



EBAFOSA

Ecosystem Based Adaptation for
Food Security Assembly



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Training Manual

Climate resilient, Ecosystem-based
Adaptation Approaches for Application
in the Cassava production and Value
addition in Uganda

Abstract

This manual is intended for use in upscaling application of Ecosystems Based Adaptation (EBA) in a market driven approach in Uganda and many other African countries. As such, four fundamental aspects have guided its development.

First, the development is in line with national standards of the Uganda National Bureau of Standards (UNBS) which calls for contextualisation of EBA within the broader continuum of production and value addition. This is the Uganda National Standard Guideline US2241:2019 – “Climate action market incentives for agro-industrialisation — Compliance guideline” of the Uganda National Bureau of Standards (UNBS).

Second, the choice of value chain of application has been taken cognisant of the need to work with some of the most lucrative value chains – both climatic and market wise – in the country. Cassava has been chosen based on its strengths as a climate resilient crop, that is also a high value and second most important staple for Uganda and many other African countries with a growing market niche. Targeting it will therefore provide a wider application market for this manual as more people invest in cassava and other crops. This however does not limit use of the manual as the principles presented are replicable to any other crops and value chain.

Third, in line with the principle to balance mitigation

and adaptation as called for in Uganda’s climate commitments and many other countries NDC’s commitments across Africa, this manual has contextualised application of EBA within the broader context of going beyond the farm gate and into value addition. This is where the pull factors for EBA application are fostered in a market paradigm, and hence, accessible value addition using climate action solutions of mechanical solar dryers has been factored in to convert postharvest losses into incomes needed to drive further application of EBA. In this way, we are having mitigation solutions powering upscaled use of EBA.

Fourth, this manual uses a case study approach where Uganda and cassava are used as examples/ case studies to enhance understanding of principles using geographical and value chain contexts. Nevertheless, the manual is applicable continentally and for multiple other value chains.

In its use, the information presented in this manual is for advisory use only. Users are encouraged to verify site specific details that relate to their agro-climatic zones from their area agricultural extension officers. This manual follows benchmarks and standards of the Uganda National Standard Guideline US2241:2019- “Climate action market incentives for agro-industrialisation — Compliance guideline”.

FACTS ABOUT CASSAVA



- ▶ Cassava is a climate resilient crop (Jarvis et al., 2012)
- ▶ It is the second most important staple crop for the country and many across Africa
- ▶ Uganda is sixth-largest producer in Africa
- ▶ Cassava is a high value crop with over 15 industrial applications. In Uganda, from roots to leaves, cassava can be processed and combined with wheat, sorghum or millet to make various products – most of them absorbed by the local Ugandan market. When fully maximized, the cassava value chain can also save Uganda up to \$300 million annually in import expenditures.
- ▶ With improved quality in value addition, cassava is projected to be a viable partial raw material substitute for wheat in over 10 current major food items in Uganda and potentially replacing imported starches.
- ▶ Cassava is classified as an emerging market oriented commodity – with potential demand increases of up to 60% annually not only within Uganda but larger East Africa.
- ▶ Uganda's cassava postharvest losses are estimated at up to 90% of its initial value – translating to over \$30 million in losses every year. This is a significant loss in job, income & revenue opportunities to the Ugandan economy
- ▶ Cassava can store for 2-3 years in the soil depending on the variety (Food security)
- ▶ Cassava flour can be mixed with maize, sorghum, millet, soya, fish to make delicious dough
- ▶ Grows well in over 80% of Uganda's arable land.

INTRODUCTION AND BACKGROUND

IMPORTANCE OF CASSAVA

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cassava is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world. Cassava originated from tropical America and was first introduced into Africa in the Congo Basin by the Portuguese around 1558. Today, over 300 million Africans their livelihood depend on cassava. In sub-Saharan Africa (SSA) cassava is mainly a subsistence crop grown for food by small-scale farmers who sell the surplus. According to the Food and Agriculture Organization (FAO) cassava has a reputation as a poor person's crop, a crop of last resort¹. It grows well in poor soils with limited labour requirements. It provides food security during conflicts when the invader cannot easily destroy or remove the crop, since it conveniently grows underground. According Uganda Bureau of Statistics cassava is one of most the important staple food crops in the country. It is useful in manufacturing industry (UBOS, 2020) Cassava is grown mainly in the Central, Northern and North-Western parts of Uganda. The crop is grown by about 29 percent of the agricultural households (UBOS, 2020). In 2018, about 4.4 million tonnes were produced from a land area of about 941,000 Ha. The annual yield of cassava was 8.7 MT/Ha (UBOS, 2020). Surveys such as that conducted by (Buyinza & Kitinoja, 2018) have shown that about 88% of cassava produced in Uganda is consumed by humans, 50% of which is processed. In addition to the starchy root, the leaves of the cassava plant are edible and rich in protein. Data from several studies suggest that In Uganda cassava is a vital food and cash crop, It is produced mostly by smallholders on marginal and sub-marginal lands in eastern and northern parts of the country contributing significantly to basic food requirements of smallholder farmers(UBOS, 2018)

Cassava products

Cassava is one of Uganda's major crops, along with plantain, maize, sweet potato and sugarcane. Cassava can be processed into up to 300 diverse products and the aim is to have these enterprises produce in all these product lines. Ensuring each product passes through national certification². In addition, cassava is the basis of a multitude of value-added products, including food, flour, animal feed, alcohol, starches for sizing paper and textiles, sweeteners, prepared foods and bio-degradable products. The products are derived from a number of forms of cassava, ranging from fresh leaves and roots to modified cassava starch. The degree of processing and the technical requirements tend to increase from the fresh form to the modified starch form.

In recent years, there has been an increasing interest in cassava

1 Importance of cassava <https://cutt.ly/KjXQjnA>

2 CLIMATE ACTION DIGEST <https://cutt.ly/GjCo2jr>

Ecological Requirements

Cassava requires warm temperatures for optimal growth. The plants require at least 8 months of warm weather, thriving in regions with warm, moist climates with regular rainfall. Root production is maximized when temperatures are between 25 and 32 °C (77–90 °F). Cassava should be planted in full sun and is very sensitive to shading, which leads to low yields. Cassava can be grown in many types of soil, producing even in poor soil but will be more productive in well-draining, sandy clay loam with a pH between 5.5 and 6.5. Cassava is drought resistant. The crop does not tolerate waterlogged soils (NaCRRI, 2019).

KEY MESSAGE:
Agriculture accounts for 70% of employment, overwhelmingly on small farms; occupies half of all land area and provides half of all exports and one quarter of GDP in Uganda

MODULE 1: SOIL MANAGEMENT PRACTICES FOR SUSTAINABLE FOR EBA- CASSAVA PRODUCTION

INTRODUCTION

In Eastern Africa, majorly Uganda, agriculture is one of the most important sectors. Soil fertility in this region is declining at an alarming rate due to unsustainable practices that lead to the degradation of soil properties. Current soil fertility management practices used by smallholders seem inadequate to counter the outflow of nutrients. As the population is increasing, this poses a great challenge for policy makers to address the declining soil fertility trend in the region. Many factors lead to the low adoption of fertilizer use in the region. Factors causing soil infertility include; Inadequate knowledge on proper soil/land use practices, Poor land management practices leading to unsustainable use, Inadequate knowledge on proper soil/land use practices (Abass et al., 2014).

Cassava is highly tolerant to acid soils, and has formed a symbiotic association with soil fungi that help its roots take up phosphorus and micronutrients. Since most of the absorbed nutrients are found in the stems and leaves, returning them to the soil helps maintain soil fertility for the next crop.

What makes a soil fertile?

- ▶ Large amounts of topsoil
- ▶ 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.

How can you identify a fertile soil?

- ▶ Vegetative growth – a fertile soil supports good crop growth
- ▶ Results of soil analysis.
- ▶ Visual symptoms or signs of active biological activities on the soil surface (e.g., worm casts)

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?

- ▶ Intercropping Cassava with legumes
- ▶ Incorporation of residues
- ▶ Mulching
- ▶ Use of biofertilizer fertilizers
- ▶ Applying agroforestry techniques to restore deforested areas, enhance soil stability, ground recharge rates, and water retention capacity
- ▶ Mulching

KEY MESSAGE: Intercrops need to be carefully managed in order to reduce the competition with cassava, for light, water and nutrients.

MODULE 2: SOURCE OF PLANTING MATERIAL

PLANTING MATERIAL

The use of high-quality planting materials that maintain genetic purity and are free of diseases and pathogens is crucial in cassava production.

Cassava is **propagated** by stem cuttings. Stems are cut from matured plants after harvest. The most common sources of the cassava cuttings are farmers own farms. Extension agents may however provide high yielding and disease tolerant planting material for their contact farmers. These cuttings must be handled properly for good sprouting and establishment . In this section we look at the best practices in stem handling for increased yield.

In Uganda, cassava supply system depends mainly on agricultural research institutions that are a source of breeder seed. Special care needs to be taken during the multiplication process to ensure pest free planting material.

SOURCE OF CASSAVA CUTTINGS: WHERE TO GET PLANTING MATERIAL

Cassava farmers usually use cuttings taken indiscriminately from a range of sources for planting the chosen varieties. Each source of cuttings has advantages and disadvantages. Identifying and discussing these advantages and disadvantages can help the farmer make better decisions about where to obtain cassava cuttings.

Qualities of good cassava cuttings

- ▶ Healthy Cassava Cuttings: cuttings should come from a multiplication field with healthy planting material.
- ▶ Age of cassava cuttings: The cuttings selected must meet several criteria, for example, an age of 9–12 month
- ▶ Disease free: an absence of Cassava brown stoke disease (CBSD), mosaic symptoms (indeed, the most efficient way to manage cassava mosaic virus is to use healthy planting material).
- ▶ Planting material should be hard (otherwise it can rot) and it must have sufficient nutrient supply to easily establish and make roots.
- ▶ Location and size of cuttings: Cassava cuttings from each stem must have nodes . In general, cuttings from the base and middle sections of the stem will grow more quickly and produce more tubers than cuttings from the top of the stem. So, to get good tuber production choose cuttings from the lower parts of the stem.

KEY MESSAGE: Make cuttings that are 20 to 30 centimetres long, at least 2 centimetres thick and have 5 to 7 nodes.

PREPARATION AND SELECTION OF CASSAVA CUTTINGS

Cassava is propagated by stem cuttings. These cuttings must be handled properly for good sprouting and establishment. In this section we look at the best practices in stem handling for increased yield.

Preparing healthy cassava stems for planting

- ▶ Obtain stems for planting from mature plants 10–18 months old.
- ▶ Store under the shade for 2–5 days (never more than 2 weeks) before cutting and planting.
- ▶ This makes the stems sprout faster than when they are planted freshly cut from the field.
- ▶ Stems should be stored vertically on the soil under a shade. The distal end of the stems should touch the soil, which is moistened
- ▶ regularly, with the surroundings kept free from weeds
- ▶ Handle the stems with care not to destroy the nodes that may result in losses. Do not make jagged cut surfaces or keep stems in the open (leading to drying).
- ▶ Cut stems, with sharp tools, preferably secateurs or cutlasses, into 15-25-cm cuttings with 5–7 nodes

HANDLING STEMS IN TRANSIT AND STORAGE

Cassava stems are bulky and do not store well for a long time. Their transportation and distribution, therefore, deserve special effort by the people who are responsible for making the materials available to farmers.

In cases where materials have to be transported over long distances and stored before planting, it's advisable to prepare 1m long stakes instead of planting size.

Any strong blow against the stems or branches selected for planting material should be avoided during cutting and transporting. Any physical damage the cutting suffers can decrease its quality.

Physical damages both to the epidermis and to buds can occur from striking or friction to the cuttings during preparation, transport, storage and planting.

To ensure safe transportation always handle the stems with care. Avoid throwing bundles of stakes about on trucks and to hard grounds or standing on and pressing them heavily for this would cause bruising and destroy nodes that may result in losses

HOW TO PLANT CASSAVA CUTTINGS

In most East African countries cassava is still planted by hand. And planting is done at the onset of the rainy season, often in flat fields, though planting on ridges is desirable in wet regions.

According to National Crops Resources Research Institute (NaCRRI) – Namulonge in Uganda it advises cassava farmers to conduct the following best practices for good cassava planting materials (NaCRRI, 2019)

- ▶ Cut stems from 9-18 months old field
- ▶ Best stem cuttings should be between 1.5-2 cm in diameter
- ▶ Stem cutting length should be between 15-25 cm
- ▶ Cuttings with 5 nodes are good

- ▶ Pack 500 cuttings per bag
- ▶ 8 bags plant 1 acre
- ▶ Plant within 10 days after cutting
- ▶ Store cuttings in a shade when ready to plant
- ▶ Plant in horizontal position
- ▶ Number of stem cutting/ hole: 1
- ▶ Gap fill dead plants 1 month after planting
- ▶ Remove unwanted cassava plants within 2-3 months after planting
- ▶ Avoid planting stem cuttings from very old plants (> 18 MAP) as they poorly sprout
- ▶ Avoid planting green portion of stems as they may rot in the ground
- ▶ Use EBA techniques as captured in module 1 to enhance soil fertility. Agroforestry is one of the most critical techniques that also act as windbreakers for cassava plant to prevent damage during adverse weather.

KEY MESSAGE: Avoid planting green portion of stems as they may rot in the ground

MODULE 3: ZERO INPUT TECHNOLOGIES TO INCREASE YIELD IN CASSAVA

You can grow cassava using zero input technology. This does not need chemicals, such as fertilizers and herbicides, or biofertilizer. The zero-input method encourages biological activity in the soil and provides natural protection from diseases (Abass et al., 2014). It can guarantee good yields, provided that you select a land with adequate organic matter, use the right varieties, plant at the right spacing and time, and ensure a weed-free farm. In this section we look at this environmentally-friendly farming practice

QUALITIES OF IMPROVED CASSAVA VARIETIES

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

CASSAVA AGRONOMY PRACTICES

- ▶ Soils: All soils BUT not water logged or rocky
- ▶ Land preparation: Plough 2 times
- ▶ Stem cutting length: 20-25 cm
- ▶ 8 bags (each 500 stem cuttings) per Acre

- ▶ Planting depth: 6-10 cm
- ▶ Number of stem cutting per hole: 1
- ▶ Spacing: 1m x 1m
- ▶ Number of plants per acre: 4,000
- ▶ Maturity period: 12 months
- ▶ Field longevity: 2-3 years
- ▶ Weeding regime: 3-4 times depending on weed type
- ▶ Stem yield (1st Crop): 40-60 bags
- ▶ Stem yield (Ratoon crop): 100-150 bags
- ▶ Tuber yield: 25-45 Tons/Ha depending on variety
- ▶ Intercrop with beans or maize: 1 month after cassava has germinated

HOW TO INCREASE CASSAVA YIELDS USING ORGANIC SOURCES OF NUTRIENTS

Farmers need to maintain and improve soil quality and health using a number of other measures include, conservation tillage, intercropping, green manuring, mulching crop residues and cover crops, alley cropping, and applying animal manure or compost

- ▶ Intercropping: Intercropping with grain legumes, which fix atmospheric nitrogen, make some N available to the cassava crop. Although biological fixation cannot meet all of cassava's nitrogen needs, it has some benefits.
- ▶ Animal manure and compost are used by smallholder farmers around the world to increase crop production. Among the various types, chicken manure tends to have the highest nutrient content. Biofertilizer – whether manure and compost are both good sources of organic matter which, when incorporated into the soil, improve its structure and aggregate stability, and enhance water holding and cation exchange capacity
- ▶ Green manuring – the practice of growing a grain- or forage legume for some months, then mulching the residues prior to planting the cassava crop – also improves soil fertility, especially levels of nitrogen. Green manures which can be used include,, cowpeas, groundnuts, pigeon peas, beans, jack-beans.

KEY MESSAGE: The full potential of cassava will not be realized until production constraints are mitigated in higher-yielding varieties, and cassava growers have access to disease-free planting material.

IMPORTANT PESTS

The most serious pests of cassava – those causing economic damage or yield losses – are generally those that have co-evolved with the crop. Cassava pests occur in all cassava growing areas of Uganda. Insect pests reduce crop yield causing food and income losses by damaging planting materials, leaves, roots and acting as vectors of major cassava diseases. Insect pests of importance in Uganda include cassava mealybug, termites and cassava green mite, hornworms, whiteflies.

IDENTIFICATION OF SOME PESTS

Cassava Mealybug

Cassava Mealybug causes yield loss through leaf loss and weakening of planting material and consequently root yield reduction which has been estimated up to 70%.

Initially the Cassava Mealybug attacks the terminal ends of cassava shoots which become stunted and the leaves curl and fold. The internode length is reduced, causing twisted stems, and the emerging leaves are compressed together into 'bunchy tops' (Figure 1 & 2). When the attack becomes very serious plants die starting with the top most growing point of the plant, where the highest pest population is found (Okao-Okuja G , Hamba S , Omara J , Nuwamanya E, 2017) .



Figure 1 Mealybug damage to leaves and stem



Figure 2 Mealybug weakening a plant

The attack of **Cassava Mealybug** on lower leaves and natural leaf fall in the dry season causes a so called "candle-stick" appearance. The affected plants may produce lateral leaves but even these become attacked by the insect pest. Cassava Mealybug damage reduces cassava yield by reducing the capacity of the plant to form tubers, and by reducing the quality of leaves as a vegetable. The twisting of stems also reduces the quantity and quality of planting material. Since the attacked plant loses leaves more weeds tend to grow underneath

CULTURAL CONTROL

Before planting:

Avoid planting in sandy or nutrient poor soil. Alternatively, add manure, and mulch to avoid moisture stress. Mealybugs infestations are a problem in these soils even though parasitoids are present.

- ▶ Do not plant infested cuttings.

During growth:

- ▶ Ensure cassava crops have adequate nutrition by applying biofertilizer or micro-dosing mineral fertilizers from the nursery and through the life of the crop. Minimal usage of organic pesticides is also applicable.

After harvest:

- ▶ Remove the remains of the crop after harvest and destroy.
- ▶ Do not replant on the same land. Rotate crops with maize, food or forage legumes or vegetables, leaving a 2-3-year interval between crops of cassava on the same land.

KEY MESSAGE: : NATURAL ENEMIES

Natural enemies of the cassava mealybug include ladybird beetle generalists, e.g., *Hyperaspis*, *Exochomus* and *Diomus* species. There are also several specific parasitoid wasps, among which *Apoanagyrus lopezi* (*Epidinocarsis lopezi*) has been the most effective parasitoid controlling the cassava mealybug since its introduction to Africa and Asia³.

CASSAVA GREEN MITES

Due to its non-conspicuous nature, CGM is only noticed through its damage symptoms. The CGM damages cassava by sucking sap from the leaves and shoot tip. The damage initially appears as yellowish (chlorotic) "pinpricks" (Figure 6.2) on the upper surface of developing and newly formed leaves, and later takes a blotched and bronzed like appearance.

Cassava Green Mite affects the important annual crop cassava and can cause a reduction of about 50% in leaf weight, and up to 80% tuber yield loss (Shukla, 1976; Gutierrez et al., 1988; Pallangyo et al., 2004). M. Tanajoa

3 Natural enemies OF cassava Mealybuy <https://cutt.ly/jjCWryj>



Figure 1 Adult female mite with egg.



Figure 2 Typical symptoms of Cassava Green Mite attack.

CGM is mainly dispersed/ spread by human activity, whereby infested plant materials and contaminated media are transported over long distances. Natural dispersion by wind and water may also spread the cassava green mite. In areas where both the pest and host plant are exotic, there is no evidence that indigenous natural enemies are significant factors in limiting the mite population growth rates. CGM can feed and reproduce on other plant species and is reported as a quarantine pest⁴.

KEY MESSAGE: : On heavily attacked plants, the youngest leaves die and drop, the shoot remains without leaves and looks like a “candle-stick”, and the plant appears stunted. CGM reduces production of the tubers by inducing chlorosis, and causing loss of leaves.

AFRICAN CASSAVA WHITEFLY

The whitefly, *Bemisia tabaci*, is a major pest of cassava, particularly in Africa where it is responsible both for the transmission of plant viruses and, increasingly, for direct damage due to feeding by high populations⁵. Whiteflies are found in all cassava growing areas of Uganda. They are tiny white insects that feed on the cassava leaves and are usually found on the underside of the young leaves of cassava, where they also lay their eggs. The eggs develop through instar stages and take about one month to become adults (Christopher A Omongo, 2012).

When they feed on the cassava leaves, whiteflies cause damage to the plant and spread Cassava Mosaic Disease (CMD) and [Cassava Brown Streak Disease \(CBSD\)](#).

CMD and CBSD can make the cassava leaves to turn yellow and also lead to stunted growth of the cassava plant as well as leading to yield loss.

4 Data Sheet *Mononychellus tanajoa* (cassava green mite) <https://cutt.ly/6jMBIde>

5 African Cassava Whitefly <https://cutt.ly/JkcG3IU>



Figure 1 Cassava plant containing African Cassava Whitefly

CONTROL:

- ▶ The best and most recommended way to control the whitefly is to use resistant varieties
- ▶ Farmers must burn and bury the affected cassava plants to minimise the spread of the diseases since whiteflies can feed on the sick cassava plant and then carry the two diseases to other healthy plants.

TERMITES

Many kinds of termites damage cassava stems and storage roots. Termites live in soil or in nests above the ground. They can also be found in tunnels on the surface of cassava stems. Termite nests contain worker, soldier, queen, and king termites. Worker and soldier termites are the ones you normally see when you break open the nests. The workers and soldiers are small insects with white or brown bodies and brown heads. They may or may not have wings. Worker termites cause all the damage to crops and feed all the other members of the nest. The soldier termites fight off other creatures which may enter or destroy the nest.

Crop damage symptoms: In newly planted cassava farms termites chew and eat stem cuttings. These grow poorly, die and rot. In older cassava farms, termites chew and enter the stems. This weakens the stems and causes them to break easily. Termite damage occurs mostly in the dry season. Reproduction: King and queen termites produce all the other members of the termite nest. They are always hidden in special chambers in the nests, and you are unlikely to see them. Other crops attacked: In addition to cassava, termites attacks many other crops including maize, yam, and groundnut

Prevention

- ▶ When selecting planting sites, avoid fields infested with termites
- ▶ Destroy termite nest before planting
- ▶ For small, localized areas with infestation, sterilize soil before planting (e.g., with hot water)
- ▶ Leave space between basil and crop because this native plant may reduce growth/ survival of cassava if grown too close
- ▶ Clear plant debris and burn
- ▶ Early burning of vegetation before planting
- ▶ Plant during rainy season
- ▶ Phytosanitary measures (for example, do not move infested material)
- ▶ Plant clean (termite-free) cuttings
- ▶ Deep planting of transplants
- ▶ If mulch material is used, do not mulch close to the cassava plant as this will attract termites
- ▶ Keep soil moist in the dry season
- ▶ Use Biofertilizer consistently from the nursery and throughout the life of a crop to ensure robust stalks and roots

Direct control

- ▶ Use driver ants. Collect driver ants and put them in areas affected by termites
- ▶ Physically destroy colonies by digging out white ant hills/ termite mounds.
- ▶ Apply wood ash to the base of the plant.
- ▶ Minimal usage of organic pesticides
- ▶ Combinations of all the above approaches

CASSAVA WHITE SCALE

Appearance: The cassava white scale, *Aonidomytilus albus*, is found mainly on cassava stem surfaces. The females are wingless, firmly attached to the stems, and covered with white material. The males have wings. Crop damage symptoms: The insect sucks sap from cassava stems. This causes the stems to lose a lot of water and die. Method of spread: Males of the cassava white scale can fly. However, the pest spreads mainly by wind and the transport and planting of infested stem cuttings.

Crop damage symptoms: The insect sucks sap from cassava stems. This causes the stems to lose a lot of water and die. Method of spread: Males of the cassava white scale can fly. However, the pest spreads mainly by wind and the transport and planting of infested stem cuttings

SCALE INSECTS

Scale insects are tiny wingless white insects that cover the cassava plant stem. The scales feed by sucking sap from the cassava plants. Therefore, they may reduce the likelihood of cassava cuttings to sprout, or they may cause death of the entire plant through loss of water from the plant. The scale insects are dispersed passively by wind, spreading from one plant to another. They are also spread through use of infested planting materials.

IDENTIFICATION OF DISEASES

I. CASSAVA BROWN STREAK DISEASE

1. What is cassava brown streak disease

Cassava brown streak disease (CBSD) is a devastating disease that causes loss of cassava root (tuber) production and quality. The Cassava Brown Streak Disease (CBSD), its main symptoms on cassava leaves, stems, and storage roots, and how it spreads. Additionally, it is explained how to manage CBSD.

2. symptoms caused by cassava brown streak disease

- ▶ Patches of yellow areas mixed with normal green colour. This phenomenon is commonly referred to as chlorosis
- ▶ Yellowing along the small veins of leaves (chlorosis)
- ▶ Brown rotting of cassava tissue.
- ▶ Deformed, constricted and misshaped storage roots
- ▶ Brown streaks, lesions and wounds on stems.
- ▶ General yellowing of entire leaf.

How Cassava brown streak disease spread?

- ▶ Planting cassava cuttings from infected cassava plants is the major way CBSD spreads. This also explains the rapid spread of the disease in areas where it is reemerging, such as Uganda.
- ▶ sharing and distribution of infected planting materials is responsible for rapid spread of the disease.
- ▶ It is also believed to be spread by insects called white flies and by infested farm implements such as knives used for cutting cassava stems.
- ▶ planting of stem cuttings from CBSD infected plants
- ▶ The virus also spreads from plant to plant by white flies
- ▶ Cassava brown streak disease also spreads through multiplication centres if the original source of cassava materials were infested or if the planting materials being distributed are not checked for the presence of CBSD.
- ▶ Farm implements such as knives used in cutting cassava sticks into cuttings can spread CBSD to healthy planting materials when the infested knife is used on them

Management of CBSD

- ▶ Planting of clean (symptomless) cassava cuttings is the main way of controlling CBSD.
- ▶ Planting resistant and tolerant varieties is the most sustainable way of controlling CBSD for example Nase 3 (migyera) Nase 14, Nase 15, Nase 18, Nase 19
- ▶ Distribute only stems and fields inspected and authorised by Agricultural officer.
- ▶ Do not move planting materials from areas where the disease is most common to other places
- ▶ Uproot and discard diseased cassava plants this helps in reducing the source of the disease.
- ▶ Use of disease-free planting materials
- ▶ Maintain healthy soils as expressed under “module 1” to enhance health of plants and hence their resistance to streak disease.

CASSAVA BACTERIAL BLIGHT

Cassava bacterial blight (CBB) is regarded as one of the most limiting diseases of cassava production. CBB can be devastating, causing total crop loss, and among the diseases which afflict cassava worldwide, CBB is regarded as causing the greatest yield losses (Chiona et al., 2016). CBB is one of the major problem of cassava in Uganda.

Symptoms include angular leaf spots, blight, wilt dieback and gum exudations. Planting of infected materials, rainfall, hailstorms, wind and insects are major factors in the spread of the disease ⁶.



How is the disease spread?

Once one cassava plant is infected, the whole crop is put at risk to infection from plant-to-plant transmission through several means, including rain-splash, insect damage, picking off young shoots as a vegetable, and contaminated cultivation tools (Jackson, 2013).

The distribution of infected vegetative planting material of cassava from diseased plantations has been the main means of disseminating the CBB bacterium over long distances into Africa.

Infected seeds are an important means of transmitting the pathogen to new crops or regions.

MANAGEMENT OF CASSAVA BACTERIAL BLIGHT

- ▶ Restriction of movement of infected cassava cuttings to non-infected areas.
- ▶ planting of resistant varieties and healthy cuttings
- ▶ encouragement of mixed cropping
- ▶ crop rotation is recommended for control
- ▶ Provide farmers with knowledge of the biology and epidemiology of the disease
- ▶ Plant tolerant and resistant varieties
- ▶ Ensure planting material is obtained from disease-free plant
- ▶ Ensure community action with all farmers working together

⁶ G. W. Otim-Nape <https://cutt.ly/Okc1zrw>

- ▶ Intercrop cassava with cereals and/or legumes
- ▶ Prevent the build-up of weeds in the crop
- ▶ Maintain healthy soils as expressed under “module 1” to enhance health of plants and hence their resistance to streak disease.

KEY MESSAGE: : Do not plant new plots of cassava next to those that are infected by the disease (Cassava Bacterial Blight). And do not plant downwind as bacteria could be spread in wind-driven rain to the new planting

CASSAVA MOSAIC DISEASE (CMD)

The African cassava mosaic disease (CMD) pandemic devastated Uganda’s cassava production between 1992 and 1997, causing losses valued in excess of US\$60 million annually

Cassava is cultivated as a tuberous root crop and propagated using stem cuttings. Stem cuttings can be entry points for diseases caused by pathogens, particularly viruses (Jameson, 2015). One of the most important diseases of cassava is cassava mosaic disease (CMD), CMD is caused by cassava mosaic geminiviruses⁷.

This is a viral disease which is usually transmitted through infected planting material and by whiteflies. Infected leaves are yellow, mottled and distorted. If leaves are yellow or brown all over but are a normal size that does not indicate CMD. CMD can cause total crop failure. CMD is controlled by strict enforcement of quarantine procedures and cultural practices, especially the use of resistant or tolerant cultivars and virus-free planting material as well as removing and destroying any plant showing symptoms of the virus. ii

Control strategies for cassava mosaic disease include;

- ▶ sanitation and plant resistance. In this case sanitation means using cuttings from healthy plants to start with a healthy plot and maintaining that healthy plot by identifying unhealthy plants and immediately removing them.
- ▶ Maintain healthy soils as expressed under “module 1” to enhance health of plants and hence their resistance to streak disease.

7 Cassava mosaic disease: a review of a threat to cassava production in Zambia. <https://cutt.ly/Mkc9Xwt>

MODULE 5: HARVESTING AND POSTHARVEST HANDLING OF CASSAVA

Depending on the variety, harvesting cassava for food could begin from the 7th month after planting for early maturing varieties; or after the 10th month for late varieties.

For a smallholder farmer you can harvest the tubers as you need them; without cutting the stems, begin by taking the biggest tubers from each plant, leaving the small ones to give them time to fill up (Chiona et al., 2016).

As a commercial farmer you would typically harvest all the cassava at the same time.

Once cassava is ready it should be harvested, because when left in the ground for a long period your cassava tubers will lose quality due to hydrolysis of starch.

HOW TO HARVEST CASSAVA

- ▶ Manual harvesting. This is the traditional method of harvesting cassava using the bare hands with or without the use of indigenous tools such as hoe, cutlass, mattock, earth chisel etc. Usually, these tools are used to dig round the standing stem to facilitate the pulling of the roots from the soil before detaching the uprooted roots from the base of the plant
- ▶ Semi-manual harvesters. Semi-manual harvesters are harvesting aids that usually adopt the lever principle to ensure that little human effort is used in uprooting the cassava. Various harvesting aids can be found in different cassava growing regions across the globe.
- ▶ Mechanised harvesters. Harvesting cassava mechanically involves the use of a harvesting implement integrally hitched to a tractor to dig out the cassava roots. Manual effort may be needed after cassava uprooting to collect and detach the cassava root tubers.

STORAGE AND VALUE ADDITION

- ▶ Harvested cassava should be cleaned, peeled, and grated under hygienic conditions
- ▶ Selection of mechanical solar dryer for use in dehydrating cassava should be one designed with a fresh air inlet and outlet a surface area of exposure that matches the amount of cassava to be dried (see figure 1a&b below on design of dryer to aid in selection)
- ▶ Before use, the dryer should be cleaned, and well exposed to direct sun away from and shade (see figures 2a&b)
- ▶ Cassava gratings should be loaded onto mechanical solar dryers for dehydration to recommended moisture levels critical to prevent growth of mold, fungus, and aflatoxins. In line with UNBS, the threshold is 8 - 10% moisture content (figure 3a shows loading process)
- ▶ The loaded pieces should be spread throughout the tray to ensure uniform exposure to heat and convection/wind across the tray (figure 4a & 5a is what a loaded dryer should look like)
- ▶ Take measurements of drying rates in 1 to 2-hour intervals using a digital moisture reader and record in a time sheet (figure 6a is sample digital moisture metre to be used).
- ▶ Readings should be taken at different points across the tray – at least 5 samples of readings should be taken and averaged to compute the moisture content at a given time t.

- ▶ Once an average of 8% is reached, dried cassava gratings should be loaded in air-tight, hermetically sealed bags, in a well aerated, cool, and dry storeroom (figure 7a is a sealed bag of dried & processed cassava).
- ▶ To prevent contamination, the dry cassava gratings should be stored in portions equal to one serving, to ensure once a bag is unsealed, the entirety of contents are consumed.
- ▶ The entire process should be done in full protective gear to prevent contamination and counter contamination

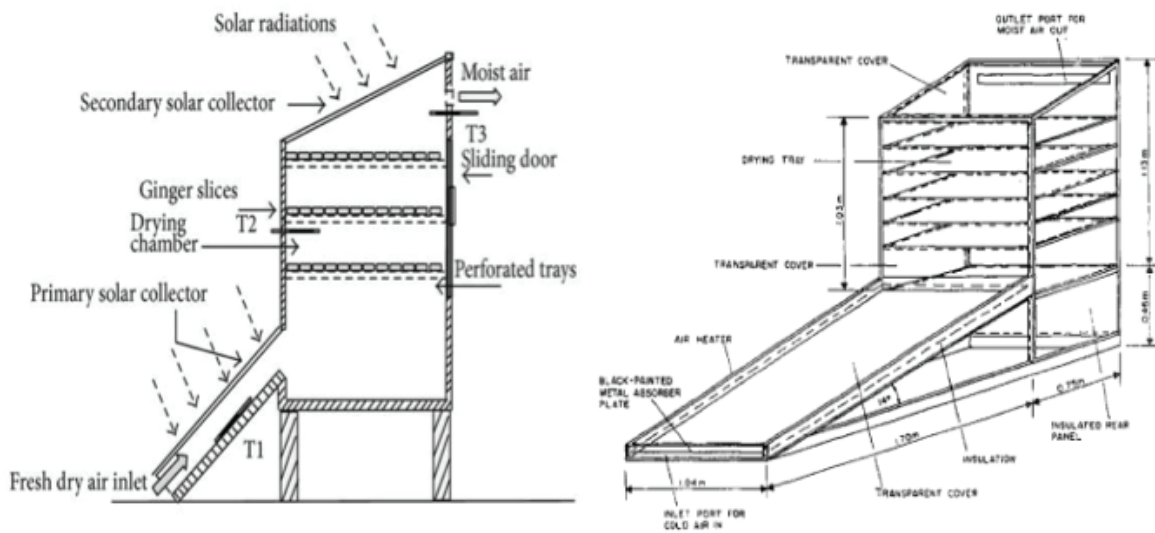


Figure 1a & b: design considerations of an appropriate mechanical solar dryer. All the parts labelled must be present in the dryer to be used.



Figure 2a & b: cleaned solar dryer free from any material and exposure to direct sun away from shared areas.



Figure 3a & 4a: cassava loading in process; loaded cassava spread over a tray to achieve uniform exposure.



Figure 5a: fully loaded dryer demonstrating the spread of material to achieve uniform exposure



Figure 6a: sample digital moisture metre for use in monitoring drying rates



Figure 7a: sample sealed dry cassava product ready for storage

CONCLUSION

This EBA manual is intended to drive upscaled use of EBA approaches in a market driven paradigm that aligns with the prevailing market forces. The choice of cassava as the subject of application is informed by its obvious market advantages as a high value crop, with a significant and growing market in Uganda. Otherwise, the approaches shared are well adaptable for use with any other tuber or value chain crop. Use of this manual is intended to guide stakeholders towards applying EBA and climate resilient approaches in market and commercial production of cassava. And by this, leverage on these market approaches to drive upscaling.

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