
- A power tiller (Fig. 48) is the next most efficient machine for soil tillage whenever tractor-mounted plow is not available.
- It can till 1.0–1.8 ha in 8 hours, depending on how wet and heavy the soil is.
- Small-scale farmers can join together and buy one power tiller that can service at least 250 ha of land in a year.

3. Planting

- Cassava stems are usually cut into 20–25 cm long stakes which are planted horizontally, inclined, or vertically on mounds or flat land.
- Generally farmers plant by hand and it takes 8–10 persons to plant 1 ha in 1 day.
- Cassava planting can be mechanized using tractor-powered planters (Fig. 49).
- A two-row planter can plant 7–10 ha in 1 day, depending on the terrain.
- It is faster and 50% less expensive than planting by hand.



Figure 49. A mechanical planter.



Figure 50. A stem cutting machine.



Figure 51. Cutting of stem with chain saw.

- The planter requires a tractor of 60–70 hp.
- Mechanical planters can be bought locally in Nigeria.

How can you plant cassava by machine?

- The cuttings need to be the same length, size, and shape with cleanly cut ends.
- Stem cuttings can be prepared by hand using simple tools such as cutlass or a small motorized chain saw (Fig. 50). A cassava stem cutting machine (Fig 51) has also been developed.

4. Mechanical weeding

- Weeds reduce crop yields. Weeding is the most expensive activity in cassava production.
- Weeds can be controlled with the use of herbicides and a boom sprayer mounted on a tractor (Fig. 52).
- Boom sprayers have a tank which can carry 400–600 liters of the chemical being sprayed. They reduce the cost of labor and save time and energy.
- The knapsack sprayer is also used (Fig. 53) and is hand-operated. It takes a lot of time and is not cost-efficient but it works well for small-scale farmers.



Figure 52. A boom sprayer.



Figure 53. A knapsack sprayer.

5. Harvesting

- Cassava is harvested manually by pulling the stem which carries the roots out of the ground (Fig. 54).
- This is usually done by hand and requires 40–60 persons, depending on the season, to harvest 1 ha of cassava in 1 day.
- A 2-row mechanical harvester (Fig. 55) can harvest 3–5 ha in 1 day, depending on the terrain.
- It is faster and 50% less expensive than harvesting by hand.
- Mechanical harvesters can be bought locally in Nigeria.



Figure 54. Manual harvesting.



Figure 55. Mechanical harvester.

7

Harvesting and postharvest handling

Cassava roots attached to the main stem can remain in the ground for several months. However, after harvest the roots start deteriorating within 2 to 3 days, and rapidly become of little value for consumption or industrial use. This section of the publication provides a guide for extension officers, NGOs, and farmers on the harvesting and postharvest handling of cassava roots.

When is harvesting done?

- Harvest cassava when the roots are old enough to have accumulated enough starch but have not yet become fibrous.
- An optimum period of 12 to 15 months after planting is recommended when the yield and quality are highest.
- Harvesting too early results in a low yield.
- Leaving the roots too long in the soil also exposes them to rodents and ties down the land unnecessarily to producing one crop.
- Harvest cassava during fairly dry weather so that you can easily remove soil from the roots (Fig. 56). Roots harvested in wet conditions get soil stuck between them and this can lead to inaccurate weight records (Fig. 57).



Figure 56. Cassava harvested during dry weather.



Figure 57. Cassava harvested in wet soil.



Figure 58. Woman pulling cassava gently from the soil.



Figure 59. Lifting cassava roots from the soil.

How do you harvest?

Manual methods:

- Pull the plant gently and do not drag the roots (Fig. 58). Dragging can cause bruises and cuts which may lead to early deterioration.
- Cut the plant at about 30 to 50 cm above the ground; use the stem to lift the roots (Fig 59).
- If the soil is compact, loosen it first but take care not to damage the roots (Fig. 60).
- Separate the roots from the stem using a sharp cutlass (Fig. 61). Cut each root near to the stem. Do not break



Figure 60. Man carefully digging soil to harvest cassava roots.



Figure 61. A good handling practice.



Figure 62. A bad handling practice.



Figure 63. Leaving roots under the sun for too long can lead to weight loss.

the roots from the stump by hand (Fig. 62). This will cause injuries which lead to root rot.

- After harvesting, do not leave the roots under the sun for a long time (Fig. 63). Too much heat causes weight loss and early deterioration.

Mechanical methods: Cassava lifter

- This equipment is manually operated and reduces the drudgery in lifting roots.
- It consists of a frame with a footboard and immovable gripping jaws with a lever (handle) attached (Fig. 64).
- The jaws will grip the base of the stem tightly.
- The lever is then used to lift the roots.
- The lifter can harvest up to 200 plants/hour.



Figure 64. A cassava lifter.

Motorized Cassava Harvester

- The mechanical harvester (refer to Fig. 55) cuts, digs, and raises up soil containing the cassava root cluster.
- The equipment is usually pulled by a tractor and used by large-scale farmers.
- It can dig and harvest 3-5 ha in 8 hours.

How do you store cassava roots?

Storage of cassava roots is not a good practice and therefore not recommended. However, if for any reason the farmers must store, the following steps will be taken:

- Select a well-drained area, preferably shaded, and slightly sloping.
- Dig trenches measuring 1 meter (m) wide and 30-40 cm deep. The length varies according to the volume of roots. A trench 1 m long can contain 70-80 kg of roots.
- Dig the trenches in such a way that their length is directed down-hill.
- At the lower end of the trench, make a drainage ditch, at least 20 cm wide and 5 to 10 cm deeper than the storage trench.
- Arrange mature, undamaged roots inside the trench (Fig. 65).
- Cover each layer with soil, preferably river- sand or sea- sand. Clay-loam soil can also be used if it is not too wet
- Do not use heavy clay. Soil of this type could speed up root deterioration.
- Do not keep cassava in a waterlogged area because roots will rot easily.



Figure 65. Cassava roots arranged in a trench.

How to transport cassava roots?

- Carefully sort and arrange roots neatly to save space.
- Load carefully to avoid damage and root rot.
- Use wheelbarrows to transport roots in low quantities and for short distances.
- Vehicles transporting cassava a long distance should be covered with tarpaulin to avoid rapid moisture loss from the roots.

How do you reduce postharvest losses of cassava?

Traditional methods to reduce postharvest losses of cassava are as follows:

- Leave the mature roots in the soil until needed.
- Coat the harvested roots with a paste of mud.
- If harvested roots must be stored, then store in a pit lined with straw and dry leaves.

These traditional methods can preserve roots for only a few days. Improved methods are mainly used for small and medium-scale production. They include:

- Dipping fresh roots in fungicide and packing them in polythene.
- Storing roots in moist sawdust.

Summary

Farmers are advised to process the raw material (cassava roots) locally into food products or sell to large-scale cassava processing factories. Storing raw cassava roots after harvest is not encouraged because it is labor-intensive and effective for only a limited time. The IITA cassava value chain unit links farmers to cassava processing factories such as the MATNA Foods Company Limited, Ogbese-Akure, Ondo State, Nigerian Starch Mills Limited, Uli-Ihiala, Anambra State, and EKHA Agro, a Glucose Syrup producing factory, Ogun State. The factories



Figure 66. Truck offloading roots at MATNA.

have the capacity to process hundreds of tonnes of cassava fresh roots/day. They operate integrated automated systems that allow them to accept fresh roots through motorized conveyors and release the end products (starch or glucose syrup) after necessary transformations have taken place. Thus, they have the potential to make bulk purchases of cassava roots, arrange transport and logistics for conveying roots, weigh roots on getting to the factories, and conduct relevant tests to ensure that farmers are not shortchanged (Figs 66, 67, and 68).

The IITA-Nestlé cassava starch project (called "Increasing cassava starch in Nigeria through the multiplication and distribution of IITA-improved varieties) has since 2011 sought to promote clustering of farmers and establishment of out-growers around the two major starch factories, Matna and NSM. The idea is to produce enough cassava at a competitive price through yield increases, to cause the processing factories remain in business, and meet the investor's demands for starch that it uses as intermediate product. This approach will enable Nestlé to have the



Figure 67. Weigh bridge at NSM.



Figure 68. Offloaded roots ready for processing at EKHA Agro.

opportunity of buying all its cassava starch locally, thereby, creating job opportunities and income for farmers. The farmers are being encouraged to identify and benefit from this golden opportunity.

8

Conclusion

In this training manual, critical issues that relate to sustainable cassava production, harvesting and post-harvest best management practices were discussed. Among other things, the manual examined the following:

- Identification and selection of site;
- Restoration/enhancement of soil fertility;
- Fertilizer and its use in cassava production;
- Meaning and use of zero input technologies;
- Qualities and use of improved cassava varieties;
- Stem handling for increased yield;
- Rapid multiplication of cassava stems;
- Weeds, weed types and methods of weed control;
- Cost-efficient mechanization practices in cassava production; and
- Cassava harvesting and post harvest best management practices.

The manual, which is meant to serve as guide to farmers, extension workers, government agencies, NGOs, students of agriculture, service providers and other stakeholders, is aimed at promoting efficiency, by increasing yield and profit through the reduction of pre- and post-harvest losses in cassava production. It seeks to promote cassava production as a commercial/business venture and emphasizes investment in the production of roots, multiplication of stems, and processing and marketing of cassava-based products to boost food and income security. It is our hope that the manual will contribute immensely in the quest to achieve national growth and development by boosting export, foreign exchange and employment opportunities, especially for the farmers, women and youths.