African Organic Agriculture Training Manual

A Resource Manual for Trainers

9-6 CASSAVA

Draft Version 1.0
June 2011

Ready for field testing

FiBL

IMPRINT

Publisher:
FiBL, Research Institute of Organic Agriculture, Switzerland, www.fibl.org

Collaboration:
› IFOAM, International Federation of Organic Agriculture Movements, Germany, www.ifoam.org
› NOGAMU, National Organic Agricultural Movement of Uganda, www.nogamu.org.ug
› FENAB, Senegal
› OPPAZ, Organic Producers and Processors Association of Zambia, www.oppaz.org.zm

Responsible author of the unit:
Hervé Bouaguimbeck (IFOAM)

Reviewers:
Olugbenga O. AdeOluwa, Ofoso Budu, Brian Ssebunya

Illustrator:
Andrew Baingana

Draft version 1.0, September 2011.
This is an interim version. Comments and recommendations for improvement are welcome.

The production of this manual was funded by the Bill and Melinda Gates Foundation and the Syngenta Foundation for Sustainable Agriculture with the goal to promote organic farming in Africa.

The African Organic Agriculture Training Manual is based on research funded by the Bill & Melinda Gates Foundation and the Syngenta Foundation for Sustainable Agriculture. The manual's findings, conclusions and recommendations are those of the authors, and do not necessarily reflect positions or policies of either Foundation.

Please cite this publication as follows:
FiBL (2011): African Organic Agriculture Training Manual. Version 1.0 June 2011. Edited by Gilles Weidmann and Lukas Kilcher. Research Institute of Organic Agriculture FiBL, Frick

ISBN 978-3-03736-197-9

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FACTSHEET 6: CASSAVA

Learning targets for farmers:

- Understand the relevance of proper site selection, cultivar selection and preparation of planting material for yield improvement
- Recognize potential for crop rotation improvement
- Learn locally adapted combinations for intercropping cassava
- Understand the relevance of proper soil fertility management for improved cassava cultivation and options for its implementation in the local context
- Understand the relevance of and the approaches to proper pest, disease and weed management in cassava
- Identify strategies to reduce harvest and postharvest losses.

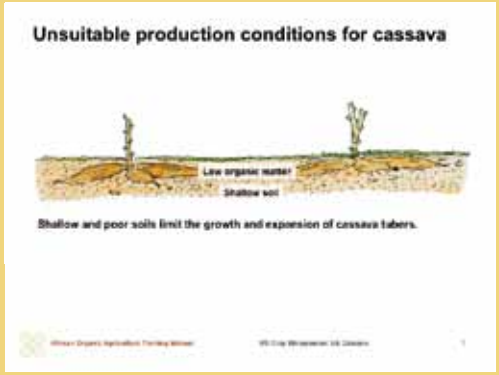
1 Introduction

Next to yam, cassava *(Manihot esculenta)* is a commonly produced tuber crop in Africa. It can be used as food and as a cash crop, feed for animals and as a source of industrial raw material. In sub-Saharan Africa, cassava is mostly used for human consumption in various forms ranging from boiling the fresh tuber to processing it into cassava flour. Cassava tubers are an important source of carbohydrates while the leaves, eaten as a vegetable, are a good source of protein and vitamins. Cassava is grown mostly by small-holder farmers as an important food and as a cash crop. According to FAO's estimates, the average fresh tuber yield of cassava under traditional farming practices in sub-Saharan Africa ranges between 5 and 8 tons per hectare. This is much lower than its potential yield capacity of 40 to 60 tons per hectare.

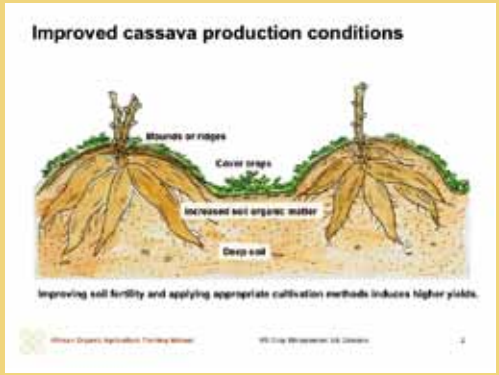
Challenges facing cassava production in Africa

- **Low productivity -** Although cassava is an important crop with multiple uses, it does not receive the much needed attention during its production. Farmers normally plant it on very poor soils, where sometimes other crops like maize have failed. Sometimes cassava is grown as an insurance intercrop with other nutrient-demanding crops like maize or sorghum, just in case the main crop

UNSUITABLE CONDITIONS



IMPROVED MANAGEMENT



fails. Cassava is predominantly a crop for small-holder farmers, who basically grow for subsistence, using rudimentary tools and operating on small and fragmented plots. Infections by the cassava leaf mosaic disease, the cassava brown streak disease and the cassava mealy bugs and scales further reduce crop yields.

› **High postharvest losses -** Poor postharvest handling leads to uneven quality of the processed cassava and results in contamination by fungi. Poor and inadequate infrastructural facilities for milling and storage, and poor access to roads, which are vital for adding value, further increase the postharvest handling challenges.

However, cassava remains a desirable crop because of its many advantages. It is easy to produce, adaptable to many environments, has minimal labour requirements and is comparatively less susceptible to pests and diseases than most other crops. This implies that there is need to address the above challenges in order to increase productivity, marketing opportunities and profitability of cassava production. The following organic practices can contribute to achieving these goals.

1. Proper establishment of the cassava garden

In organic farming, crop management begins by giving the plants good growing conditions, for example through improving soil fertility, and by using healthy and appropriate planting material. This will make the crop grow healthier, and thus produce higher yields.

a. Selection of suitable varieties

Cassava varieties differ with regard to yield potential, flesh colour (white or yellow-fleshed), diameter and length of the tubers, disease and pest resistance levels, time from planting to harvest, cooking quality and taste. Some cultivars require 18 months or more from planting to harvest while others are ready to harvest in 9 months. Most cultivars have been selected by farmers under their growing conditions based on yields and cultural tendencies. Each growing region has its own special cultivars with farmers, often growing several different cultivars in the field at the same time.

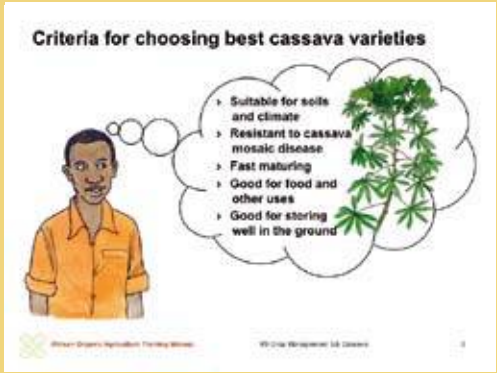
Assessment of the local cassava production situation

Inquire among the participants about cassava production in the area by asking the following questions:

› What is the general perception about cassava as a food crop? Is it considered an important crop?
› Under what conditions is it normally cultivated?
› What are the advantages of growing cassava as a crop compared to other crops?
› How is cassava used in the area?

Use transparencies 1 and 2 to discuss the status of cassava to the farmers.

CHOOSING BEST VARIETIES



Recommendations to farmers for selecting suitable cultivars:
The best cassava varieties are those that are preferred by consumers and—important to the farmer—grow fast, give good yields, store well in the soil and are tolerant to the major pests and diseases. The following criteria could be useful for selecting cassava varieties for organic production:

- **Good adaptation to local conditions -** To figure out which variety can do well in your area, it is important to be aware of the general growing conditions for cassava including length of the rainy season, prevalent diseases, pests and weeds. Such information helps to determine, what characteristics a variety needs to perform well.
- **Varieties with high dry matter and good food quality -** Cassava varieties with tubers with a dry matter content of more than 30 percent are said to produce good quality products and are, therefore, more profitable for processing.
- **Adaptability to different uses -** The selected cassava variety should be adapted to multiple uses such as food, animal feed or industrial processing. Varieties that are commonly preferred are with tubers that are tasty for home consumption, can store well for processing purposes and produce enough foliage for animals.
- **Ability to bulk early -** Varieties that show early bulking, meaning the swelling of the root tubers, are better able to compete with weeds, for example, than late maturing varieties, and are suitable for drier areas with short rains.
- **Ability to store well in the ground -** Varieties that keep the tubers in good condition for a long time after reaching maturity are preferred by some farmers. Good ground storability leaves more time for harvesting, thus reducing the duration of postharvest storage problems of fresh roots.
- **Resistance to local weeds, pests and diseases -** Varieties that can tolerate the prevalent diseases and pests in the area are most preferable.

b. Selection of an appropriate planting site

Cassava is drought tolerant and can be grown on most soils, and will give some yields even on poor soils where most other crops fail. However, high yields are obtained in areas with well-drained loamy soils, well-distributed annual rainfall of 1,000 to 1,500 mm, and warm and moist climatic conditions only. The best site for planting cassava is flat or gently sloping land. Steep slopes are susceptible to erosion and are, therefore, not very suitable areas for growing cassava. Valleys and depression areas are also not recommended because they are prone to wa-

Knowledge sharing on selection of suitable cassava cultivars

Note down the common cultivars grown in the region and involve the participants in the discussion about the differences between these cultivars in their suitability to local conditions, their tuber form, size and use, their adaptability to processing and market requirements, their resistance to local pests, diseases and weeds, and yields, and their availability.

ter logging. Cassava is sensitive to water logging and heavy soils do not allow the crop's roots to proliferate and develop well.

c. Proper land and seedbed preparation

In cassava cultivation, it is important to till the land in order to loosen up the soil, improve soil drainage and make it easy for roots to develop. The level of tillage required for the cassava field mainly depends on the soil type and the drainage at the site selected for cassava cultivation. In places with shallow soils or poorly drained clayey soils, it is important to make mounds or ridges onto which the cassava is planted to encourage better root development and yields. In sandy soils, minimum tillage and planting of cassava flat into the soil are more appropriate, as the soil is sufficiently loose to allow root development.

d. Preparing good quality planting material

Cassava is mainly propagated by planting pieces of the stem (stem cuttings). This means that the development of cassava and amount of yields will depend on the quality of stem cuttings. There are several cassava pests and diseases, which are stem-borne. Therefore, selection of healthy stem cuttings will greatly reduce the spread and damage caused by these pests and diseases.

Recommendations to farmers for selecting good cassava stem cuttings:

1. Select planting material from healthy growing, high-yielding, 8 and 18 month old cassava plants. Healthy cassava plants have robust stems and branches, lush foliage, and minimal stem and leaf damage caused by pests and diseases.
2. From each plant select the middle, brown-skinned portion of stems as stem cuttings. The stems should be 2 to 4 cm thick. These parts sprout and ensure plant vigour better than the top green stem portions. Stem cuttings taken from the top green portions or extreme top and bottom portions of stems are unsuitable. They will dehydrate quickly, produce unhealthy sprouts, and are easily damaged by pests and diseases.
3. Tie the selected stems in bundles and wait for at least 10 days before planting them. The harvested stems can be stored for over 2 months in dry, well-ventilated, shaded areas away from direct sunlight until it is time for planting. One simple method of storing stems consists of arranging them vertically under a shady tree, with the oldest part of the stem buried in the soil. The soil should be moist to keep the stems 'alive' as leaves will form on the upper part of the

Discussion on preparation of planting materials

Let the farmers explain how they prepare their cassava cuttings according to their local conditions. How do they store cassava cuttings for later planting? Identify any shortcomings of the methods used and introduce the recommendations below.

SELECTING HEALTHY STEM CUTTINGS

stems. After storage, discard the top and basal parts of the stems, and use the middle part as cuttings. Another method, mainly used under cold conditions, consists of storing the stems in underground tunnels, which are protected from water. The stems are placed inside the tunnel on top of a layer of dry straw, and then covered with another layer of straw and soil.

e. Proper planting of cassava stem cuttings

In order to get the best sprouting and growth from cassava stem cuttings, it is important to plant them properly. For this reason, the following considerations are recommended:

Selection of suitable planting dates - Planting cassava early, at the beginning of the rainy season, ensures healthy sprouting and good plant establishment. This enables the plant to withstand attack by diseases and pests later in the season.

Proper preparation and handling of stem cuttings - When cutting up cassava stems into pieces for planting, each cutting should be between 20 and 30 cm long and have about 5 to 8 nodes, where the roots and shoots originate. The interval between cutting of the stems and planting into the ground should be as short as possible to avoid dehydration and poor performance. Soaking the stem cuttings before planting in warm water (500 C) by mixing equal volumes of boiling and cold water for 5 to 10 minutes just before planting prevents stem-borne pest attacks.

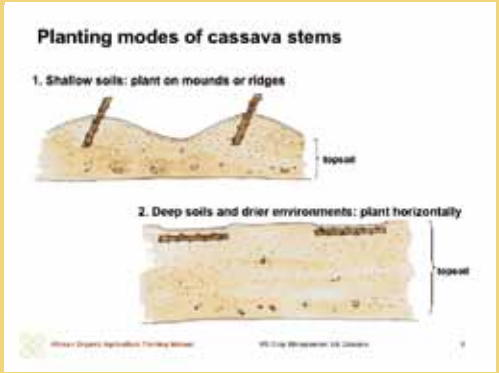
Adopt suitable planting mode according to the type of the soil - Cassava cuttings can be planted by hand vertically, at an angle (inclined) or horizontally, depending on soil types. The drier the soil, the bigger the part of stem placed in the soil. The vertical planting method is best suitable in sandy soils and consists of planting the cuttings vertically with two-thirds of the length of the cutting below the soil. Planting at an angle is most suitable in loamy soils and consists of planting the stem cuttings vertically and with an angle ranging from slightly above horizontal to about 45°. Horizontal planting is recommended for dry climates and consists of placing the entire stem cutting horizontally in the soil at a depth of about 5 to 10 cm.

The spacing between the cassava plants depends on several factors such as the variety used, the soil type, soil fertility and water availability and on whether cassava is grown alone (monocrop) or with other crops (intercrop). For example, if cassava is being grown alone, a distance of 1 metre between the plants should

Discussion on proper planting of cassava

Inquire among the farmers about how cassava is planted locally. At what time of the year is it planted and why? How is it planted?

PLANTING MODES OF CASSAVA STEMS



be considered. If cassava is being grown as an intercrop, the distance between the crops should range from 1 to 4 meters depending on the branching habit of both the cassava and the other crops to make sure there is enough space for the plants.

f. Intercropping

Due to the fact that cassava has a slow initial development, intercropping during early crop development is feasible, and helps reduce soil erosion. However, farmers should consider that cassava is a poor competitor and can easily be shaded out by tall intercrops like maize. For this reason, it is important to consider the branching habit of both the cassava and the other crops in the intercropping system and make sure there is enough space for both crops. Furthermore, cassava can suffer from nutrient and/or water competition from intercrops. Therefore, attention must be given to the intercropping species that have different root systems and nutrient requirements.

Farmers usually intercrop cassava in simple or complex mixed cropping systems with vegetables such as amaranth and okra, plantation crops such as coconut and coffee, maize and legumes such as cowpea and groundnuts. The intercropping pattern depends on the environmental conditions, food preferences and market conditions of the region.

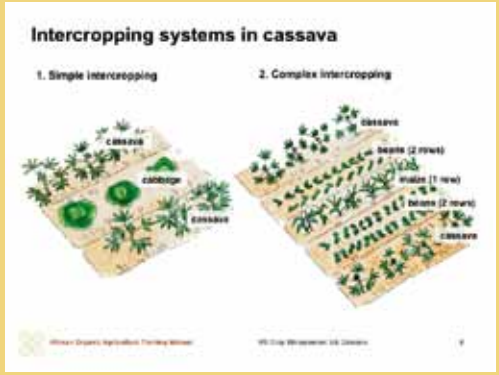
Simple mixtures consist of the intercropping of only two crops, in which farmers select arable crops on the basis of differences in growth habit and time of maturity. For example, cassava, which is a long-duration crop with 9 to 18 months to maturity, is often intercropped with short-duration crops with 2 to 5 months to maturity such as maize, cowpeas, groundnut, okra and melon. These crops mature when the cassava is just attaining its maximum leaf area development and thus is able to expand its root tubers without competition. In complex mixtures consisting of three or four crops, good yields have been obtained with the following combinations:

- maize / cassava / melon
- maize / groundnuts / cassava
- maize / cassava / okra / cowpea
- maize / yam / cassava
- maize / beans / cassava

Group work and discussion on intercropping patterns

Ask the farmers to form groups and to design an intercropping system according to the specificities of the region. Each group should present the results for discussion in the plenum.

INTERCROPPING SYSTEMS



Complex mixtures improve weed suppression, reduce soil temperature, retain higher soil moisture in the topsoil, and produce more organic matter than single cropping or simple mixtures. Nutrient loss from erosion in complex mixtures is less than in single cropping.

2. Improving soil fertility

As already mentioned, cassava is known for its ability to produce good yields where other crops fail. This has led many farmers to believe that soil fertility is not important in cassava production. Experience and research have shown that this is a misconception. On the contrary, it is important to improve the nutrient availability of the soil by adding amounts of organic matter to the soil in order to maintain a good nutrient balance. This is particularly important at the early growth stage of cassava, as the root system of cassava develops slowly and has limited uptake. The type and quantities of fertilisers required by a cassava crop depend on several conditions, such as the type of soil.

Organic farmers use different strategies to improve soil fertility in cassava production. These strategies aim at preventing the loss of nutrients and organic matter on one hand and at maximizing the nutrient cycles on the other hand.

a. Returning cassava leaves and stems to the soil after harvest

Research has shown that below a yield of 15 kg per hectare, cassava removes much less nitrogen, phosphorus and potassium than most other crops. Each ton of fresh roots produced per hectare removes about 3 kg of nitrogen, 1 kg phosphorus and 7 kg potassium per hectare from the soil. This is because most nutrients, except K, are mainly present in cassava leaves and stems. Therefore, if leaves and stems are returned to the soil, nutrient removal will be minimal. However, in areas where leaves and stems are also utilized and removed from the field, nutrient removal will increase. In this case, nutrient depletion can become a serious concern if soil fertility is not maintained properly. Returning leaves and stems to the soil is an essential first step in preventing nutrient depletion and maintaining soil fertility. It is, therefore, important to avoid burning of cassava and other crop residues. The practice of burning crop residues is not allowed in organic agriculture.

Working group on improving soil fertility

Organize working groups to discuss ways of improving soil fertility in cassava production. Let each working group discuss and formulate organic fertilization strategies for cassava that can be implemented according to the local conditions. They should include the advantages and disadvantages of each strategy recommended.

b. Application of organic materials

Animal manure contains plant nutrients and improves the physical condition of the soil. The integration of farm animals can, therefore, contribute to better recycling of nutrients within the farm, if the animals are fed on farm-own forage legumes and the manure is returned to the field. Cassava plants will benefit from the valuable manure the cattle, sheep, goats, pigs or chicken offer. In order to minimize nutrient losses from manures, special attention must be paid to their collection, storage and application.

An interesting example of animal manure application is the 'Parcagem' system in Brazil, which is also applicable in Africa.

The Brazilian 'Parcagem' approach for plant nutrition

In Brazil very high yields of cassava have been obtained using the 'parcagem' system. This system consists of *in situ* application of cattle manure, by leaving a high number of cattle overnight on a small area of land (30 animals per hectare during 60 nights) before planting cassava in the manured land.

Organic wastes such as kitchen wastes, animal manure and plant materials can also be collected, composted and applied to the cassava field to replenish the nutrients taken away through harvest. These materials improve the amount of nutrients as well as the soil organic matter content, and thus the soil's physical conditions and water-holding capacity.

It is advisable to avoid using weed residues containing seeds, rhizomes, stolons, or tubers as mulch because these can increase weed problems on the farm. Also, straws of maize and guinea grass are bad mulch materials, as they take too long to rot and temporally reduce soil nitrogen before they are decomposed. In addition, organic farmers can also grow 'live mulches'. For example, egusi melon (a food crop), planted at very close spacing on cassava seedbeds is a good live mulch.

c. Green manuring

Planting of green manures and their subsequent mulching or incorporation into the soil before planting cassava is a traditional way to improve soil fertility. Leguminous crops such as cowpea *(Vigna unguiculata),* jack beans *(Carnavalia ensiformis)* or Crotalaria *(C. ochroleuca G. Don.)* make good green manure and have

SOIL FERTILITY MANAGEMENT

a significant beneficial effect on the subsequent yield of cassava. However, in many systems, cowpea has proved to be more promising. It can provide 80 kg of nitrogen per hectare to a subsequent crop in 8 to 10 weeks of growth. It is tolerant of drought and well-adapted to sandy and poor soils.

d. Crop rotation

The continuous planting of cassava in the same field year after year leads to increased disease and pest levels, reduced yields and crop failure. To avoid such development, organic farmers should wait for at least 2 years before planting cassava on the same field again and develop a crop rotation system. A rotation system generally improves soil fertility, reduces soil erosion and helps to control diseases and pests. The suitable crop rotation depends on several factors such as the climatic conditions, the market requirements and the skills and objectives of the farmer. However, within a pattern of crop rotation, cassava is often grown in sub-Saharan Africa at the end of the sequence, as it can still produce relatively well at lower fertility levels, where other crops would not grow well. This practice, however, leads to lower cassava yields. It is, therefore, important to establish a balanced crop rotation, which maintains or improves soil fertility, and to give cassava a place in the rotation that corresponds to farmer expectations. Cassava is a good crop to follow such crops as pumpkin, squashes, maize, sorghum or improved fallow. A 3-season rotation example that can be used in organic cassava production is maize-beans / cassava / groundnuts.

3. Proper weed management

Weeds can reduce cassava yields by competing with the cassava crop for moisture, nutrients, space and light. Slow initial development of stem cuttings/sprouts makes cassava susceptible to weed competition in the first 3 to 4 months. Weeds may also harbour pests and diseases or physically injure cassava plants and root tubers. For these reasons, close attention should be paid to weed control in the field in an effort to grow a healthy crop and obtain high yields of cassava.

Common weeds affecting cassava production in Africa are:

- Grasses such as the feathery Pennisetum *(Pennisetum polystachion)*, the spear grass *(Imperata cylindrica)* and the guinea grass *(Panicum maximum)*

Discussion on the design of suitable crop rotations

Prepare a crop rotation table on a paper chart or board and discuss with the farmers, which rotation patterns are most suitable under regional conditions. Identify which specific crop rotation patterns are common in the area. Discuss with the farmers, how they may be improved with the goals to improve soil fertility, prevent buildup of pest and disease populations, and promote higher cassava and total harvests. Discuss the advantages and disadvantages of different proposed rotation patterns and select the most suitable ones.

› Sedges, particularly Mariscus alternifolius and Cyperus rotundus
› Broadleaf weeds such as Siam weed *(Chromolaena odorata)*, giant sensitive weed *(Mimosa invisa)* and goat weed *(Ageratum conyzoides)*

Under organic farming conditions, in order to manage weeds, it is important to combine different practices, from land preparation, planting to post-planting stages of growing cassava. These practices include:

i. **Practices at planting -** Proper land preparation, for example by cleaning cassava seedbeds of weed rhizomes, stolons and tubers, reduces weed pressure by root weeds. Growing fast growing cassava varieties with branching habit may contribute to weed suppression. Mulching cassava seedbeds with dead plant foliage or using cover crops as live mulch on seedbeds prevents early germination of seed weeds. Planting cassava in association with other crops, especially dense-covering leguminous species, ensures good weed suppression between the rows, and provides valuable nitrogen to the cassava crop. Adopting suitable planting distances is another possibility to improve the competitiveness of the cassava crop against weeds.
ii. **Practices after planting -** Weeding by hand hoeing or hand pulling of the weeds in its early stages prevents weeds from competing with cassava root tuber formation and expansion. Weeds may also be controlled by slashing, especially in mature cassava gardens just to reduce the ability of the weeds to produce seeds and compete strongly with the crop.

Discussion on weed management in cassava production

Inquire among the farmers about the most important weeds in the region. How are they commonly managed under local cropping conditions? Evaluate the advantages and disadvantages of major techniques and introduce the practices below.

4. Effective pest management

The major pests of cassava in sub-Saharan Africa are the cassava mealybug, the cassava green mite, the variegated grasshopper, whiteflies and vertebrate pests (rodents). Some feed on the leaves and stems while others feed on the stems and roots.

Leaf and stem feeders:

› **The cassava mealybug** *(Phenacoccus manihoti)* **-** reduces the lengths of the internodes and causes the leaves to clump together into 'bunchy tops'. The insect survives on cassava stems and leaves and is easily carried to new field. It can drastically reduce leaf and root yields, sometimes by as much as 80 %.

- **The cassava green mite** *(Mononychellus tanajoa)* - causes tiny yellow chlorotic leaf spots, the size of pin pricks, on the upper leaf surfaces. Heavily attacked leaves become stunted and deformed. Severe mite attack can result in 13 to 80 % loss in tuber yield.
- **The variegated grasshopper** *(Zonocerus variegatus)* - chews leaves, petioles, and green stems. It feeds on the plant leaves and the bark of the stems. The pest damage is more common in older cassava plants than younger plants, and is particularly severe during the dry season.
- **Whiteflies** - Two species of whiteflies mainly cause damage to cassava. Spiralling whiteflies (Aleurodicus dispersus) damage cassava by sucking sap from the leaves. As they feed, they secrete large amounts of honeydew that supports the growth of black sooty mould on the plant, causing premature fall of older leaves. Bemisia whiteflies (Bemisia tabaci) also suck sap from the leaves, but this does not cause damage to the plant. However, as they feed, the insects inject viruses into the plant, and thus transmit the cassava mosaic disease, one of the most important limiting cassava diseases in Africa.

Stem and root feeders:

- **Termites** - chew and eat stem cuttings, causing the cassava to grow poorly and die and rot. Many different kinds of termites damage cassava stems and tubers.
- **Cassava root scale** *(Stictococcus vayssierrei)* - causes the tubers to be smaller than normal and deformed.
- **Cassava white scale** *(Aonidomytilus albus)* - causes the stems to lose a lot of water and die.

Vertebrate pests:

Birds, rodents, monkeys, pigs, cattle, goats and sheep are common vertebrate pests of cassava. These pests, especially grass cutters (also known as cane rats), defoliate the crop by eating the leaves, green stems and tubers/roots after bulking and during late harvest.

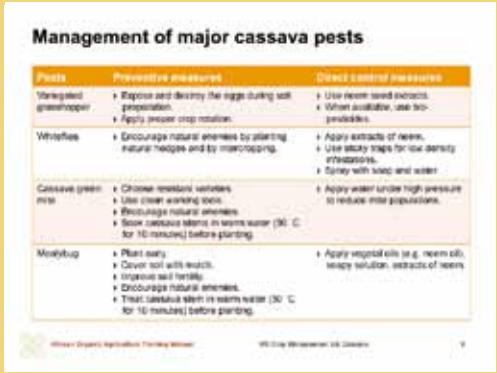
Recommendations for farmers for pest management in cassava production:

In order to manage cassava pests, farmers should first and foremost identify the common pests, their damage symptoms and the conditions under which the pests will cause severe losses. This is done through closer monitoring and vigi-

Field visit

Visit different cassava fields andidentify together with the farmers any observable signs of pest and disease problems. Ask the participants, whether they are familiar with those signs of infection and whether they know, under which conditions the pests and diseases will cause severe losses.

PEST MANAGEMENT


Management of major cassava pests

Pests	Preventive measures	Direct control measures
Variegated grasshopper	• Expose and destroy the eggs during soil preparation. • Apply proper crop rotation.	• Use neem seed extracts. • When available, use bio-pesticides.
Whiteflies	• Encourage natural enemies by planting natural hedges and by intercropping.	• Apply extracts of neem. • Use sticky traps for low density infestations. • Spray with soap and water
Cassava green mite	• Choose resistant varieties. • Use clean working tools. • Encourage natural enemies. • Soak cassava stems in warm water (30 °C for 10 minutes) before planting.	• Apply water under high pressure to reduce mite populations.
Mealybug	• Plant early. • Cover soil with mulch. • Improve soil fertility. • Encourage natural enemies. • Treat cassava stem in warm water (30 °C for 10 minutes) before planting.	• Apply vegetal oils (e.g. neem oil), soapy solution, extracts of neem.

lance. Then they shall apply the following measures:

- Ensure field sanitation by planting healthy stem cuttings or treat the stem cuttings against pest damage. Avoid transporting and planting cassava stems infested with stem-borne pests. After harvesting, destroy cassava stems infested with stem-borne pests.
- Encourage natural enemies against cassava pests by encouraging hedge rows and flower strips along the field boundaries and within the crop fields respectively. Intercropping and agroforestry also help to encourage natural enemies. The most important natural enemies in cassava are: ants, spiders, ladybird beetles and predatory mites, which feed on green mites, parasitic wasps – which parasitizes the bugs – and whiteflies.
- Maintain strong and healthy plants by keeping adequate conditions (e.g. application of organic manure) healthy and free of pest planting material. Where possible, grow cassava varieties that tolerate the common pests in the local area.
- Apply plant extracts, for example, turmeric *(Curcuma longa)* against green mites or neem *(Azadirachta indica)* against whiteflies, when major damage is expected.
- When available, use biopesticides. For example, the International Institute of Tropical Agriculture (IITA) has developed a bioinsecticide consisting of naturally occurring fungual spores mixed in oil as a commercial product against grasshoppers. It does not damage other insects, plants, animals or people.
- In the control of birds, rodents and other vertebrate pests of cassava, fence-in the farm or the field and set traps in the fence. Cover exposed tubers with soil. Apply appropriate weed management of the cassava crop to discourage rodent pests in fields. And harvest cassava tubers as soon as they are mature.

5. Effective disease management

The main diseases affecting cassava can be divided into two groups: leaf and stem diseases and stem and root diseases. However, the major diseases in sub-Saharan Africa are cassava mosaic disease, cassava bacterial blight, cassava anthracnose disease and root rot.

Leaf and stem diseases:

- **Cassava leaf mosaic disease** causes yield reductions of up to 90 %. It is caused by the African cassava mosaic virus which occurs inside the leaves and stems. The symptoms are discoloured leaves with patches of normal green colour mixed with light green, yellow, and white area (chlorosis). The symptoms are more pronounced on younger plants, usually under 6 months, than older plants. The disease is spread through infected cuttings and by whiteflies (Bemisia tabaci).
- **Cassava bacterial blight** (Xanthomonas campestris pv. manihotis) is caused by a bacterium which occurs inside cassava leaves and stems. Damage appears as water-soaked dead spots. The lesions occur between leaf veins and are most evident on the lower surfaces of the leaves. The symptoms are more evident in the wet than in the dry season and the disease is more severe in young plants than in older ones. The disease is mainly spread through infected cuttings and can cause yield losses of 20 to 100 %.

Stem and root diseases:

- **Cassava brown streak disease** is transmitted by whiteflies through infected cuttings. Symptoms of damage appear on the leaves (yellow patches), stems (dark brown streaks), and tubers of cassava plants (cracks and discoloration).
- **Cassava root rot diseases** are caused by various kinds of fungi living on or in the soil. The fungi occur mainly in poorly drained soils. The leaves on cassava plants affected by root rot disease turn brown, wilt, and the plant appears scotched. The disease kills both feeder and storage roots of cassava. The affected storage roots have an unusual smell and develop light brown colouration.

Recommendations for farmers for effective disease management:

The best way to control diseases is to grow a healthy cassava crop and avoid infestation by preventing the introduction of disease pathogens. This can be achieved by combining plant production and protection strategies. The strategies include the following recommendations:

- Practise appropriate crop rotation, intercropping and improving soil fertility through application of well-decomposed organic manures. For example, intercropping cassava with maize and melon can reduce cassava bacterial blight significantly. Rotation and fallowing should last at least one growing season.

DISEASE MANAGEMENT

- Plant disease free cuttings from healthy plants without leaf chlorosis, shoot tip die-back, cankers, fungus patches, or streaks on the stems. Where possible, grow cassava varieties that are tolerant or resistant to the common cassava diseases in the local area. For example, cassava varieties resistant to cassava mosaic disease are commonly available in Africa.
- Improve the growing conditions by improving soil fertility (through manuring) in order to encourage cassava plants to grow vigorously and offset damage by cassava diseases. Timely planting especially at the beginning of the rainy season is also important to promote proper establishment and good growth of the cassava plants. Improving soil drainage will also reduce the incidence of root rot.
- Remove infested cassava plants from the field as soon as possible. After root harvest, destroy discarded cassava stems and tubers showing any symptom of disease. Clean farm tools that are used to cut infested cassava plants immediately after use. This reduces the spread of diseases from damaged areas to healthy cassava crops.

6. Reducing postharvest losses

Proper postharvest handling of organic cassava aims at maximizing tuber quality by minimizing any damage or cuts on the tubers during harvesting and transportation of the tubers. In many African countries, young leaves and shoots of cassava are also harvested to be consumed as vegetables and may be as important as tubers for generating cash income. However, excessive harvesting of the leaves can have a negative effect on the yield of tubers.

6.1 Timely harvesting

Early-maturing cassava varieties are ready for harvesting at 7 months, while late-maturing varieties are ready 12 months after planting. The proper stage for harvesting is when the leaves turn yellow and fall down and the roots are mature. It is advisable to harvest cassava once it is mature. If the tubers are left in the ground over long periods, they lose quality due to hydrolysis of starch to sugars and become woody. Care should be taken to avoid damage to the tubers dur-

Group work on postharvest handling of cassava

Form groups and let each group determine sources for losses in harvest and postharvest handling of cassava. In a second step, ask them to formulate practical strategies on how to manage cassava during harvesting and postharvest handling and storage of the tubers, while avoiding contamination and spoilage. One representative of each group should present the results in the plenum. Try to come to a collective agreement on a recommended strategy.

PROPER POSTHARVEST HANDLING PROCEDURES

ing harvesting. Damaged roots are highly susceptible to fungal attack and decay. Harvesting cassava tubers is labour-intensive and usually done by hand. It is easy if the soil is sandy or during the rainy season, but in heavier soils or during the dry season, harvesting usually requires digging around the tubers to free them of the covering soil and then lifting/pulling the plant. The day before harvest, the plants are normally 'topped'; the stalks are cut off 40 to 60 cm above ground and piled at the side of the field. From this material, the stalks for the next planting are selected. Excess soil is then scraped off from the tubers by hand. This should be done carefully so as not to peel or damage the outside protective skin of the tubers.

6.2 Transportation

The first thing to be done after the harvest is to transport the tubers from the production and harvest field to the processing and utilization site. This is because fresh cassava is highly perishable (i.e. within 2 to 3 days after harvesting). Transportation of cassava tubers should also be done carefully to avoid bruising and dehydrating the cassava tubers, especially if it is meant for fresh consumption.

6.3 Preservation

Since cassava roots can remain in the soil for up to 18 months after reaching maturity, the simplest means of preservation is to delay the harvest until the crop is needed. However, this method has the following disadvantages: cassava roots increasingly lose starch, the constituent defining its value and they become fibrous and woody with prolonged in-ground storage. Furthermore, the longer the roots remain in the ground, the longer they become exposed to insect, disease, or rodent attack. Also, the land may be needed to plant other crops.

Freshly harvested tubers can be preserved by the following methods:

a) **Cassava buried in straw-lined trenches -** and protected from seepage of ground water can hold for periods of up to 12 months. A shade is needed around the trenches; therefore, it is better to put several trenches under the same shade (roof).

STORING METHODS

b) **Storage in tightly woven bags** such as rice or cocoa sacks. With this technique, storage times of 7 to 10 days are achievable.
c) **In a clamp storage system -** a conical pile of 300 to 500 kg of fresh cassava roots is seated on a circular bed of straw and covered with more straw. The whole unit is covered with soil to a thickness of 10 to 15 cm, the soil being dug from around the clamp so as to form a drainage ditch. With this storage system, minimal losses up to 20 % may be expected for periods of up to 2 months.
d) **Storage of tubers in wooden crates** containing absorbent material such as damp sawdust. However, if the sawdust is too moist it may promote fungal growth and if it is too dry, the roots deteriorate quickly. Lining the crates with perforated plastic prevents dehydration of the sawdust, resulting in a storage period of about 1 to 2 months.
e) **Cold storage** by keeping the cassava tubers below 4 °C. This system greatly reduces cassava deterioration and may be practicable for high-value markets. Alternatively, roots—or more commonly—pieces of root, can be stored frozen. This is a satisfactory method to conserve the tubers. But, although the flavour is preserved, freezing changes the structure of cassava tubers, making them spongier.

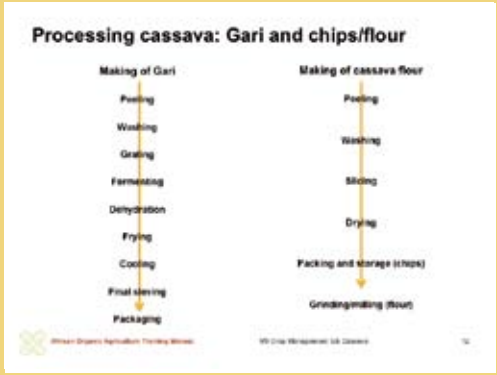
6.4 Cassava processing

Cassava processing aims at increasing the quality and storability of cassava tubers. This enhances the ability of the farmers to develop additional products, such as baking products out of cassava flour. It further ensures reduction or total elimination of undesirable toxic constituents in cassava so that it is suitable for human consumption.

Cassava chips and flour

› **Using low-cyanide varieties -** Freshly harvested cassava is peeled using a knife. The peeled cassava is then washed and sliced into smaller pieces (chips). These are then dried on a raised platform under direct sun or specially-made driers, until moisture content of about 8 to 10 % is reached. Properly dried chips become tough to break, but crumble into flour when hit with a hard item like a hammer. The drying process should be done continuously and the drying chips should not be exposed again to water to avoid moulding. The

MAKING CASSAVA CHIPS AND GARI



chips may then be ground or milled into flour; dried chips store better than flour.

› **Using high-cyanide varieties** - Freshly uprooted cassava are peeled and sliced into smaller pieces (chips). The sliced chips are then dried in the sun for about 3 days to about 14 % moisture content. The chips are then soaked in water for 8 hours, and dried again to a moisture content of about 8 %.

Fermented cassava dough - gari

Gari is a creamy-white or yellow dried cassava product, common in West Africa. It is prepared by peeling the outside of the tuber skin and washed. The washed tubers are then grated using a grater. It is then packed in bags with holes to drain off the liquid and left to ferment for 1 to 5 days, depending on the preferred flavour. The fermented material is then pressed to let out the extra water leaving a cassava cake. The remaining cake is broken loose and spread on frying metal trays above a fire. The particles are fried until crisp and dry, about 10 % moisture content. The gari is then cooled, sieved and packed for sale or storage.

7. Marketing and Organic certification of cassava production

Much of the cassava production is used for household food consumption either nationally or regionally. It is also increasingly becoming a raw material for industrial production, especially for starch production. Organic certification of cassava production is, therefore, only reasonable as a market requirement if there is a market that demands it. In such a case, interested farmers should be willing to adopt the general organic production requirements like not using synthetic pesticides and fertilisers, and applying other sustainable production methods as discussed in the previous sections of this chapter.

Other considerations include:

› Farmers should have enough land to produce cassava beyond the household requirement (commercial volumes), in order to be able to cover the extra costs of certification.

› For successful marketing, farmers may need to work as a group in order to increase production volumes needed to justify the cost of certification.

Assessment of the local situation on cassava marketing and organic certification

Inquire among the farmers about marketing and certification by asking the following questions:

› Who are the main buyers of cassava in the area? How is cassava commonly used?

› Are there any companies that require certified organic cassava? What are their requirements in terms of quantity and quality?

Specific national or international organic standards may define additional requirements for production and postharvest handling of cassava. Farmers should, therefore, consult the national organic movement or organic certification body operating within the region or country.

Recommended further reading

- International Institute of Tropical Agriculture (IITA). Starting a Cassava Farm – IPM Field Guide for Extensions Agents. 2008. Free download available at http://old.iita.org
- International Institute of Tropical Agriculture (IITA). Disease Control in Cassava Farms. IPM Field Guide for Extension Agents. http://old.iita.org
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- Technical Centre for Agricultural and Rural Co-operation (CTA). Controlling African Cassava Mosaic Disease.
- Technical Centre for Agricultural and Rural Co-operation (CTA). Larger Grain Borer. 1998. Technical Leaflet No.1