Cassava

Striped mealybug *(Ferrisia virgata)*
(c) F. Haas, icipe

Scientific Name: *Manihot esculenta*
Order / Family: Euphorbiales: Euphorbiaceae
Local Names: Manioc, Mandioca, Tapioca; Mhogo
Pests & Diseases: African cassava mosaic virus (ACMV) , Anthracnose, Birds and Vertebrates, Brown leaf spot, Cassava bacterial blight, Cassava brown streak virus disease, Cassava green spider mite, Cassava scales, Grasshoppers, Larger grain borer (LGB), Mealybugs, Post harvest diseases, Spider mites, Storage pests, Stripped mealybug, Termites, Whiteflies

1. General Information and Agronomic Aspects

Cassava typically grows as a shrub. Cassava is native of Latin America and was introduced to the African continent by Portuguese traders in the late 16th century.

Cassava is grown on an estimated 80 million hectares in 34 African countries. It is an important crop in subsistence farming, as it requires few production skills or inputs. It is drought tolerant and produces reasonable yields under adverse conditions. Most important is its ability to remain in the soil as a famine reserve. Other factors that make cassava popular with small-scale farmers, particularly in Africa, are that it requires little labour in its production and there are no labour peaks because the necessary operations in its production can be spread throughout the year, and its yields fluctuate less than those of cereals.

The storage root (some people refer to it as "tuber") is a major source of energy and the leaves, which contain a high level of vitamin A and up to 17% protein, are often used as green vegetables. Its limitations are its poor nutritive value (mainly carbohydrates) and its cyanogenic

glucoside content (HCN) that can lead to poisoning unless precautions (proper peeling/soaking in water/fermenting/drying/cooking) are taken during preparation of the tubers. The latter is only applicable to bitter cassava varieties. Sweet varieties can even be eaten raw and fresh as they have very low content of HCN.

The **main diseases** affecting cassava are African cassava mosaic virus (ACMV), cassava bacterial blight, cassava anthracnose, and root rot. Pests and diseases, in combination with poor agronomic practices cause high yield losses in Africa. While biological and chemical control practices are available for other pests and diseases attacking cassava, ACMV is difficult to control. In severe cases, plants become stunted. In fact, this disease can cause up to 60% yield loss, and no biological or chemical control is now available to farmers. Given the vegetative propagation method used for cassava, availability of clean planting material for propagation is a major constraint, since white flies and infested planting material transmit the disease.

While cassava production demands few external inputs, labour and planting material are main costs of production. As a root crop, cassava requires a lot of labour to harvest. The production of cassava is dependent on a supply of good quality stem cuttings. The multiplication rate of these vegetative planting materials is very low, compared to grain crops, which are propagated by true seeds. Post harvest deterioration of cassava is a major constraint. Cassava stem cuttings are bulky and highly perishable, drying up within a few days. Consequently, roots must be processed into a storable form soon after harvest. Farmers recognise post harvest loss as a major risk factor in cassava production. Nevertheless, the rapid post harvest perishability might lead to comparative disadvantages for small-scale producers linked to small-scale processing units.

Furthermore, many cassava varieties contain cyanogenic glucosides, and inadequate processing can lead to high toxicity. Various processing methods, such as grating, sun drying, and fermenting, are used to reduce the cyanide content.

Varieties

A number of both local and improved varieties exist in Kenya:

1**. Coast region**		
a.) Local types	I	"Kibanda meno" - very sweet
	II	"Katsunga" - leaves taste like wild lettuce when cooked
b) Improved types	I	"Kaleso" (46106/27) - high yielding, for human consumption
	II	"Guso" - Better yielder than Kaleso. Also for human consumption
	III	"5543/156" - It is a high yielding variety for livestock. It is bitter.
2. Eastern Region Katumani	I	"KME 2" - Sweet, less fibrous and has low cyanide content
	II	"KME 61" - Bitter and more fibrous than KME
3. Western Kenya	I	"2200", "Tereka", "Serere", "Adhiambo lera", "CKI", "TMS 60142", "BAO""Migyeera", "SS 4", "MH 95/0183", "MM 96/2480", "MM 96/4884", "MM 96/5280", "MM 96/5588", "MM 97/2270"

Cassava KME 2, 6 months old
(c) A.A.Seif, icipe

Cassava KME 2, 12 months
(c) A.A.Seif, icipe

Cassava KME 2, 18 months old

(c) A.A.Seif, icipe

For more information on these varieties please contact the Kenya Agriculture and Livestock Research Organization (KALRO).

Cassava varieties in coastal and eastern Kenya (KALRO/KEPHIS)

Variety	Optimal production altitude range (masl) (region)	Maturity (months)	Tuber yield (t/ha)	Special attributes
"5543/156"	1-500 (coast/eastern lowlands)	10-12	40-50	Tolerant to ACMD; bitter
"Guso"	1-700 (coast/eastern lowlands)	12-15	20-40	Resistant to (ACMD); sweet
"Kaleso" ("46106/27")	1-1500 (coast /eastern)	10-12	25-30	Tolerant to ACMD and cassava brown streak disease (CBSD); sweet
"Karembo" ("KME-08-05")	15-1200 (coast/eastern)	8	50-70	Tolerant to ACMD and CBSD; sweet; short with open structure
"Karibuni" ("KME-08-01")	15-1200 (coast/eastern)	8-12	50-70	Tolerant to ACMD and CBSD; sweet; high branching; good for intercropping
"Kibanda Meno"	1-500	6-8	20-30	Very susceptible to ACMD,; very sweet
"KME 1"	250-1500 (eastern)	12-14	20	Sweet
"KME 2"	250-1500 (eastern)	8-10	40	Tolerant to ACMD; sweet
"KME 3"	250-1500 (eastern)	8-10	40	Tolerant to ACMD; sweet
"KME 4"	250-1500 (eastern)	8-10	40	Tolerant to ACMD; sweet
"KME 61"	250-1500 (eastern)	14	35	Tolerant to ACMD; bitter
"Mucericeri"	250-1750 (eastern)	12-14	20	Sweet
"Nzalauka" ("KME-08-06")	15-1200 (coast/eastern)	6-8	50-70	Tolerant to ACMD and CBSD; sweet; straight stems ideal for intercropping
"Shibe" ("KME-08-04")	15-1200 (coast/eastern)	8-12	50-70	Tolerant to ACMD and CBSD; sweet; straight stems ideal for intercropping
"Siri"	15-1200 (coast/eastern)	8-12	50	Tolerant to ACMD and CBSD; sweet; very short without branches
"Tajirika" ("KME-08-02")	15-1200 (coast/eastern)	8	50-70	Tolerant to ACMD and CBSD; sweet; straight stems ideal for intercropping

Examples of cassava varieties grown in Tanzania (varieties listed are resistant/tolerant to ACMD)

- "Kachaga"
- "191/0057"
- "191/0063"
- "191/0067"
- "MM 96/0876"
- "MM 96/3075B"
- "MM 96/4619"
- "MM 96/4684"
- "MM 96/5725"
- "MM 96/8233"
- "MM 96/8450"
- "SS 4"
- "TME 14"
- "TMS 4(2)1425"

Examples of cassava varieties grown in Uganda (varieties listed are resistant/tolerant to ACMD)

- "Migyeera"
- "NASE 1 to 12"
- "SS 4"
- "TME 14"
- "TMS 4(2)1425"
- "TMS 192/0067"

- "TMS 50395"
- "Uganda MH 97/2961"

Nutritive value per 100 g of edible portion

Raw or Cooked Cassava	Food Energy (Calories / %Daily Value*)	Carbohydrates (g / %DV)	Fat (g / %DV)	Protein (g / %DV)	Calcium (g / %DV)	Phosphorus (mg / %DV)	Iron (mg / %DV)	Potassium (mg / %DV)	Vitamin A (I.U)	Vitamin C (I.U)	Vitamin B 6 (I.U)	Vitamin B 12 (I.U)	Thiamine (mg / %DV)	Riboflavin (mg / %DV)	Ash (g / %DV)
Cassava raw	160 / 8%	38.1 / 13%	0.3 / 0%	1.4 / 3%	16.0 / 2%	27.0 / 3%	0.3 / 1%	271 / 8%	13.0 IU / 0%	20.6 / 34%	0.1 / 4%	0.0 / 0%	0.1 / 6%	0.0 / 3%	0.6

*Percent Daily Values (DV) are based on a 2000 calorie diet. Your daily values may be higher or lower, depending on your calorie needs.

Propagation and planting

Propagation from storage roots is impossible, as the roots have no buds. Cassava is propagated through cuttings. The most suitable cuttings are 20-30 cm long and 20-25 mm in diameter (with 5-8 nodes), preferably from the middle browned-skinned portion of the stems of plants 8-14 months old. Cuttings from older, more mature parts of the stem give better yield than cuttings from younger parts, and long cuttings give higher yields than short cuttings. Select cuttings from healthy plants. Cuttings slightly infested with pests can be treated by immersion in heated water (mixing equal volumes of boiling and cold water) for 5-10 minutes just before planting.

The interval between cutting stems and planting should be as short as possible (not more than a couple of days). Cassava cuttings may be planted vertically, at an angle, or horizontally. The drier the soil the bigger the part of the stem placed in the soil. Under very dry conditions, plant cuttings at an angle and cover the larger part with soil. Vertical planting is best in sandy soils, as the roots develop deeper in the soil. Horizontal planting leads to a large number of thin stems, which may cause lodging. Moreover, the roots develop more closely to the surface and are more likely to be exposed and attacked by rodents and birds. Do not plant cuttings upside down, as this drastically reduces yield.

The spacing between plants will depend on whether cassava is grown as a sole crop or with other crops (intercropping). If cassava is being grown alone, plants should be planted 1 meter apart from each other. This means that 10.000 cuttings are required for 1 ha (4000 cuttings per acre). If cassava is being grown as an intercrop, the branching habit of both the cassava and the other crops should be considered, making sure there is enough space for the plants.

The best land for planting cassava is flat or gently sloping land. Steep slopes are easily eroded. Valleys and depression areas that usually get waterlogged are not very suitable and cassava roots do not develop well. Before planting get to know the history of the land (previous crops, types of weeds, diseases and pests).

Soil preparation varies from practically zero under shifting cultivation to ploughing, harrowing and possible ridging in more intensive cropping systems. Planting on mounds and ridges is recommended, especially for areas with rainfall of more than 1200 mm per year or in areas where soils get waterlogged (e.g. valleys and depressions). Ridging may not give higher yield, but harvesting is easier and soil erosion may be reduced, especially by contoured ridges. In sandy soils, minimum tillage and planting cassava on the flat are appropriate. Plant at the beginning of the rainy season.

Husbandry

Weeding is necessary every 3-4 weeks until 2-3 months after planting. Afterwards the canopy may cover the soil and weeding is less necessary. Although cassava grows rather well on poor soils, it requires large amount of nutrients to produce high yields. To maintain high yields, it is

necessary to maintain the fertility of the soil. Phosphorous is important for root development. Symptoms of phosphorous deficiency are stunted growth and violet or purple discolouration of the leaves. In the absence of good compost, rock phosphate can be applied if needed. Potassium is also needed by cassava and can be applied in the form of compost or wood ashes. Potassium deficiency symptoms are: stunted growth, dark leaf colour which gradually becomes paler, dry brown spots on tips and margins of the leaves and "burnt" edges of leaves.

Fertilizers and manures are usually not used by small-scale cassava growers in most African countries because, in many cases, they cannot afford such additional inputs. However, it is important to provide good growing conditions for the plants, as healthy plants are able to withstand some damage by pests and diseases. In general, cassava responds well to farmyard manure. Manure can be applied at land preparation to increase soil nutrients, to improve the soil structure, and to improve the ability of the soil to hold water.

Mulching cassava, especially after planting, is helpful when growing cassava in dry areas or on slopes.

Crop rotation and intercropping

There is a wide variety of cropping patterns and rotations with cassava. Though rotation with other crops is preferable, cassava is sometimes grown continuously on the same land, especially in dry areas not suitable for other crops. When grown in bush-fallow systems, cassava is usually planted at the end of the rotation cycle, as it still produces relatively well at lower fertility levels and also allows a smooth transition to the fallow.

Cassava when planted as an intercrop along with cowpea groundnut or tree crops like *Leucaena* reduces soil run-off and soil-loss. Forage yield of *Leucaena* improves when grown with cassava and groundnut. *Canavalia* or *Crotalaria* (legume crops) when planted as intercrops with cassava improves soil productivity.

Sow 1 row of *Canavalia* or C*rotalaria* between rows of cassava immediately after planting cassava. Let these grow until harvest. Plough after harvest to incorporate crop residues into the soil.

Harvesting

Harvesting is done either piece-meal or by uprooting whole plants. Young plants are usually harvested piece-meal, while old plants are more commonly uprooted to prevent the storage roots becoming very fibrous. As cassava roots do not keep fresh more than 2-3 days after harvesting, not all plants are harvested at once, but rather harvesting as the roots are consumed. When cassava is grown for urban markets they are harvested in bulk. Cassava is usually harvested 9-12 months after planting. It is sometimes harvested earlier if needed for food. Storage roots become

too woody if harvesting is delayed. Early maturing varieties are ready for harvesting at 6 months while late maturing varieties are ready 12 months after planting.

Storage

Cassava does not store well when fresh and therefore has to be peeled, chopped and dried in the sun. It can then be stored in the form of chips or flour under dry conditions.

Average yields are between 3-4 tons of fresh tubers per acre (7.5-10 tons per ha) although with reasonable care and attention yields of up to 10 tons per acre (25 tons per ha) and more are possible. The ratio of fresh tubers to peeled and dried chips is about 3:1.

Marketing

Manual from IITA Starting a cassava farm Of the world production of cassava, 65% is used directly for human consumption, 20% for animal feed and the remaining 15% for starch and industrial uses (alcohol production). In Africa, stems are often used as firewood.

Climate conditions, soil and water management

In equatorial areas, cassava can be grown up to 1500 m altitude. The optimum temperature range is 20-30deg. Specific cultivars are necessary for successful cultivation at an average temperature of 20deg. Cassava is grown in regions with 500-6000 mm of rainfall per year. Optimum annual rainfall is 1000-1500 mm, without distinct dry periods. Once established, cassava can resist severe drought. With prolonged periods of drought, cassava plants shed their leaves but resume growth after the rains start, making it a suitable crop in areas with uncertain rainfall distribution. Because of its drought resistance, in many regions cassava is planted as a reserve crop against famine in dry years. Good drainage is essential for cassava; the crop does not tolerate water logging. High irradiance is preferred.

Best growth and yield are obtained on fertile sandy loams. Cassava is able to produce reasonable yields on severely depleted or even eroded soils where other crops fail. Gravelly or stony soils cause problems with root penetration and are unsuitable. Also heavy clay or other poorly drained soils are not suitable.

Cassava growth and yield are reduced drastically on saline soils and on alkaline soils with a pH above 8.0. The optimum pH is between 5.5 and 7.5, but cultivars are available that tolerate a pH as low as 4.6 or as high as 8.0. Reasonably salt-tolerant cultivars have also been selected. Very fertile soils encourage excessive foliage growth at the expense of storage roots.

2. Information on Pests

Furthermore, many cassava varieties contain cyanogenic glucosides, and inadequate processing can lead to high toxicity. Various processing methods, such as grating, sun drying, and fermenting, are used to reduce the cyanide content.

Cassava mealybug (*Phenacoccus manihoti*)

The cassava mealybug is pinkish in colour. Its body is surrounded by very short filaments, and covered with a fine coating of wax. Adults are 0.5-1.4 mm long. This mealybug does not have males. Females live for about 20 days and lay 400 eggs in average. The lifecycle from egg to adult is completed in about 1 month at 27°C. It reproduces throughout the year and it reaches peak densities during the dry season. Mealybugs are dispersed by wind and through planting material.

The cassava mealybug strongly prefers cassava and other *Manihot* species; other host crops and wild hosts are only marginally infested. It sucks sap at cassava shoot tips, on the lower surface of leaves, and on stems. During feeding the mealybug injects a toxin into the cassava plant causing deformation of terminal shoots, which become stunted, resulting in compression of terminal leaves into "bunchy tops". The length of internodes is reduced, and stems are distorted. When attack is severe plants die, starting at the plant tip, where most mealybugs are found.

Mealybug attack results in leaf loss and poor quality planting material (stem cuttings) due to dieback and weakening of stems used for crop propagation. Tuber losses have been estimated up to 80%. The pest-induced defoliation reduces availability of healthy leaves, which are consumed as leafy vegetables in most of West and Central Africa. After the pest cripples plant growth, weed and erosion sometimes lead to total destruction of the crops. In general, yield losses depend upon age of plant when attacked, length of dry season, severity of attack and general conditions of the plant. Mealybug damage is more severe in the dry than in the wet season.

The cassava mealybug was accidentally introduced to Africa from South America. After the first reports in the 1970s, the insect became the major cassava pest within a few years and spread rapidly through most of the African cassava belt. The outbreak led to famine in several countries where cassava is a staple crop and particularly important in times of drought. In an attempt to control this pest natural enemies, mainly parasitic wasps and ladybird beetles, were introduced from South America.

The most effective has been the parasitic wasp (*Apoanagyrus* (*=Epidinocarsis*) *lopezi*), which has kept this mealybug at low levels, resulting on significant reduction of yield losses in most areas in Africa (Neuenschwander, 2003).

What to do:

- Plant early in the rainy season to allow the cassava plants a good growth before the dry season. Strong plants are more likely to withstand pest attacks.
- Use soil amendments and mulch to avoid moisture stress in sandy or poor soils. Mealybug numbers are higher on cassava grown on poor, sandy soils, and may cause damage in spite of the presence of natural enemies.
- Avoid using infested plant material. Before planting cutting can be treated with hot water [by immersing them in heated water (mixing equal volumes of boiling and cold water) for 5-10 minutes just before planting] to kill all insects/mites and to avoid transfer into the newly planted field. For more information on Hot water treatment click here.
- Avoid using pesticides on crops surrounding cassava fields. Although, no pesticides are used on cassava in Africa, insecticide drift from neighbouring fields may affect natural enemies that keep mealybugs and other pests under control.
- Use of manure or other fertilisers can result in a reduction in the mealybug population because improved nutrition results in the production of larger parasitoid wasps with higher fertility levels. Mulch and fertilizer use also enhances the antibiotic properties of cassava against mealybug infestation.

The **cassava mealybug** is pinkish in colour. Its body is surrounded by very short filaments, and covered with a fine coating of wax. Adults are 0.5 - 1.4mm long.

(c) G. Goergen (Courtesy of EcoPort, www.ecoport.org)

More information on Mealybugs

Larger grain borer (*Prostephanus truncatus*)

The larger grain borer has been found infesting cassava chips in storage particularly during the rainy season in West Africa. This beetle is currently the most serious pest of dried cassava in storage. Weight losses as high as 70% after 4 months of storage have been reported elsewhere.

What to do:

- Use botanicals or plant parts to protect stored cassava. There are reports in Kenya, that the larger grain borer can be effectively repelled by storing cassava or grains with a fairly large amount of dried lantana or eucalyptus leaves (Personal communication, field officer of Meru herbs). Neem is also reported to be effective.

For more information on Neem click here.

Larger grain borer *(Prostephanus truncatus)*. The adult beetle is 3-4.5 mm long.

More information on Larger grain borer (LGB)

Birds and other vertebrate pests

Birds, rodents, monkeys, pigs and domestic animals (cattle, goat and sheep) are common vertebrate pests of cassava.

Measures that help to manage damage by these pests include:

What to do:

- Fence farms and set traps in the fence.

- Cover exposed roots with soil.
- Weed your cassava farm to discourage rodents pests.
- Harvest roots as soon as they are mature (James et al., 2000).

Red-Billed Quelae Bird is one of the most dangerous of all agricultural pests in Africa, and causes food shortages in many countries. The flock breeds at times of abundant rainfall and young are ready to move with the nomadic flock within six weeks,often coinciding with the ripening of grain crops. A nesting colony of Red-billed quelea can extend over hundreds of acres, and a single flock may number millions of birds, moving together in a synchronized fashion. Recent discussions about quelea bird pest control have started to turn towards prediction of breeding based on weather patterns

(c) Courtesy EcoPort (http://www.ecoport.org) : C.Elliott.

Striped mealybug (*Ferrisia virgata*)

It is a whitish mealybug with two longitudinal dark stripes, long glassy wax threads and two long tails. It attains a length of 4 mm. The stripped mealybug occurs on the underside of leaves near the petioles and on the stems. It sucks sap but does not inject any toxin into plants. Severely attacked plants show general symptoms of weakening but do not show distortion.

It is a minor pest of cassava, and no control is usually required as is controlled naturally by natural enemies.

What to do:

- Select mealybug-free planting material.

Striped mealybug *(Ferrisia virgata)*

(c) F. Haas, icipe

Cassava green spider mite (*Mononychellus tanajoa* or *M. progresivus*)

This mite is green in colour at a young age turning yellowish as adult. Adult females attain a size of 0.8 mm. They appear as yellowish green specks to the naked eye. They occur on the lower surface of young leaves, green stems and auxiliary buds of cassava. Damage initially appears as yellowish "pinpricks" on the surface of young leaves.

Symptoms vary from a few chlorotic spots to complete chlorosis. These symptoms are somehow similar to African cassava mosaic disease, and should not be confused. Heavily attacked leaves are stunted and become deformed. Severe attacks cause the terminal leaves to die and drop, and the shoot tip looks like a "candle stick". Green spider mites are major pests in dry season. Severe mite attack results in 20-80 % loss in tuber yield.

Predatory mites (mainly *Typhlodromalus aripo* and *T. manihoti*) introduced from South America, the home of the cassava green mite, have given effective control of the cassava green mites in Africa (Yaninek and Hanna, 2003).

What to do:

- Whenever possible, use varieties with good tolerance to green mites (Examples from West Africa: "BEN 86052", "MS6" and "NR8082") (James et al, 2000).
- Use clean plant material for planting.
- Plant at the onset of the rains to encourage vigorous growth and thereby increase tolerance to mite attack. Cassava plants aged 2-9 months are the most vulnerable to infestation.

- Practise intercropping. Cassava intercropped with pigeon pea has been reported to suffer less damage from cassava green mite than that grown on a pure stand in Nigeria. Higher tuber yields were obtained when cassava was intercropped with pigeon pea in triple and double rows than when it was alternated in a single row or in a pure stand (Ezulike and Egwuatu, 1993).

Cassava green mite *(Mononychellus tanajoa)* and eggs. Real size 0.8 mm, egg 0.2 mm.

(c) F. Haas, icipe

Red spider mites (*Oligonychus gossypii* and *Tetranychus* spp.)

Several species of red spider mites also occur on cassava, mostly on the older leaves. Adults are about 0.6 mm long. Initial symptoms are yellowish pinpricks along the main vein of mature leaves. Spider mites produce protective webbing that can be readily seen on the plant. Attacked leaves turn reddish, brown or rusty in colour. Under severe mite attack, leaves die and drop beginning with older leaves. Most damage occurs at the beginning of the dry season.

What to do:

- Conserve natural enemies. Local natural enemies usually control these spider mites and no further control measures are needed.
- Avoid planting next to infested fields.
- Avoid use of broad-spectrum pesticides, in particular pyrethroids; this may lead to spider mite outbreaks.

Two-spotted **spider mite** *(Tetranychus urticae)* . The adult female is 0.6 mm long. The male is smaller.

(c) Warwick HRI, University of Warwick

More information on Spider mites

Cassava scales (Aonidomytilus albus)

It is a mussel-shaped scale with an elongated silvery-white cover and about 2-2.5 mm long. This scale may cover the stem with conspicuous white secretions, and eventually the leaves. This scale sucks from the stem and dehydrates it. The leaves of attacked plants turn pale, wilt and drop off. Severely attacked plants are stunted and yield poorly. Scale attack can kill cassava plants, in particular plants weakened by previous insect attack and drought. Stem cuttings derived from infested stem portions normally do not sprout.

What to do:

- Apply of organic matter to improve soil fertility.
- Selection of clean (scale free) planting material.
- Destroy infested stems.
- Avoid use of pesticides in the cassava field or in neighbouring crops, which may kill natural enemies.

Scale insect. This is not the cassava scale, but an armored scale (related species)

(c) USDA ARS, Bugwood.org

Grasshoppers (*Zonocerus variegatus*)

Grasshoppers such as the variegated grasshopper (West to East Africa south of the Sahara), and the elegant grasshopper (*Z. elegans*) (Southern Africa and East Africa) are brightly coloured grasshoppers.

Adults are dark green with yellow, black and orange marking on their bodies. Nymphs are black with yellow markings on the body, legs and antenna and wing pads. Female grasshoppers lay many eggs just below the surface of the soil in the shade under evergreen plants, usually outside cassava fields. Eggs are laid in masses of froth, which harden to form sponge-like packets, known as egg pods, which look like tiny groundnut pods. Eggs start to hatch at the beginning of the main dry season.

Grasshoppers attack a wide range of crops mainly in the seedling stage. They feed on cassava plants, chewing leaves and stems and may cause defoliation and debark stems. This is particularly severe in fields next to the bush when the dry season is prolonged.

What to do:

- Hand pick grasshoppers. This is feasible in small plots.
- Locate and dig egg-laying sites to expose and destroy the eggs before they start to hatch early in the dry season. However, egg pod destruction has to be done over a wide area in the wet season in order to be effective. This will require participation of farmers on many neighbouring farms. If only one neighbour destroys the eggs in his/her farm, the grasshoppers will later invade the farm from the neighbouring farms and bushes.

- When available, use biopesticides. IITA researchers and partners have developed an environmental friendly biopesticide "Green Muscle(r)". It is based on a naturally occurring fungus strain indigenous to Africa (Metarhizium anisopliae) which is deadly to locusts and grasshoppers but reportedly does not damage other insects, plants, animals, or people. Typically 70 to 100% mortality rates were obtained after 8 to 28 days of application (www.iita.org). The bioinsecticide "Green Muscle(r)" is effective in grasshopper management in outbreak situations. However, it is costly and currently, it is only available in South Africa and West Africa.

- Use neem extracts. Neem protects cassava from grasshopper damage. It acts as antifeedant (grasshoppers stop feeding when exposed to neem products) and affects development of the grasshoppers (Nicol et al, 1995; Olaoifa and Adenuga, 1988). In Nigeria, the following neem products have given good control of Z. variegatus on cassava: 1.) Emulsifiable concentrate of neem oil at 0.5% to 2% applied at 8-day intervals or at 3-4% at 10-day intervals, 2.) Aqueous neem kernel water extracts (NSKE) at 7-10% applied every 12 days and aqueous neem leaf water extracts (NLWE) 50% applied every 6 days. Aqueous extracts from neem leaves were less effective than neem seed extracts (Olaoifa and Adenuga, 1988). For more information on Neem click here.

Variegated grasshopper *(Zonocerus variegatus)*
(c) Georg Goergen (Courtesy of EcoPort, www.ecoport.org)

Whiteflies (*Bemisia tabaci*, *Aleurodicus dispersus*)

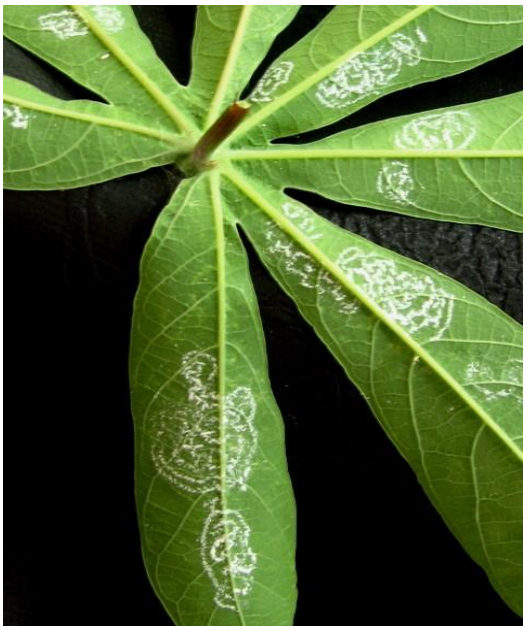
Several species of whiteflies are found on cassava in Africa. Feeding causes direct damage, which may cause considerable reduction in root yield if prolonged feeding occurs. Some whiteflies cause major damage to cassava as vectors of cassava viruses. The spiralling whitefly (*Aleurodicus dispersus*) was reported as a new pest of cassava in West Africa in the early 90s.

The adults and nymphs of this whitefly occur in large numbers on the lower surfaces of leaves covered with large amount of white waxy material. Females lay eggs on the lower leaf surface in spiral patterns (like fingerprints) of white material secreted by the female. This whitefly sucks sap from cassava leaves. It excretes large amounts of honeydew, which supports the growth of black sooty mould on the plant, causing premature fall of older leaves.

The **tobacco whitefly** (*Bemisia tabaci*) transmits the African cassava mosaic virus, one of the most important factors limiting production in Africa. The adults and nymphs of the tobacco whitefly occur on the lower surface of young leaves. They are not covered with white material. The nymphs appear as pale yellow oval specks to the naked eye.

What to do:

- Conserve natural enemies. Parasitic wasps in particular are very important for natural control of whiteflies. For instance *Encarsia formosa*, natural enemy of the tobacco whitefly, and *Encarsia haitiensis* a natural enemy of the spiralling whitefly (Neuenschwander, 1998; James, et al, 2000).



Whiteflies egg laying on lower leaf surface of cassava plant

(c) A.A. Seif

More information on Whiteflies

Termites

Different species of termites damage cassava stems and roots. Termites damage cassava planted late or in the dry season, in particular when the crop is still young at the peak of the dry season. They chew and eat stem cuttings which grow poorly, die and rot. The may destroy whole plantations. In older cassava plants termites chew and enter the stems. This weakens the stems and causes them to break easily.

What to do:

- Plant early with the rains.
- Avoid planting on very dry land or on termite mounds.

Close-up **termites on mango stem.***(Coptotermes formosanus)*

(c) A. M. Varela, icipe

More information on Termites

Storage pests

A number of **beetles** feed on dry cassava causing post harvest losses. In Benin Republic the most common are *Dinoderus* sp., *Carpophilus* sp., the coffee bean weevil (*Araecerus fasciculatus*), the lesser grain borer (*Rhizopertha dominica*), and more recently, the larger grain borer (*Prostephanus truncatus*).

Infestation by these insects is heavier in the rainy season than in the dry season, is more prevalent in the humid zone than in the savannah, and is found more in large chips than in smaller ones. Maximum infestation was found after 6 to 8 months in storage, at which time chips would fall into dust when squeezed (Bokanga, IITA, FAO).

What to do:

- Use botanicals or plant parts to protect stored cassava. There are reports in Kenya, that the larger grain borer can be effectively repelled by storing cassava or grains with a fairly large amount of dried lantana or eucalyptus leaves (Personal communication, field officer of Meru herbs). Neem is also reported to be effective.

For more information on Neem click here.

Damage to cassava chips by **Larger Grain Borer**

(c) GTZ

More information on Storage pests

3. Information on Diseases

African Cassava Mosaic Disease (ACMD)

African cassava mosaic disease is one of the most serious and widespread diseases throughout cassava growing areas in Africa, causing yield reductions of up to 90%. It is spread through infected cuttings and by whiteflies (*Bemisia tabaci*).

Symptoms occur as characteristic leaf mosaic patterns that affect discrete areas and are determined at an early stage of leaf development. Symptoms vary from leaf to leaf, shoot to shoot and plant to plant, even of the same variety and virus strain in the same locality. Some leaves situated between affected ones may seem normal and give the appearance of recovery.

What to do:

- Use disease-free cuttings. If it is not possible to find cassava plants that are completely free from the disease, select cuttings from stem branches instead of from the main stem. Stem cuttings from the branches are more likely to sprout into disease-free plants than stem cuttings from the main stems (James et al, 2000).
- Resistance to ACMD has been successfully incorporated into high yielding cultivars of acceptable quality through breeding programmes at IITA. Use resistant/tolerant varieties (e.g. "SS 4", "TMS 60142", "TMS 30337" and "TMS 30572").

Cassava plant showing severe symptoms of the **African Cassava Mosaic Disease** (ACMD).

(c) A.A. Seif, icipe

More information on African cassava mosaic virus (ACMV)

Cassava bacterial blight (*Xanthomonas campestris* pv. *manihotis*)

It is a major constraint to cassava cultivation in Africa. Infected leaves show localised, angular, water-soaked areas. Under severe disease attack heavy defoliation occurs, leaving bare stems, referred to as "candle sticks". Since the disease is systemic, infected stems and roots show brownish discolouration. During periods of high humidity, bacterial exudation (appears as gum) can readily be observed on the lower leaf surfaces of infected leaves and on the petioles and stems. The disease is favoured by wet conditions.

This disease is primarily spread by infected cuttings. It can also be mechanically transmitted by raindrops, use of contaminated farm tools (e.g. knives), chewing insects (e.g. grasshoppers) and movement of man and animals through plantations, especially during or after rain. Yield loss due to the disease may range from 20 to 100% depending on variety, bacterial strain and environmental conditions.

What to do:

- Use clean planting material. This can reduce disease incidence in areas where cassava bacterial blight is already widespread.
- In cases of sporadic occurrence of the disease, collect cuttings only from healthy plants and from the most lignified portion of the stem, up to 1 m from the base. Check visually the cuttings for vascular browning. Disinfect tools regularly.
- Intercrop cassava with maize or melon. This been reported to reduce cassava bacterial blight significantly.

- Practise crop rotation and fallowing. These practices proved very successful when the new crop was planted with uninfected cuttings. Rotation or fallowing should last at least 1 rainy season.
- Remove and burn all infected plant debris and weeds. Alternatively plough them into the soil.

Cassava bacterial blight *(Xanthomonas campestris pv. manihotis)*. Angular leaf spots, sometimes with yellow haloes, rapidly expanding, leading to necrosis and leaf fall.

(c) Grahame Jackson (Courtesy of EcoPort)

Brown leaf spot (*Cercosporidium henningsii*)

Symptoms are restricted to older leaves. Brownish round spots with definite borders appear on the upper leaf surface. On the lower leaf surface, they are brownish-grey in colour. Infected leaves later become yellow and eventually drop. In wet areas the disease may cause a yield reduction of up to 20%.

What to do:

- Though the disease is widespread in most cassava growing countries, it is not an economically important disease problem and it does not warrant any intervention.

Cassava brown leaf spot *(Cercosporidium henningsii)*

(c) A.A.Seif, icipe

Cassava brown streak virus disease (Potyvirus - Potyviridae)

It is particularly serious in coastal areas of Kenya, Zanzibar, Mozambique and Tanzania and lakeshore region of Malawi and in Uganda and is a threat to the whole of sub-Saharan Africa.

The virus is vectored by whiteflies (*Bemisia* spp.) and also transmitted through infected cuttings. Symptoms include yellowing (leaf chlorosis) and brown streaks in the stem bark (cortex). Infected tubers have brown streaks (root necrosis) (Field Crops Technical Handbook, MoA, Kenya). It's a stealth virus, which destroys everything in the field. The leaves may appear healthy even when the roots have rotted away.

What to do:

- Use diseased-free cuttings.
- Use tolerant/resistant varieties (e.g. "5543/156", "TMS 30572")
- Remove diseased plants from the field.

Cassava roots completely destroyed by **Cassava Brown Streak Disease**. This disease renders cassava roots unfit for consumption and use.

(c) IITA, 2010

Anthracnose (*Glomerella manihotis*)

Initial symptoms of the disease are oval lesions ("sores") on young stems. On older stems, raised fibrous lesions develop that eventually become sunken.

What to do:

- It is not an economically important disease in most cassava growing countries and it does not warrant any intervention.

Severe stem infection by **cassava anthracnose**

(c) IITA, 2010

More information on Anthracnose

Post harvest diseases

Some fungi growth on cassava chips, usually when the moisture content of cassava chips exceeds 14%, making them unfit for feed and food. A survey of cassava chips processing areas

of West Africa has indicated that the most common fungi were *Rhizopus* sp. and *Aspergillus* sp. (IITA, 1996).

What to do:

- Early harvesting prevents or reduces the incidence of rots on farms.
- Rotate cassava with cereals to help reduce the levels of inoculum (spores etc.) on fields.

For more information on Storage pests click here.

Cassava roots infected with **cassava root rot disease**.

(c) IITA, 2005

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