



Pest Control in Cassava Farms

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About this booklet

This booklet is one in a set of field guides prepared by the International Institute of Tropical Agriculture (IITA) to increase the technical knowledge of extension agents and enhance the integration of plant protection and plant production practices in farmers' efforts to grow a healthy crop of cassava. The booklet is based largely on the extension and farmer training experience of the regional project "Ecologically Sustainable Cassava Plant Protection" (ESCaPP), 1993–1997. ESCaPP was executed by IITA's Plant Health Management Division (PHMD), in collaboration with national agricultural research and extension systems in Bénin, Cameroon, Ghana, and Nigeria, and funded by the Division of Global and Interregional Programmes of the United Nations Development Programme (UNDP).

IITA is one of 16 nonprofit international agricultural research and training centers supported by the Consultative Group on International Agricultural Research (CGIAR). Their shared mission is the alleviation of hunger and poverty in tropical developing countries by generating appropriate plant production and protection technologies which benefit the poor and enhance agricultural production while preserving the natural resource base. At IITA, PHMD is dedicated to sustainable plant protection of primary food crops in Africa. The division's research philosophy is to identify and correct the ecological imbalances in agricultural systems causing pest problems and to provide environmentally and economically appropriate options for integrated pest management (IPM).

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IPM Field Guide for Extension Agents

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What are the objectives of this guide?

This field guide has been prepared to help you to:

- identify pests in cassava farms,
- specify how the pests can damage cassava,
- specify how the pests multiply and spread in cassava farms,
- identify and recognize the role of the natural enemies of cassava pests, and
- combine the most appropriate practices to control pests and grow a healthy crop of cassava.

Introduction

Insects, mites, spiders, and other creatures occur in cassava farms. Some of these creatures are harmful while others are beneficial. The harmful creatures are called pests because they feed on and damage cassava leaves and stems (Figures 1 and 2) and roots, causing losses to the farmer. Some of these pests are easily seen. However, there are others such as tiny mites which may not be easily noticed especially if you are not trained to look for them. Even though the damage caused by pests may be obvious, this does not necessarily mean that the pest is causing yield loss. Pest control measures should be undertaken only when the pests are becoming very abundant and pose a high risk of yield loss, and/or the crop looks unhealthy.

The beneficial creatures do not feed on cassava at all. Some feed on weeds, flowers, and dead plants. Others pollinate flowers or feed on pests. Those that feed on pests are called “natural enemies” (Figure 3). Natural enemies are your friends because they help to control pests on the farm.



Figure 1: Cassava leaves damaged by cassava mealybug



Figure 2: Cassava plants debarked by variegated grasshopper



Figure 3: Ladybird beetle feeding on cassava mealybug (as seen enlarged under the microscope)

What are the common pests in cassava farms?

The pests of cassava are insects, mites, and vertebrates. The pests attack and feed on different parts of cassava plants. Some feed on the leaves and stems while others feed on the stems and roots.

Leaf and stem feeders

The common leaf and stem pests of cassava are cassava mealybug, cassava green mite, variegated grasshopper, and whiteflies.

Cassava mealybug

Appearance: The cassava mealybug, *Phenacoccus manihoti* is commonly found at cassava shoot tips, on the under surfaces of leaves (Figure 4), and on stems. The insects are covered with large amounts of white waxy materials. They are wingless, pink in color, oval in shape, and have very short body filaments (Figure 5).

Two other kinds of mealybugs occur on cassava. These are the green mealybug, *Phenacoccus madeirensis*, and the striped mealybug, *Ferrisia virgata*. You should not confuse these with the cassava mealybug. The green mealybug is greenish white and not pink. The striped mealybug occurs mostly on surfaces of cassava stems (Figure 6). It has two long tail filaments, two dark stripes running along its upper body surface, and produces longer threads of white materials than the cassava mealybug. The green mealybug is more common on cassava than the striped mealybug.

Crop damage symptoms: The cassava mealybug sucks sap from cassava leaves and

shoot tips. The pest reduces the lengths of the internodes and causes the leaves to clump together into “bunchy tops” (Figure 7). The pest also distorts the stems (Figure 8), dries up the leaves and eventually, if the attack is particularly severe, it defoliates the plants (Figure 1). The damage is more severe in the dry than in the wet season.

Reproduction: Populations of the cassava mealybug are all females. The insect lays eggs without mating. A single insect can therefore start a severe infestation. You may notice masses of golden yellow eggs within colonies of the pest. The pest is more abundant in the dry than in the wet season.

Method of spread: Newly hatched cassava mealybugs are tiny, light, and easily blown by wind from plant to plant. Also, the pest survives on stem surfaces and is spread by being carried by farmers on cassava stem planting materials.

Other crops attacked: The cassava mealybug feeds on cassava and no other food crops.



Figure 4: Cassava mealybug on the under surface of a cassava leaf



Figure 5: Body form of the cassava mealybug (as seen enlarged under the microscope)



Figure 6: Striped mealybug on cassava stem



Figure 7: Cassava shoot tip with “bunchy top” caused by cassava mealybug



Figure 8: Cassava stem distorted by cassava mealybug

Cassava green mite

Appearance: Cassava green mite, *Mononychellus tanajoa*, lives on the under surface of young cassava leaves (Figure 9). Mites are wingless, very tiny, and appear as specks to the naked eye. In the farm, you can see them more clearly if you look at them under a hand lens. The nymphs (immature mites) are green in color and turn yellowish as they get older. Red mites also occur on cassava, mostly on the older leaves, but they are not common and do not cause serious damage.

Crop damage symptoms: Cassava green mite sucks sap from cassava leaves and shoot tips. The pest causes tiny yellow chlorotic spots the size of pin pricks, on the upper leaf surfaces (Figure 10). You should not confuse chlorotic spots caused by the pest with the chlorotic patches of cassava mosaic disease (Figure 11). Young leaves attacked by cassava green mite become small and narrow (Figure 12). The pest kills the terminal leaves and as these drop the shoot tip looks like a “candlestick” (Figure 13). Cassava crop damage by the pest is more severe in the dry than in the wet season.

Reproduction: Populations of cassava green mite consist of eggs, nymphs, and adult males and females. The pest mates before laying eggs. It is more abundant in the dry than in the wet season.

Method of spread: Cassava green mite is tiny, light, and easily blown by wind from plant to plant. Also, it survives on stem surfaces and is spread by being carried by farmers on cassava stem planting materials.

Other crops attacked: The cassava green mite feeds only on cassava and not on other food crops.



Figure 9: Cassava green mite (as seen enlarged under the microscope)



Figure 10: Cassava leaf with chlorotic (pale) spots caused by cassava green mite



Figure 11: Cassava leaves with chlorotic (pale) patches of cassava mosaic disease



Figure 12: Cassava shoot tip with small and narrow leaves caused by cassava green mite



Figure 13: Cassava shoot tip in “candlestick” condition caused by cassava green mite

Variegated grasshopper

Appearance: Adults of the variegated grasshopper, *Zonocerus variegatus*, are green and have bold yellow, black, white and orange markings on their bodies (Figure 14). The nymphs are black with yellow markings on the body, legs, antennae and wing pads (Figure 15). The young nymphs gather in large numbers on weeds (Figure 16) and low-growing crops.

Crop damage symptoms: The variegated grasshopper chews cassava leaves, petioles, and green stems. It defoliates the plants and debarks the stems (Figure 17). The pest damage is more common on older than on younger cassava plants, and is more severe in the dry than in the wet season.

Reproduction: After mating, female variegated grasshoppers lay many egg pods just below the surface of the soil. The egg pods look like tiny groundnut pods. The egg laying sites always have vegetation which casts shade on the ground and keeps it moist, soft, and suitable for egg laying. These sites are usually close to cassava fields and small in surface area. In most of West and Central Africa, adult grasshoppers can be seen in large numbers at such sites, usually between March and May. The eggs start to hatch at the beginning of the main dry season, usually in October and November.

Method of spread: The variegated grasshopper spreads by flying from farm to farm. However, the insect does not fly over long distances. It spreads faster in areas where the forest has been cleared than in thick vegetation.

Other crops attacked: In addition to cassava, the variegated grasshopper also feeds on citrus, cashew, cowpea, plantain, vegetables, and many other crops.



Figure 14: Adult of the variegated grasshopper on cassava



Figure 15: Nymph of the variegated grasshopper



Figure 16: Nymphs of the variegated grasshopper on Siam weed, *Chromolaena odorata*



Figure 17: Cassava plants defoliated and debarked by the variegated grasshopper

Spiraling whitefly

Appearance: Adults of the spiraling whitefly, *Aleurodicus dispersus*, are bright white in color. Adults and nymphs of the insect occur in large numbers on the undersurfaces of cassava leaves covered with large amounts of white waxy materials (Figure 18).

Crop damage symptoms: The spiraling whitefly sucks sap from cassava leaves. As it feeds, it secretes large amounts of honeydew which supports the growth of black mold on the plant (Figure 19). The blackened leaves dry up and drop.

Reproduction: After mating, females of the spiraling whitefly lay eggs on the undersurface of leaves. The eggs occur in spiral patterns (like fingerprints) of white material secreted by the insect on the leaves (Figure 20). The insects are numerous mainly in the dry season.

Method of spread: The spiraling whitefly spreads by active flight and by being transported on stem planting materials.

Other crops attacked: In addition to cassava, the spiraling whitefly feeds on many types of fruit trees (for example, citrus, banana, plantains), vegetables, and ornamental plants.



Figure 18: Adults of the spiraling whitefly

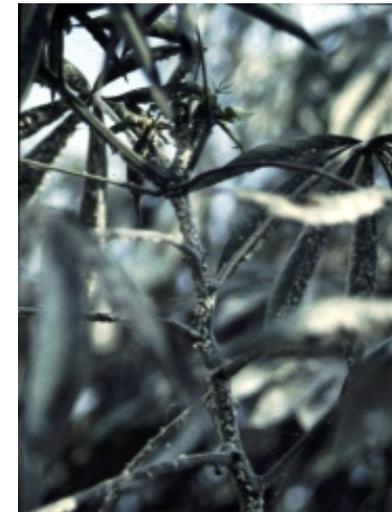


Figure 19: Cassava plant blackened under attack by the spiraling whitefly



Figure 20: Spiral pattern of white secretions within which eggs of the spiraling whitefly are located

***Bemisia* whitefly**

Appearance: Adults of the whitefly, *Bemisia tabaci*, have bright white wings, as in the spiraling whitefly. The insects are, however, smaller than the spiraling whitefly and are not covered with white material (Figure 21). The adults and nymphs occur on the undersurfaces of young leaves. The nymphs appear as pale yellow oval specks to the naked eye.

Crop damage symptoms: *Bemisia* whiteflies suck sap from the leaves, but this does not cause physical damage to the plant. As they feed, the insects inject the plant with viruses which cause cassava mosaic disease (Figure 11). This is the main reason why the insect is an important cassava pest.



Figure 21: Adults of the *Bemisia* whitefly (as seen enlarged under the microscope)

Stem and root feeders

The common stem and root pests of cassava are termites, cassava root scale, cassava white scale, and vertebrates.

Termites

Appearance: Many different 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 (Figure 22). These grow poorly, die and rot. In older cassava farms, termites chew and enter the stems (Figure 23). 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

Cassava root scale

The cassava root scale, *Stictococcus vayssierrei*, seems to be restricted to parts of Central Africa.

Appearance: The cassava root scale lives underground on the storage roots, feeder roots and submerged stems of cassava. The insects are reddish-purple or brown in color, oval in shape, and look like ticks on cassava (Figure 24). They lack wings and are attached firmly to the plant.

Crop damage symptoms: Cassava root scale attack causes the storage roots to be smaller than normal and deformed.

Method of spread: It is not yet known how the cassava root scale spreads.

Other crops attacked: In addition to cassava, the cassava root scale attacks yam, cocoyam, and groundnut.



Figure 22: Cassava stem cutting destroyed by termites

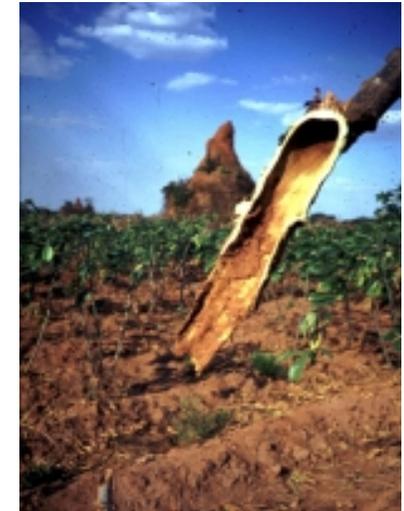


Figure 23: Stem of a mature cassava plant chewed off by termites (termite nest in background, center)



Figure 24: Cassava root scale on underground cassava stem

Cassava white scale

Appearance: The cassava white scale, *Aonido-mytilus albus*, is found mainly on cassava stem surfaces (Figure 25). 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.

Vertebrate pests

The common vertebrate pests of cassava are birds, rodents, monkeys, pigs, and domestic animals. The bird pests are usually bush fowl or francolins (*Francolinus* sp.) and wild guinea fowl. These birds feed on storage roots that have been exposed. They also scratch the soil surface to expose the storage roots (Figure 26). The remaining portions of the attacked roots later rot. Birds are particularly a problem where cassava is planted in soils that are loose and easy to scratch away.

The major rodent pests of cassava are the grasscutter or cane rat (*Thryonomys swinderianus*), the giant rat (*Cricetomys gambianus*), other rats, mice, and squirrels. Among these, the grasscutter (Figure 27) causes the greatest damage to cassava. It cuts down and chews the stems, and also feeds on the storage roots. Pigs dig, uproot, and feed on cassava storage roots; monkeys damage cassava in a similar manner. Cattle, goats, and sheep defoliate cassava by eating the leaves and green stems.



Figure 25: Cassava white scale on cassava stem



Figure 26: Cassava storage root pecked away by birds



Figure 27: Grasscutters

Why are cassava pests important?

Cassava pests are important because they reduce the yield from the crop. They cause food and income losses from cassava in the following ways.

Loss of roots: Damage caused by pests to cassava leaves and green stems interferes with the way the plant makes food for storage in the roots. This will reduce the growth of the plants, the number of storage roots they can form, and the ability of the storage roots to swell with food and mature for harvest (Figures 28 and 29). However, most cassava varieties can lose a lot of leaves before the root yield is reduced. Farmers should be discouraged from rushing to tackle control measures at the first signs of damage.

Loss of planting material: Some of the pests reduce the ability of cassava stem cuttings to sprout. For example, the variegated grasshopper kills the axillary buds (“eyes” of stem cuttings) by debarking the stem (Figure 17); the white scale (Figure 25) kills the axillary buds by covering and dehydrating the stems; cassava mealybug distorts and destroys cassava stems (Figure 8); and termites weaken the stems by chewing and burrowing into them (Figures 22 and 23). Other pests contaminate cassava stems and make them unhealthy for planting. Examples of such pests are the cassava mealybug (Figure 5), cassava green mite (Figure 9), and spiraling whitefly (Figure 18).

Loss of leaves: In areas where cassava leaves are used as food, leaf-feeding pests “rob” farmers and other consumers directly of leafy vegetables (Figure 30). For example, the cas-

sava mealybug and variegated grasshopper defoliate cassava plants (Figures 1 and 2). Cassava mealybug and cassava green mite distort cassava leaf shape and size (Figures 7 and 12). Cassava mealybug and spiraling whitefly contaminate cassava leaves with whitish waxy materials and sooty mold (Figures 4 and 19). Cassava green mite and spiraling whitefly discolor the leaves. These kinds of damage to the leaves will also reduce the ability of cassava plants to make sufficient food for storage in the roots.

Carrier of cassava diseases: The whitefly, *Bemisia tabaci* (Figure 21), sucks sap from the leaves but causes little physical damage to cassava by doing so. However, during feeding the insect picks up viruses which cause cassava mosaic disease (Figure 11). It can later spread the viruses to other healthy cassava plants as it feeds.

Increase in weed growth and soil erosion: Pests that defoliate cassava plants encourage weed growth in farms because the cassava plants are no longer able to block sunlight from reaching the weeds growing underneath. In loose soils, defoliation of cassava plants will expose the soil to erosion.

Damage to other crops: In addition to cassava, most of the pests also feed on and damage other crops. Examples of cassava pests that feed on a wide range of crops are the variegated grasshopper, whiteflies, termites, and cassava root scale.



Figure 28: Poor cassava storage root yield



Figure 29: Good cassava storage root yield



Figure 30: Good cassava leaf harvest

When are cassava pests likely to cause severe losses?

The presence of pests in cassava farms does not always mean that they will cause severe losses in food and income. The appearances of pests and pest damage can be misleading. In some cases, cassava plants recover from the damage and provide good leaf, stem, and root yield. It is therefore very important to know the conditions under which pests can be serious problems. The following pointers will help you to know when pests are likely to cause severe losses in cassava farms.

The origin of pests: Some cassava pests have always been in Africa. These are known as “native pests”. Examples of native pests are the variegated grasshopper (Figures 14 and 15), termites, and cassava root scale (Figure 24). Some other pests are new to Africa, and are only recently being seen on cassava plants. These kinds of pests were introduced by accident to Africa from other continents (Figure 31). They are called “introduced pests”. Examples of introduced pests are the cassava mealybug (Figure 5), cassava green mite (Figure 9), and spiraling whitefly (Figure 18). These pests are frequently introduced without the natural enemies which kill them in the areas from where they come. Hence they usually multiply and spread very rapidly causing severe crop damage.

Cassava varieties: Losses caused by pests are less severe on some cassava varieties than on others. Generally, not much is known about cassava varieties which can tolerate damage by the pests. However, the IITA variety TMS 30572 and the national varieties 8017

and 8034 in Cameroon, and MS6 and NR 8082 in Nigeria are good varieties against the cassava green mite (Table 1).

The stage of plant growth at attack: Generally, young cassava plants suffer more from pest attack than older plants. At 3–4 months after planting, the roots of most cassava varieties start to swell with food. At about 7 months after planting, the plants have formed the number of storage roots they will carry during their growing period. This number will not increase much after this time, but the storage roots will continue to swell with food until they are harvested. Therefore, if pests attack cassava farms aged 7 months or less, the losses will be greater than if older plants are attacked.

The plant parts attacked: Pests which damage the plant parts that you harvest “rob” you directly of food and income. For example, when cassava storage roots are attacked the plants do not replace them with more roots nor do the roots become bigger to compensate for the damage. Pests which cause this kind of damage are the cassava root scale and vertebrates which feed on the roots. However, when pests attack cassava leaves the plants may produce new leaves and later produce a good root yield.

The season of attack: Many cassava pests are dry season pests. They will cause greater yield loss in cassava planted at the end of the wet season (late planting) than at the beginning of the season (early planting).

The frequency of attack: Cassava plants usually recover from initial pest attack by producing new leaves. However, the plants may not recover from continued attack by the pest.

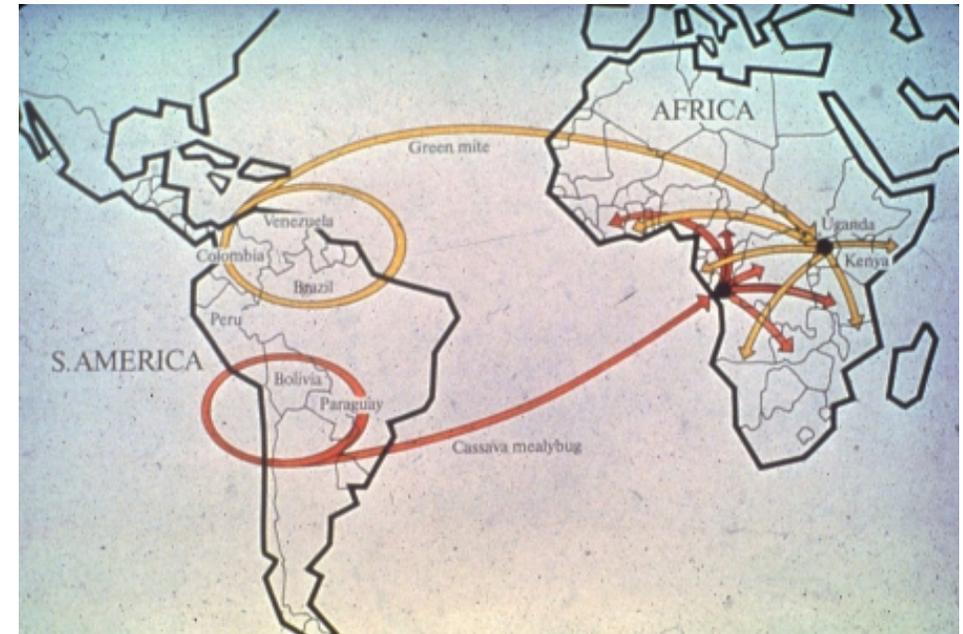


Figure 31: Map showing the origin and introduction of cassava mealybug and cassava green mite from South America to Africa

How can I best control cassava pests?

The best way to control pests is to grow a healthy crop of cassava rather than simply aim at killing pest organisms. In order to grow a healthy crop, you will need to combine plant production and plant protection practices.

IPM practices at planting

Many integrated pest management (IPM) practices in cassava are appropriate at planting. These include site selection, soil improvement practices, selection of appropriate varieties and planting materials. These practices are covered in the companion field guide “Starting a Cassava Farm”. Table 1 lists some cassava varieties that can withstand pest attack better than others. For example, the IITA variety TMS 30572 and the national varieties 8017 and 8034 in Cameroon, and MS6 and NR 8082 in Nigeria are good against the cassava green mite. In selecting a variety to grow against pests you should find out if the selected variety also has other features you may want.

Many cassava pests are spread by carrying and planting infested stem cuttings. The main stem-borne pests are cassava mealybug (Figure 5), cassava green mite (Figure 9), spiraling whitefly (Figure 18) and white scale (Figure 25). These pests survive on cassava stems and leaves and are easily carried to new fields in this way. The companion field guide “Starting a Cassava Farm” presents the general guidelines on how to select healthy stem cuttings to grow a healthy cassava crop. In selecting healthy planting material you should look for cassava plants with robust stems and stem branches, lush foliage, and minimal

stem and leaf damage. You should avoid selecting planting material from cassava plants with stem-borne pests or their damage symptoms.

Cassava white scale normally occurs on a few cassava plants in cassava farms. During the growing period of the plants and after cassava root harvest, try and destroy the stems infested with the pest. Do not store cassava stems with any of the stem-borne pests. Remove such infested stems from cassava stem bundles in storage.

If it is difficult to get sufficient quantities of healthy stems you should treat the stem cuttings against certain pests. For example, you can plant affected stem cuttings in a horizontal manner by laying them flat and burying them completely in the soil to kill pests on the stem surface. You can also dip cassava cuttings in diluted solution of a suitable pesticide (for example, 1% Rogor) to kill the pests. If pesticides are to be used, you should consult the label for guidelines on their application methods and how to avoid personal and environmental hazards associated with their use. In areas where termites are particularly a problem, you can smear the cut ends of cassava stem cuttings with a watery paste of soil mixed with kerosene. This can limit termite damage.

When cutting cassava stems into stem cuttings for planting, you should select the middle brown-skinned portions of the stems. These parts sprout and ensure plant vigour better than the top green stem portions. The top green stems dehydrate quickly and are easily damaged by pests. Avoid unhealthy stem cuttings as planting material.

Table 1: Some features of common cassava varieties in West and Central Africa
Expression of selected features

Variety	Yield potential	% dry matter	Cyanogenic potential	Ground storability	Weed suppression	Tolerance to CGM	Tolerance to CMD	Tolerance to CBB
IITA								
TMS 4(2)1425	High	High	Low	Good	Good	Moderate	Moderate	Good
TMS 30572	High	High	Moderate	Moderate	Good	Moderate	Good	Good
Benin								
BEN 86052	High	High	Low	Poor	Moderate	Good	Good	Poor
RB 89509	Moderate	Moderate	Low	Good	Poor	Poor	Good	Moderate
Cameroon								
8017	High	High	Moderate	Poor	Good	Moderate	Moderate	Moderate
8034	High	High	Moderate	Poor	Good	Moderate	Moderate	Moderate
Ghana								
"Afsiafi"	High	High	Moderate	Moderate	Good	Moderate	Good	Good
"Abasa fitaa"	High	High	Low	Good	Good	Moderate	Moderate	Good
Nigeria								
MS 6	High	High	Low	Poor	Poor	Good	Good	Moderate
NR 8082	High	High	High	Moderate	Good	Good	Good	Good

CGM = Cassava green mite
CMD = Cassava mosaic disease
CBB = Cassava bacterial blight

Source: IITA, INRAB-Benin, MoFA-CSD Ghana, IRAD-Cameroon, and NRCRI-Nigeria

The numbers of most cassava pests are higher and their damage is more severe in the dry season than in the wet season. It is therefore advisable to plant cassava early, at the beginning of the rains. This allows the crop to grow more vigorously and better withstand pest damage than in late planting.

IPM practices after planting

The common IPM practices after planting are biological control, microbial control, and cultural control.

Biological control

Many of the insects that you find in your cassava fields are “natural enemies”. Natural enemies feed on other insects, including important cassava pests such as mites, mealybugs, scale insects, and whiteflies. The natural enemies commonly found in cassava fields include several kinds of beetles, predatory mites, and tiny wasps. The tiny wasps are called “parasitoids”. There are also some microbes that cause diseases in pests, but you cannot usually see these. Natural enemies are your friends in the fight against cassava pests. Using (or allowing) natural enemies to control your pests is called “biological control”.

Cassava originally came from South America and many of its important pests, including the cassava mealybug and cassava green mite, were also brought to Africa from elsewhere. Biological control is especially effective against these “introduced” pests. In this kind of biological control, scientists identify where the pest came from and then go to that “home region” and find the most effective natural enemies that control the pest and prevent it from becoming a pest

there. The most promising natural enemies are then carefully tested to ensure that they will cause no harm in the new locality. When scientists are completely sure that a natural enemy is safe, they will bring it to the place where it is to be used as a “biological control agent”. Scientists initially rear large numbers of natural enemies (Figures 32 and 33) and release them in cassava farms. Usually natural enemies only have to be released once in a particular area and then they reproduce, multiply, and spread on their own, providing permanent control without farmers or plant protection services having to take any further action.

Biological control does not eradicate pests. It reduces their numbers to low levels that do not cause severe damage to the crop. As the numbers of a pest drop, the number of natural enemies will also drop. Similarly, if the pest numbers increase, the natural enemies will also increase. In this way both pest and natural enemies remain in balance in the locality. Because the natural enemies may take a short while to build up, you may sometimes see some plants with pest damage symptoms, even in farms where biological control is already in action. This should not cause any alarm. As long as the pest's natural enemies continue to survive in the general area, they will soon arrive on the infested plants, multiply, and prevent the pest from causing severe damage.

The common natural enemies used in biological control are predators and parasitoids. Sometimes, farmers can actively help them to work better. For the most part, the farmer needs only to avoid doing anything to disrupt the good job that natural enemies are doing.



Figure 32: “Cassava trees” for rearing natural enemies of pests



Figure 33: Wooden sleeve cages for rearing natural enemies of cassava pests

Above all, farmers should avoid the use of pesticides on cassava because natural enemies are easily killed by pesticides. Wherever possible, use pest control measures that do not harm natural enemies.

Predators control pests by feeding on and killing them. Predatory ladybird beetles (Figure 3) can help to control cassava mealybug or cassava white scale. Predatory beetles are also sometimes seen feeding on cassava green mite, but the most important biological control agents of mite pests are predatory mites, called “phytoseiids” (Figure 34). Phytoseiids on cassava resemble the cassava green mite, but their body surface is shinier, and they run faster than the pests. In the farm you will see phytoseiids and the cassava green mite clearly only if you looked at them using a magnifying glass. Among predatory mites, *Typhlodromalus aripo* is the most effective against the cassava green mite. The predator occurs mainly on young leaves at cassava shoot tips. It spreads by wind and by being carried on stem cuttings.

Farmers can increase the spread of predatory mites by plucking and carrying cassava shoot tips with the predator from one field to another. Farmers can also increase the survival and spread of these predators by growing cassava varieties whose new leaves clump together at the shoot tip. These will attract the predators better than varieties whose young leaves are widely spread. Even though farmers may not grow such varieties for food or sale, they can grow a few plants in farms to attract the predators.

Farmers can also leave certain weeds such as *Euphorbia heterophylla* (Figure 35) and *Mallotus oppositifolius* (Figure 36) on cassava farms to

attract phytoseiids. The predators can live on these weeds when their food is scarce on cassava, ensuring that they are there to provide biological control when the cassava green mite comes up again. During weeding, farmers can leave the weeds to grow along the margins or in other parts of cassava farms — but, of course, not so many that they compete with the crop. This cultural practice will be especially useful at sites where cassava is grown continuously, with little or no fallow.



Figure 34: Predatory mite (yellowish) feeding on cassava green mite (as seen enlarged under the microscope)



Figure 35: Wild poinsettia, *Euphorbia heterophylla*



Figure 36: Shoot of *Mallotus oppositifolius*

Parasitoids are natural enemies that kill insect pests by living and growing inside them. The parasitoids reared and released against cassava pests are mainly tiny wasps which lay their eggs inside the pests. The eggs hatch into larvae which eat the internal tissues of the pest, growing and killing it. The body of the dead pest does not rot but it becomes hard. This hardened body is called a “mummy”. The larvae grow into adult wasps inside the mummies. Later, tiny wasps emerge from these mummies and kill more pests by laying eggs in them.

The wasp *Apoanygyrus* (= *Epidinocarsis*) *lopezi* (Figure 37) is the most effective natural enemy against the cassava mealybug, and it has controlled the pest in most of Africa. Another tiny wasp, *Encarsia haitiensis* (Figure 39), is a common natural enemy of the spiraling whitefly. Mummies of the cassava mealybug are brown (Figure 38) while those of the spiraling whitefly are black (Figure 40).

The wasp used in the biological control of the cassava mealybug prefers mealybugs that are large in size. Large mealybugs are found on vigorously growing cassava plants. Soil improvement practices which promote vigorous cassava plant growth will therefore improve biological control of the mealybug by the wasp.

Biological control is safe because natural enemies attack only the pests against which they have been reared and released; they do not attack other insects or plants. Biological control is effective because natural enemies stay on the farm permanently and reproduce quickly to respond to any pest outbreak. Bio-

logical control saves farmers the cost of pesticides and avoids the dangers of pesticides which can poison people, livestock, and the environment.



Figure 37: A parasitoid wasp of cassava mealybug (as seen enlarged under the microscope)



Figure 38: Mummy of the cassava mealybug (as seen enlarged under the microscope)

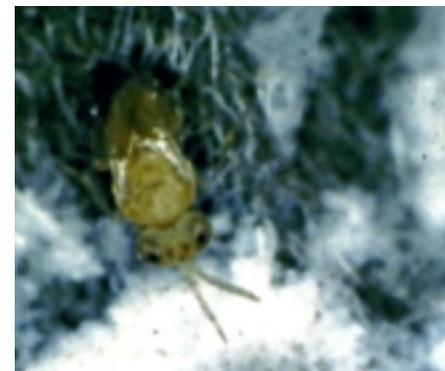


Figure 39: A parasitoid of spiraling whitefly (as seen enlarged under the microscope)

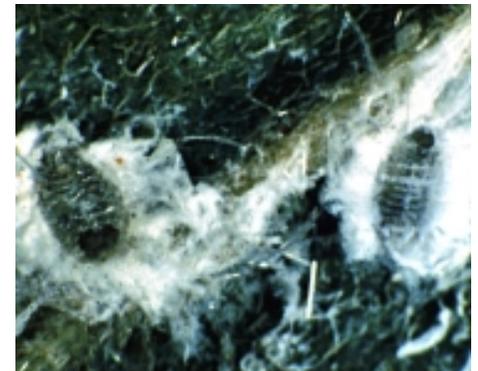


Figure 40: Mummies of the spiraling whitefly (as seen enlarged under the microscope)

Microbial control

Microbial control is a special form of biological control in which the natural enemies are “microbes” (fungi, bacteria, or viruses) that kill the pests by causing diseases in them. These “microbial control agents” may occur naturally on cassava farms and, like other natural enemies, they do their job without harming the crop or affecting people.

Fungi have been found that kill the variegated grasshopper. The fungi are spread as “spores” which are like tiny seeds. The spores land on a pest, germinate, and the fungus then penetrates the body of the pest, growing and killing it within a few days. When a diseased grasshopper dies, its dead body may remain firmly gripped to the plant (Figure 41) or drop to the ground. “Biopesticides” consisting of fungus spores mixed in oil are being prepared by scientists as commercial products against the grasshopper. The product can be sprayed on weeds such as the Siam weed, *Chromolaena odorata* (Figure 42), to kill newly hatched nymphs which gather in large numbers on the weed (Figure 16). The product can also be sprayed directly on cassava to kill nymphs and adults of the grasshopper on the plant.

Biopesticides can be sprayed using the same equipment as ordinary pesticides. However, biopesticides are much safer than chemical pesticides because they are not poisonous to people and domestic animals. Moreover, biopesticides do not kill natural enemies, so they can be used to kill one kind of pest without disrupting other kinds of biological control in the cassava farm.



Figure 41: Nymph of the variegated grasshopper killed by fungal disease



Figure 42: Shoots of Siam weed, *Chromolaena odorata*

Cultural control

The **variegated grasshopper** can also be controlled by cultural practices. In any year, the abundance of the variegated grasshopper depends largely on the number of egg pods that survive in the soil during the wet season. The destruction of egg pods will therefore reduce the numbers of the pest. Farmers can locate and mark egg-laying sites early in the wet season. At a later stage they can then dig up the soil at the sites to expose and destroy the egg pods. The digging up of eggs should be done before the eggs start to hatch early in the dry season, for example, in October in most of West Africa.

The variegated grasshopper does not lay egg pods deep in the soil. Therefore, it is easy to dig out the egg pods. However, egg pod destruction needs to be carried out over a wide area in the wet season in order to control the pest effectively. This will require the participation of many farmers on many neighboring cassava farms. If only one farmer destroys the eggs in and around his/her farm, the pest will later invade the farm from the neighboring farms and bushes. Extension agents can organize the community of villages to dig up and destroy the egg pods on as many farms as possible.

Certain weeds, for example, the Siam weed *Chromolaena odorata* (Figure 42), harbor immature stages of the variegated grasshopper (Figure 16). From the weeds the pest will move onto cassava plants. You can therefore discourage the pests from gathering in your farm by removing these weeds in your farm.

Vertebrate pests of cassava are usually difficult to control. A number of cultural practices will however help to reduce the damage caused by these pests:

- make good seedbeds for planting cassava so that the storage roots will not be easily exposed later on; if the storage roots are exposed, cover them with soil to prevent them from being attacked and eaten by birds and rodents;
- fence farms to prevent entry by grasscutters, cattle, sheep, and goats; set traps in the fence against grasscutters and other rodents;
- weed cassava farms on time and slash weeds and vegetation around the farm to discourage grasscutters and other rodents;
- organize the village community to hunt for grasscutters in your area;
- grow “bitter” cassava varieties where pigs and monkeys are a severe problem; pigs and monkeys prefer “sweet” cassava varieties;
- harvest cassava storage roots as soon as they are mature; this will reduce the length of time they can be exposed and damaged by the pests.

Summary

To control pests and grow a healthy crop of cassava:

- Identify the common pests, their damage symptoms, and natural enemies correctly; know the conditions under which the pests will cause severe losses.
- Select sites with dense vegetation, deep loamy soils, and flat or gently sloping land to plant cassava.
- Improve the soils by manuring, mulching, and intercropping.
- Grow cassava varieties that tolerate the common pests in your area.
- Plant 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.
- Plant cassava mainly at the beginning of the wet season; avoid late planting
- Use natural enemies against cassava pests.
- Do not spray pesticides on cassava as these will kill the natural enemies of cassava pests.
- Dig egg-laying sites of the variegated grasshopper in the wet season to expose and destroy egg pods of the pest.
- In the control of bird, rodent, and other vertebrate pests of cassava, fence farms and set traps in the fence; cover exposed storage roots with soil; organize villages to hunt for grasscutters; weed your cassava farm on time to discourage rodent pests; and harvest cassava storage roots as soon as they are mature.

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