

**Part I**  
**Technical bulletins for trainers**

## Black pod disease, including tree canker

### Importance

- Of all cocoa diseases in the world, black pod disease causes the largest loss of pods. The *Phytophthora* fungus that is common in areas with heavy rainfall and high humidity causes black pod disease.
- There are four strains of the fungus that causes black pod, but only two are important. This fungus also causes tree canker.
- Serious attack can lead to complete decay of pods. Pod losses can be very high: up to 50% or more. On the stem and branches, canker reduces the strength of the tree as well as the yield.

### Symptoms

- On pods, the disease begins with a small chocolate brown spot. In a few days, this spot turns brown-black and expands until the whole pod is covered. Within 14 days, the pod can turn completely black (see “Black pod disease zoo in the field”). The surface of the pod also becomes covered with yellow-white, chalky-like dust or mould. Thousands, even millions, of very tiny spores or seeds of the disease, form this ‘dust’.
- When rain splashes onto such disease-covered pods, those spores/seeds are released. These can germinate on other parts of the cocoa tree and cause further infections and disease symptoms.
- Besides pods, the disease can also infect the stem, flower cushions and chupons. Here, the disease causes tree canker. When the bark covering a canker is removed, you can see a reddish discoloration. When branches are affected, they may wilt and die and eventually this can kill the tree. When cankers develop on the tree trunk, these can encircle the whole trunk and cause tree death too.

### Spread

- The disease develops fastest in moist, rainy conditions. It is especially serious in dense farms with heavy shade. During dryer seasons, the disease survives in rotten, dried pods (mummies) and in cankers. The fungus also survives in soil.
- Spreading of spores can happen through raindrops falling from sporulating infected pods to pods lower on the tree from splash of rainwater from infested pods (see “The role of soil in the spread of black pod”), or spores on the ground back on the tree, or through activities of insects such as ants, or rodents such as rats or squirrels.
- The fungus will spread to pods in all stages of development.

## Farmer practices

- Farmers often try to use pesticides regularly. When the correct fungicides are used in the correct dosage and using appropriate knapsack sprayers and nozzles, these will kill off the disease. But the problem is that the conditions are not always perfect and some parts of the cocoa tree or areas of the farm will be missed.
- With the fast development rate of the disease, despite spraying, it comes back quickly and farmers feel forced to spray more and more often. This is expensive and often not productive. For this reason, a combination of practices is recommended below.

## Control methods

A combination of practices will help to keep black pod disease at a low level. One can choose between a few options:

### 1. Plant resistant cocoa trees

When black pod resistant cocoa material is available, farmers can choose to use this material for replanting. Check with your local cocoa research institute and find out about their resistant varieties. If not available, seek out healthy trees during the black pod season and label them. These trees can then be used to collect shoots from when grafting old trees and rejuvenate your plantation. When establishing new cocoa farms, avoid areas that are known to have black pod infested soil.

### 2. Do regular field inspections

Inspect field regularly to remove diseased pods (see field guide on sanitary harvesting). Trees that died due to tree canker should be cut down and destroyed.

### 3. Harvest regularly

Regularly harvest ripe, healthy pods to prevent post-harvest losses. Even minor infections can cause spoilage.

### 4. Improve air flow in the plantation

To reduce disease incidence, seedlings should be planted well apart and in well-drained sites. This works because black pod disease needs high humidity for fast development. Thin the cocoa tree canopy and remove shade trees where necessary – but take care not to make gaps in the canopy to avoid attracting mirids (see “Pruning older cocoa trees” and “Impact of shading on humidity in a cocoa farm”). Weed regularly, especially at the beginning and during the wet season to reduce humidity in the cocoa farm.

5. Remove soil on cocoa trunks

Look for soil tunnels built by ants on the surface of cocoa trunks and remove them. This removes two sources of disease: spores carried in infested soil and those carried by the ants themselves.

6. Promote soil health

Soil health and general good crop management are essential. Soils contain the food for the cocoa trees, but also can contain disease. 'Healthy soils' have lots of organic matter and good drainage. Having a good drainage system means that the spores cannot spread in puddles of water. This reduces the level of disease in soils.

7. Apply correct fungicides using correct application methods

Fungicides will only work well in combination with some of the cultural options listed above. For example, when using fungicide in a farm that has been well pruned, one could reduce fungicide and labour costs by spraying only pods (so-called spot applications) (see technical bulletin on rational pesticide use). Copper compounds and metalaxyl are widely available fungicides that are effective. But care must be taken when applying these products, as they are poisonous to humans too! In the case of tree cankers, scrape off the bark from infected areas and spray only that area with fungicides.

## Cocoa Swollen Shoot Virus (CSSV)

### Importance

- Cocoa swollen shoot virus is a serious problem of cocoa production in West Africa. When severe, this disease can kill cocoa trees within 2 to 3 years.

### Symptoms

- This disease is caused by a virus, which is injected into cocoa by insects, (mealy bugs), that have fed on diseased trees. Just as mosquitoes transfer malaria from infected to healthy people, mealy bugs transfer cocoa swollen shoot virus from one cocoa tree to another. The virus is not spread through seed, but it can spread through grafting.
- Symptoms are difficult to see, but can be observed as leaf discoloration, stem and root swellings and/or pod deformation. On leaves one can see reddening and yellowing along the veins. Stem swelling happens in chupons, fans or branches. Root swelling can also occur (but difficult to observe!). Diseased trees start losing leaves and produce smaller, rounder pods.

### Farmer practices

When diseased trees slowly die, farmers tend to keep them in the hope that they will recover. Farmers are generally not aware that CSSV diseased trees are sources of infection for other cocoa trees in their farm.

### Control methods

- Farmers can contain the disease by cutting out infected trees and alerting neighboring farmers to do the same. This method is costly, but can be effective if done quickly and completely.
- One should remove the diseased trees as well as their neighboring cocoa trees (that might look healthy, but are expected to be infected with the virus). This works for small outbreaks. When more than 100 trees in any one area are diseased, the adjacent trees and any other cocoa trees up till 15 m from trees with disease symptoms should be removed.
- Alternative methods are using resistant cocoa trees when replanting cocoa. Check with your local cocoa research institute and find out about resistant varieties. When establishing new cocoa farms, where possible, plant trees away from known CSSV areas. Use natural barriers, such as are oil palm, coffee and citrus to prevent or slow-down the spread of the mealy bugs within cocoa farms.
- Using pesticides to control mealy bugs has so far not been very effective and is not recommended.

## Mirids (capsids)

### Importance

- Mirids are the number one insect pest on cocoa in West Africa. These insects use their needle-like mouthpart to pierce the surface of cocoa stems, branches and pods and suck the sap of the cocoa tree. While sucking, they inject toxic spit into the plant. This causes the dying of internal cocoa tissue.
- Infestation on cocoa pods results in minor direct losses, if any. Beans from these pods are generally not affected but may be a little smaller than without infestation. The many little scars on the pods are an easy target for black pod, which often causes more losses than the mirid itself.
- Attack on shoots and young branches reduces the canopy of a tree, and the tree becomes more vulnerable to other pests and diseases. Young trees can die within a year if attack is serious, and even mature trees can be affected very severely, to the point that they are almost dead.
- Losses can be as high as 30% or more if infestation is severe.
- Mirids are good flyers and they like semi-shaded cocoa and bright light zones best. They lay eggs in the skin of pods and other parts of the cocoa tree.
- In West Africa, it takes roughly 40 days for a mirid to develop from egg to adult. Adults are about 1 cm long and very slender.

### Symptoms

- Mirids prefer feeding and laying eggs on young shoots and new branches. Attack on a shoot can be recognised by the oval and oblong scars of about 4 -7 mm long on the bark. Leaves further down this shoot will die.
- Pods, if heavily attacked, show many black spots of about 1 – 4 mm, and the skin becomes brittle.
- Often the canopy of the tree will look poor and 'scorched' and will have denuded top branches with brown dead leaves on them.

### Farmer practices

It is difficult for smallholder farmers to combat mirids through pesticide applications. This is due to of the high cost of the most correct application method (using motorised mist blowers to get into the canopy of the cocoa trees). In addition, many of the previously registered, cheap mirid insecticides are no longer allowed on cocoa. A combination of practices is recommended below.

## Control methods

Mirids are a problem in farms where shade is thin or non-existent. This happens when shade or neighbour trees are felled, when cocoa trees die due to other reasons or when cocoa farms are rejuvenated. The following options are suggestions to avoid gaps in the canopy and manage mirids:

1. Maintain a complete canopy

In young plantings, temporary shading is needed, e.g. with bananas and plantains or with tree cassava. In mature cocoa farms, one should avoid shade or neighbour trees that attract mirids, such as kola trees.

2. Remove chupons regularly

Mirids are attracted to the young and soft shoots that cocoa trees grow throughout the season. Chupons that emerge at the base of trees should be removed regularly, not just during the peak mirid season. Do not prune too heavily as this will stress the trees and cause the growth of new chupons, which are a mirid feeding ground.

3. Maintain a healthy and balanced ecosystem

There are various natural enemies (or insects that attack pest insects, not the crop) that kill mirids. These are usually not so well known to farmers. The better-known example is the weaver ant. This weaver ant makes nests in the cocoa canopy and protects cocoa pods from mirids. The ant is aggressive and therefore usually not liked by cocoa farmers. But try this: rub wood ash on arms and hands to avoid ant bites! Natural enemies can help reduce mirids, but these friendly insects can't survive when pesticides are used intensively.

4. Rational pesticide use

Rational pesticide use will allow natural enemies to keep pest insects in check. If possible, only spray those areas in the farm that are attacked by mirids (spot application) and only when mirids are around (see "Determining mirid damage threshold for essential insecticide application" and "Improved spraying practice for mirid control"). More modern and specific pesticides, such as imidacloprid, are nowadays available, but these are expensive and not always available. Pyrethroids work, but they also kill off the good insects such as ants, so these must only be used as little as possible and only where mirids actually occur.

5. Mirid traps are being tested and may be used in future by farmers. There is also evidence that neem, a safe botanical pesticide, can help reduce mirid problems. Find out whether this is available locally and try it out on a small portion of your farm to see whether this works for you. Always use pesticides in combination with one or more of the other options to manage mirids, never as a stand-alone!

## Stem borer

### Importance

- The West African stem borer is a moth. Losses from this insect are usually low but a high number can seriously affect yields and tree health.
- If stem borers attack young trees, it can easily damage and kill the whole tree. Stem borer attack on older trees will, if the stem of the tree is seriously damaged, result in lower yields because of insufficient nutrient supply to the affected branches or to the whole tree.
- Stem borer has been said to spread as a pest in cases of heavy pesticide abuse on trees, which kills off the natural predators of this pest. However, from the late 1990s onwards, stem borer has becoming more noticeable, even on farms where no pesticides are used.
- A further problem is that the stem borer entrance holes also give entrance to diseases such as black pod.
- Stem borer is a slow spreading pest as it has a long life cycle. The pest appears to spread to neighbouring trees, which results in farms having areas with stem borer attack, while other areas appear untouched.

### Symptoms

- The stem borer creates the most damage in the caterpillar stage. In West Africa, this lasts about three months. During that time, the caterpillar grows and bores its way into the trunk, creating various tunnels.
- When the caterpillar is active inside the tunnel, a sticky sap may dribble down the bark from the entry hole. The caterpillars like moist wood and when tunnels dry out, they move to other parts of the tree.
- Once the caterpillar is full-grown, it turns into a cocoon, deep inside the tunnel. After a couple of weeks, the adult moth emerges and leaves the tunnel.
- The moth lives for only a few days. They don't eat, but mate and thereafter the females lay eggs (about 500 per female!). The eggs hatch and the tiny caterpillars spin silk threads, which they use as parachutes to be carried by wind to new sites, from which they start boring new tunnels.
- Attacked branches lose their leaves, dry out and die off.



## Farmer practices

Farmers easily recognise the entrance holes of the stem borer. Some farmers try to kill the stem borers inside tunnels using pieces of wire or sticks. This can give good results, if started as soon as entrance holes are seen but must be done carefully to avoid serious damage to trees. Other local practices exist, such as covering the entrance hole with mud to cut-off the oxygen to the stem borer caterpillar.

## Control methods

- Stem borer has been said to spread as a pest in cases of heavy pesticide abuse on trees, which kills off the natural predators of this pest. However, from the late 1990s onwards, stem borer has becoming more noticeable, even on farms where no pesticides are used.
- Maintain a healthy and balanced ecosystem to preserve natural enemies that kill stem borer caterpillars. Use pesticides rationally to keep insect pests in check and to preserve natural enemies of stem borer.
- Natural enemies of stem borer include is the woodpecker, which will peck out borers and the weaver ant. There are also parasites, tiny insects that lay their eggs into the caterpillars and develop inside. The caterpillars will not feed much once the parasites are inside, but will survive until the parasites emerge (they slowly die during the process or afterwards)
- Plant a barrier crop that is not attractive to stem borers, such as *Imperata* sp., *Leucaena glauca*, cocoyam, sweet potato or *Pueraria* species. The barrier must be at least 15 m wide and established early for new plantings.

## Termites (white ants)

### Importance

- There are types of termites that live in the wood of trees, and there are other types that mostly live underground.
- They attack seedlings or young trees at the base and without control, these will wilt suddenly and die. This type of damage can also happen to suckers of full-grown trees. In full-grown trees, some types of termites attack injured and dead wood. They may enter a wound higher up in the tree and spread downwards. Other types chew into the roots and tunnel up into the branch.
- Termites can attack living cocoa wood. They chew the wood, which causes openings for diseases, such as black pod.
- Termites will also attack shade trees in the farm, causing the same type of damage as on cocoa.
- In low numbers, termites are beneficial in cocoa farms because they break down plant material (stems, leaves, etc.) and recycle nutrients. They can also improve the soil structure through their tunnelling activities.

### Symptoms

Termites attack cocoa trees in two different ways. They attack young plants in nurseries or in older trees they attack the collar area, the tap and other roots and the stem base. This type of attack results in severe and sudden wilt if not noticed. Termites also attack chupons on the base of mature trees.

### Farmer practices

- A traditional method for removing mound-building termites is to break open the nest and remove the queen. Burning straw suffocates and can kill such a colony. Heaping wood ash around trees may help prevent termite attacks.
- Various home made botanicals have been tried: e.g. neem, wild tobacco and dried chilli. These need to be tested on small plots to check what works best locally.

### Control methods

There are various options to choose from, but it is important to test which works best in your location:

1. Use deep ploughing or hand tilling to break open underground nests. The termites are then exposed and dry-out or are picked up by birds or other predators.

2. Keep trees undamaged to make them less attractive to termite attack.
3. Scatter herbs or other plants that termites find poisonous or unpleasant around cocoa trees.
4. Ants are the greatest enemies of termites, so farmers should try to conserve ants in their farms as a way of managing termites.
5. Try spot application of botanicals, such as neem or others, rather than chemical pesticides (as chemical pesticides will kill off the natural enemies of termites and other pests).

## Rodents (squirrels and rats)

### Importance

- Rodents can cause a lot of damage in cocoa farms. Often, squirrels are more important than rats. Per day, one squirrel can attack up to 4 cocoa pods. A rat on average takes one whole week to attack up to 4 pods. Note however that rats alone have been reported to damage more than 9000 pods per hectare!
- Rats like ripe pods. This means that farmers need to search for rats when pods are ripening. Squirrels like heavily shaded farms. Both squirrels and rats prefer badly maintained farms.

### Symptoms

- Squirrels bore oval shaped holes away from the stalk. They make large chips.
- Rats bore round, oval shaped holes near the stalk. Rats make smaller chips than squirrels.

### Control methods

- A combination of good practices will help keep rodents away. These must be implemented on a large area as rodents reproduce and spread quickly. So, whole villages should work together, if possible.
- Good farm management (weeding, light shade management, timely pruning, etc) is important.
- Barn owls are great enemies of rats. When barn owl nest boxes were established in cocoa plantations in Malaysia, rat damage was reduced to a minimum.
- When rodents attack more than 4 out of 100 cocoa pods, farmers may want to think about chemical control. Rodents can be baited and killed with poisoned wax blocks (containing *brodifacoum*, *bromadiolone* or *warfarin*), put around the base of shade trees. But be careful to avoid poisoning children, farm animals and barn owls. Another problem is that rats adapt and learn quickly - after a while, they won't eat the bait anymore!

## Mistletoe

### Importance

- Mistletoes are plants that live on other plants (parasite). There are different types of mistletoe on cocoa in West Africa. The main type has red flowers and berries. Another type has yellow flowers and blue fruits.
- Through their special roots into the cocoa tree, they take food and water from the cocoa tree, and cut off the supply to the rest of the cocoa branch. They cause dieback of cocoa branches, loss of cocoa tree strength and reduced yield. Without control, they kill the tree.
- Mistletoe in cocoa provides a habitat for a certain species of ants that protects mealy bugs, a pest that transmits cocoa swollen shoot virus. The presence of mistletoe also favours infestation by mirids.
- Birds eat the berries and spread the seeds with their excrements. It is also thought that rodents (squirrels, porcupines), as well as cocoa pruning and harvesting equipment spread mistletoe seeds.
- The seeds will not germinate in shade.

### Symptoms

- Infested trees tend to occur in clusters.
- Heavy infestation by mistletoe is more common in poorly maintained farms with little or no shade.

### Farmer practices

- Pruning mistletoe is labour intensive, but farmers know that without control there will be serious yield losses. On the other hand, a disadvantage of too much pruning can be that gaps occur in the canopy. These encourage re-growth of chupons and attract infestation by mirids.

### Control methods

- In general, cutting-out mistletoes is recommended every other year. In heavily infested farms, cutting-out should be done each year until the infestation becomes more manageable.
- Pesticides are not effective and not recommended as it is impossible to apply them safely and efficiently.

## Cocoa dieback

### What is dieback?

Dieback is a general term used to describe the decline in the health over time of a cocoa tree. It is not a specific disease but a symptom of various related or unrelated problems, some of which can be controlled. Some causes of dieback that can be controlled include: mirids, canker, poor soil fertility. Old age, root disease and cocoa swollen shoot virus are causes of dieback that cannot be easily controlled but require replanting.

### Symptoms

The symptoms of dieback vary by cause as follows:

- Poor soil fertility
  - Gradual decline in production over a number of years
  - Decline in tree health, vigour and canopy over a number of years
  - Where there are no signs of mirid, canker or root disease problems, soil fertility is likely to be the problem
- Old age of trees
  - Symptoms are similar to those of poor soil fertility
  - Applying fertilizer use does not have much effect
- Root disease
  - Symptoms are similar to those of poor soil fertility but production declines faster
  - Rotting roots caused by old, decaying root systems from other (non-cocoa) trees often when trees are still young (from planting to a few years)

For symptoms of black pod (canker), mirids, and cocoa swollen shoot virus, see technical bulletins.

### Control measures

- Poor soil fertility
  - Apply appropriate fertilizer (see technical bulletin on applying fertilizer to cocoa trees) and monitor for recovery, which may take one or two years depending on the soil degradation
  - Note that replanting will not help when soils are exhausted
- Old age of trees

- Regeneration through growth of basal chupons, with or without grafting of improved planting material to replace the whole tree or replanting
- Replanting may work as the soil is, to some extent, still fertile
- Root disease

If the roots are not badly affected and the larger roots near the trunk are not damaged at all, you can do something to improve the situation.

1. Cut and remove the infected roots
2. Clean the stumps with acid tar and wipe them with a "collar protectant" (tridermorph) before filling the holes in the ground.

If the cocoa tree is dead because of root disease:

1. Remove infected trees and roots.
2. Dig a drainage ditch around where the infested tree stood to prevent roots from nearby cocoa trees from infection. The ditch must be 45 cm deep and 30 cm wide.

Before planting cocoa, always remove tree stumps or big roots and make sure that the planting hole is free from tree stumps or rotting roots.

See technical bulletins on and black pod disease, mirids and cocoa swollen shoot virus for control measures related to those specific problems.

## Rational pesticide use

### Problems with pesticide use

- Many cocoa farmers in West and Central Africa use pesticides to reduce pests because several methods may be needed to control cocoa diseases and insect pests such as black pod and mirids.
- Many cocoa farmers abuse pesticides because they:
  - Use poor spraying equipment (badly maintained with unsuitable nozzles)
  - Do not have information about which pesticides to use, and
  - Do not properly protect themselves when applying pesticides (see “Spray dye exercise”).
- As a result, many farmers waste a lot of pesticide and use more than necessary, with little effect on disease and insect pest infestation. The result is unnecessary expenditure and use of labour.
- Lack of farmer protection when applying pesticides can lead to health problems and improper use of pesticides can cause damage to the environment, especially by killing off the good bugs and other animals in the ecosystem.

### What is rational pesticide use?

- Rational pesticide use includes:
  - Selecting the most effective, but least poisonous pesticides
  - Improving how pesticides are applied
  - Improving when pesticides are applied.
- One of the primary objectives of rational pesticide use is to reduce farmers' dependence on pesticides, especially those pesticides that are highly poisonous and harmful to all insects, whether pests or beneficials.
- Pesticide use may sometimes be necessary, but it must be combined with sound crop and pest management practices and based on tree health observations.
- When farmers apply rational pesticide use principles, they may be able to reduce the amount of pesticides used, save money, increase their yields and protect human health and the environment from the negative effects of pesticides.

### Decision steps for applying pesticides to cocoa in the field

#### **1. See if there is a problem**

Question: Is there a problem on my farm?



Action: Inspect your farm regularly for signs of insect damage or disease symptoms.

## **2. Find out what you are trying to control**

Question: What is causing the problem-- insects, animals, disease, not enough water, too much water etc?

Action: Inspect the farm in more details to find the cause of the problem. Get advice from other farmers or an extension agent. If it is a insect or disease, identify which the specific insect or disease.

## **3. Decide whether the problem is serious**

Pesticides are expensive and could be harmful to you and the environment. Decide if the problem is serious enough -- or will become serious enough-- to justify spending time and money to control it.

Question: Is the pest problem serious? Should I act now, or watch and wait?

Action: For some pests like mirids, follow the guidelines which tell you how to decide when to use insecticides.

## **4. Decide whether you need to use pesticides**

Applying good farm sanitation practices can help to control pests. No one pesticide can control all pests. Before you use a pesticide, be sure it will control the pest that is damaging your crop.

Question: Is using a pesticide the best way to control this pest? If so, do I have the right pesticide for the job?

Action: Start by applying good farm sanitation practices. If you see no results, consider using pesticides. For some pests like mirids, follow the guidelines which tell you how to decide when to use insecticides.

## **5. Select the right pesticide**

Questions: Am I using a suitable product for cocoa? Is it on the recommended list for controlling the problem I have? Is there enough time to apply the pesticide before harvesting time?

Action: Get advice from an experienced farmer, extension agent or agrochemical dealer on which product is best for your problem. Look over the list of recommended pesticides to see if the product is on the list. Read the label on the container carefully.

## **6. Apply the pesticide correctly and safely**

Questions:

- Have I been trained on how to use pesticides?
- Am I following all the instructions on the label?
- Am I using the right type of sprayer and nozzle?
- Am I wearing the right clothing and protective wear?
- Do I know how to take care of my spraying equipment?
- Do I know what to do after spraying (how to handle the equipment, empty containers etc)?

Action: Get training from an experienced farmer, extension agent or another source on how to apply pesticides correctly and safely.

### Recommended pesticides

Pesticides are classified into 3 classes that tell how hazardous (poisonous) they are:

Class I-- Extremely hazardous	DO NOT USE (For example Thionex (Endosulfan))
Class II-- Moderately hazardous	Take great care when using
Class III--- Slightly hazardous	Take care
Class 1V---Unlikely to be hazardous	Take care

Only cocoa that has been sprayed with class 2, 3 or 4 pesticides can be exported to Europe, the United States and Japan.

The government will decide which pesticide can be used in your country. However the following table indicates pesticides that are permitted for use on cocoa.

### Permitted pesticides for cocoa

Common name	Active ingredient	Class indicating how poisonous the product is
<b><u>Fungicides</u></b>		
Kocide	Copper hydroxide	3
Nordox	Copper oxide	2
Ridomil 72 WP	Metalaxyl and copper oxide	2
<b><u>Insecticides</u></b>		
Confidor	Imidacloprid	2
Decis 25 EC	Deltamethrin	2
Akate Master	Bifenthrin	2
Actara 25 WG	Thiamethoxam	3

### Reading pesticide labels

It is important to read pesticide labels (or have someone read it to you) because the label tells the name of the product, what the pesticide is used for, the ingredients, expiry date, how to mix, apply, store and dispose of the product, the pre-harvest interval and what to do in case of emergencies. Do not use pesticides that do not have a label or if you are uncertain of the origins.

### **Using pesticides more efficiently**

There are three things that farmers can do to use pesticides more efficiently:

#### *1. Select the least dangerous pesticides available*

Where possible, use products that control the pest you are targeting, without harming the good insects and other plants and animals. These are called specific pesticides.

Read the label on the pesticide and ask:

- Is it the best pesticide for my problem?
- How safe is it? (see the above table of recommended pesticides)
- How much should I mix into my spray tank?
- Are there any other important precautions I should take?

#### *2. Target the application of pesticides*

Make sure that the pesticides reach the part of the tree (pods, leaves etc) where it will have the most effect (see “Improved spraying practices for mirid control”).

#### *3. Better timing of treatments*

Apply the pesticides at the right time to have the most effect on the disease or pest. For some pests, mirids for example, instead of spraying on a calendar basis, you can use damage thresholds to decide when to spray (see “Determining mirid damage threshold for essential insecticide use”).

## Reducing pesticide residues in cocoa

### What are pesticide residues?

When pesticides (fungicide, insecticide, herbicide) are applied to cocoa (or any other crop) in the field and during transportation and storage, some of the pesticide remains in the crop and is taken in the bodies of humans who eat the crop as food. The pesticide that remains in the crop after harvesting is called pesticide residue.

### Regulations on pesticide residues

Eating chocolate that has a high level of pesticide residue is harmful to human health. To protect people's health, countries that eat a lot of chocolate (Europe, Japan, United States etc) have established guidelines on the maximum level of pesticide residue they allow in cocoa imported into those countries. All cocoa going to Europe, United States and Japan is now tested in those importing countries and in some African countries to see whether it contains the level of pesticide residues allowed. Cocoa which contain more than the maximum pesticide residue (MPR) allowed is rejected.

To ensure that cocoa from your country is not rejected because of high pesticide residues, farmers, traders, transporters and exporters need to follow set guidelines.

### Guidelines for farmers

To avoid high pesticide residues, cocoa farmers need to:

- ✓ Apply the right pesticide (s) to solve the problem
- ✓ Apply only recommended pesticides
- ✓ Apply the pesticide in the right way (see "Calibration and performance of sprayers, improved spraying practice for mirids, spray dye exercise)
- ✓ Apply the pesticide at the right time to effectively control the pest (see "Determining mirid threshold damage for essential pesticide application")
- ✓ Apply the pesticide before the pre-harvest interval (PHI): The pre-harvest interval is the minimum permitted number of days between the last spray and harvest. The PHI is different for different pesticides. For example, the PHI for some fungicides is one month.

## Applying pesticides safely and effeciently on cocoa farms

### Basic sprayer maintenance and repair

- Use a robust sprayer. A cheap sprayer may not save you money in the long run if it does not last long.
- Using plain water, check pump operation – does the nozzle produce a spray? If not, check diaphragm/piston, valves, seals and make sure filters are not blocked.
- Check all hose clips, unions and seals for leakages before starting to spray. Use plumber's tape (Teflon or similar) and/or cut up old bicycle inner tubes to make repairs if spare parts are not available. Check seals, gaskets, hoses etc. regularly (2-3 times per season) for wear.
- Does the nozzle produce a fine spray? If not, it may be worn. Does the nozzle/lance/trigger valve leak? If any do, repair with plumber's tape or rubber seals.
- Check straps and fixings to make sure they are comfortable and not broken. Repair/replace as necessary. This is important and can make spraying much easier.

### Good practices when mixing and applying pesticides

- Select your target – what are you trying to control? Where does the spray deposit need to go?
- Select the right nozzle for the job. For a sprayer fitted with variable hollow cone nozzle, decide what setting should be selected. Squirting high targets with a jet is usually wasteful. Remember, the high flow rate leads to bigger droplets, causing a greater risk of run-off (dripping from pods or leaves). When there is run-off, most of the pesticide will end up on the soil surface, rather than on the pods or branches where you need it!
- Calibrate the right amount of water (volume rate) and pesticide (see “Calibration and performance of sprayers”). How many trees per tank load? How many tank loads (thus litres) are required to spray the whole farm?
- Use proper application technique. Be systematic about treating trees. Are all the pods being sprayed effectively?
- Watch for dripping from the pods or leaves. This means you are wasting pesticide.
- After spraying, clean out the sprayer thoroughly first with water and then use a small amount of soap. Don't forget to wash yourself and your clothes thoroughly.
- 7. **Never** allow children to mix or apply pesticides. They should not even be around when these activities are taking place, as they are more likely to be harmed by exposure to pesticides than adults.

## Safe pesticide use

Farmers are most likely to be exposed to pesticides when:

- Mixing and loading. Farmers must handle concentrated pesticides to measure the amount they need. Then they must dilute it and pour it into the application equipment.
- Using hand-held application equipment. Farmers must walk near spray mists and dusts. If they are treating a large area, they might walk through or very near an area they just treated. If they touch treated plant parts, some of the pesticide might transfer onto them or their clothing
- Using equipment not designed for the job. Farmers who do not have sprayers might be exposed to pesticides when using the wrong kind of devices to apply pesticides to plants.
- Cleaning equipment

## Best practices for safe pesticide use

- Wear protective clothing when using pesticides including gloves, long trousers and sleeves, closed shoes, an eye or face shield and a hat
- Wear rubber/plastic gloves to protect your hands. Use gloves that are long enough to protect the forearms as well as the hands and make sure that there are no holes in the gloves. Do not use cloth or leather gloves as these materials absorb pesticide. Do not use cloth-lined gloves as the lining will absorb pesticides. Wear the shirt over the gloves when mixing, filling the applicator, applying pesticides and when cleaning up to prevent the liquid from running down your arm and into the glove. Wear the shirt inside the gloves when spraying upward.
- Eye and face mask protect the eyes and mouth. Wear a mask when mixing and applying pesticides. Putting a handkerchief over your mouth will not protect you from the pesticide.
- Wear boots during all parts of pesticide application to protect your feet. Make sure to wear the trousers over the top of the boots and not tucked into the boots when mixing and filling the applicator.
- Do not eat, drink or smoke when using pesticides
- Only use recommended pesticides
- Use a good quality sprayer that does not leak. Check your sprayer for leakage before spraying
- Be aware of wind conditions and direction when you spray to protect yourself from pesticides

- After use, bury pesticide containers in a pit at least 50 m from water sources (rivers, streams, bore holes, dams etc) and as far as possible from children's play areas and domestic animals. Put flattened containers in layers or 10-15 cm deep and cover.
- Avoid reusing pesticide bottles. It is difficult or impossible to rinse all of the pesticide residue out of a container.
- If a pesticide container is re-used for drinking water or for preparing food, it might cause people who drink the water or eat the food to become ill -- or even die!
- After spraying, clean out the sprayer with soap and clean water
- Wash yourself and your clothes

## Farm maintenance

### Importance

- Both young and mature cocoa farms need regular maintenance. Maintenance includes:
  - Pruning
  - Tree and farm sanitation (removing dead and diseased pods, mistletoes, mosses and epiphytes, cocoa husks, stagnant water etc from the tree and farm)
  - Applying fertilizers
- Maintenance is important because every activity carried out on a cocoa farm affects other aspects of the farm. The following activities are related to each other:
  - Planting
  - Weeding
  - Pruning
  - Farm sanitation
  - Spraying
  - Applying fertilizers
  - Harvesting
  - Marketing

The following situation shows how activities carried out on a cocoa farm are related:

If seedlings are planted too close together, the young trees will compete for sunlight and will become very tall. Tall trees cannot be pruned, sprayed or even and harvested easily.

Because it is difficult to harvest the good pods and remove the diseased pods, and because the trees are too tall to reach by spraying, there will be many pests and diseases.

Applying fertilizer to tall trees will lead to more pods as well as more branches and leaves, especially at the top of the trees. However, the farmer will not benefit from the increased number of pods as they will be difficult to harvest.

Pests or diseases that occur high in the tree may also affect those pods that the farmer is able to harvest, and the quality of the beans may not be good. Poor quality beans are more difficult to sell, and the price may be lower.



## Pruning

### Importance

- Cocoa trees produce more branches and leaves than they need in order to be strong enough to compete with other trees. The more branches a tree grows, the more energy and “food” it must provide to these branches which reduces the size and number of pods that reach maturity.
- The best cocoa tree has one stem only and two or three main branches, with enough side branches and leaves to capture most of the sunlight. Removing unnecessary branches by pruning is therefore important for increasing production and reducing pests and diseases.
- Pruning leads to:
  - Reduced pests and diseases and therefore increased production: Tall trees with a lot of branches attract rats and squirrels. Black pod disease spreads quickly in the warm, humid atmosphere found in unpruned cocoa farms. In addition, there are often more diseased and dead pods in unpruned farms where the disease can live. Pruning reduces the number of unnecessary branches, and allows more light and wind to pass through the branches which reduces pest and disease levels.
  - Easier pesticide application: In well pruned farms, it is easy to see all the pods: the diseased and dead ones, as well as the ripe ones. Because all pods, and most of the branches can be seen, you can more easily judge if there is a disease or pest problem that needs treatment. It is easier to spray pesticides on pods, branches and leaves that you can reach, which saves time, chemicals and money.
  - Easier harvesting: You will get more profit from your farm if you harvest all pods on a regular basis. It is difficult to harvest pods that are very high up in an unpruned tree.

### Best practices

There are three types of pruning: architecture, shape and maintenance pruning.

- Architectural pruning is done when trees are young (up to 4 years of age). The purpose of this type of pruning is to make sure the trees do not grow too tall, and have the right shape. If trees are not properly pruned at this age, they will become too tall for you to properly manage.
- The purpose of shape pruning is to give cocoa trees a shape that allows them to capture the most sunlight with the fewest branches, without leaving holes in the canopy (see “Pruning older cocoa trees”). This is done by removing branches that trees do not need.

- Shape pruning is best done at the beginning of the rainy season, after most leaves have dropped and trees have no pods yet. Leave enough branches and leaves to make sure little or no sunlight reaches the ground, as this will increase weeds. You can prune cocoa trees more severely when there is shade from other trees
- Removing new shoots and new branches that are not needed for the health and strength of the tree throughout the year is called maintenance pruning. This type of pruning can be done at any time of the year.
- Tall trees take more effort to prune than small trees, but it is worth the effort. If trees are too tall to prune (or even to harvest), consider rehabilitation options (see “Deciding to rehabilitate or renew a cocoa farm” and the technical bulletin on rehabilitation).

## Farm sanitation

### Importance

- Farm sanitation means removing unnecessary or unwanted things from the farm. This includes:
  - Dead, diseased or damaged pods
  - Dead branches and trees
  - Weeds
  - Mistletoe
  - Chupons
  - Piles of cocoa husks
  - Stagnant water
- Removing damaged, diseased and dead pods, dead branches and decaying tree stems regularly helps to reduce diseases.
- Removing mistletoes improves tree health, as these plants reduce the amount of food and water getting to branches and pods.
- Weeds, such as grasses and ferns that grow on the tree, compete with cocoa trees for nutrients and water from the soil. Weeds also increase humidity in the farm. Too many weeds on a farm make it more difficult to remove dead and diseased pods, branches etc. that may carry pests and diseases.
- Moss holds moisture that increases the risk of black pod disease and tree canker. Because moss covers the bark of the stems and the tree, it stops flowers from growing on the bark, which reduces the number of pods produced.
- An epiphyte is a type of plant that grows on another plant or object but is not rooted in soil. These plants do not drain the water, energy or nutrients from cocoa trees, as they get nutrients from the air and other sources. Some mosses and ferns are epiphytes. Epiphytes are only a problem when they cover the bark and stem of a tree, stopping flowers from growing or when they create high levels of moisture on tree stems that encourage black pod disease.
- Because chupons take up a lot of food and energy from the tree, which is not good for production, they should be removed.
- Where black pod disease is a problem, cocoa husks should be moved away from the farm. Those husks can be used to make compost somewhere else and used as fertiliser on the cocoa farm. Where black pod disease is not a problem, cocoa husks can be spread around the cocoa trees where they will decay and fertilise the trees.
- Cocoa trees standing in pools of water will often become unhealthy. Stagnant water may also encourage the spread of black pod disease. Remove stagnant water by digging small drainage canals.

## Farmer practice

- Many farmers are not aware of the need to remove unnecessary or unwanted things from their farms. For example, some farmers only weed once instead of the recommended least twice per year: during the rainy season, and after the short dry season.
- Some farmers do not remove chupons because they believe that more stems and branches will give them higher production. These farmers do not realize that extra stems and branches compete with cocoa pods for water and food. The result is lower production.
- Other farmers do not prune their trees because they believe that pruning harms the trees. Some believe that tall trees are stronger and healthier. These farmers do not know that shape pruning is only done at the beginning of the rainy season when there is no risk of stress on the trees.
- Other farmers do not do farm sanitation practices because they do not have enough labour.

See field guides for best practices on how to remove chupons and moss and apply fertilizers.

## Understanding soil nutrients for improved management of cocoa farms

### Importance

The soil is like a “pantry”, a place in people’s homes where food is stored. In order for the family to be able to eat, the pantry needs to have food in it. Similarly, if the soil is “tired” or all the nutrients have been removed from it, the “pantry” is empty. Putting nutrients back into the soil is important to ensure that the soil is healthy. But unlike a pantry in the house, the soil has to serve many generations of farmers---our children, their children, their children’s children and so on. This means that the soil/land does not belong to us but is on loan to us by future generations.

The cocoa tree uses nutrients in the soil to grow and to produce beans, leaves, roots etc. It is important to understand the functions of the major nutrients.

### Key nutrients and their role in the cocoa plant

Plants like humans need different types of foods or nutrients. Soil is made up of different nutrients and micronutrients which are need for plant growth. The key nutrients are Nitrogen (N), Phosphorus (P), Potassium (K) Magnesium (Mg), Zinc (Zn) and Boron (B).

### Nitrogen

Nitrogen is needed for growth of the cocoa tree, flowering, leaf growth and development of the beans. If nitrogen in the soil is low, almost all plant functions are disturbed and the most direct result is that plant growth is slowed down and the leaves are pale green or yellow. Too much nitrogen produces a lot of leaves and increases humidity in the field, contributing to more black pod disease. Because of this nitrogen fertilizer is generally not recommended for use in West Africa. However, in some areas, there is need to apply nitrogen to cocoa fields. A new, improved mineral nitrogen fertilizer for cocoa trees is now available in some countries.

### Phosphorus

A good level of phosphorus is important for many functions of the cocoa tree, especially blooming, root growth and maturation. Phosphorus levels are sufficient in nearly cleared forest soils but drop over time as the cocoa crop is harvested and husks are removed from the farm. With each harvest, the soil becomes more acidic and making it difficult for the tree to take in phosphorus.

### Potassium

Potassium is important for moving nutrients around the tree, for tree health and pod growth. Like phosphorous, potassium levels are high in nearly cleared forest soils but

drop over time as the cocoa crop is harvested and husks are removed from the farm. Most of the potassium is in the cocoa husks. You will notice that when husks are left near banana stands, the bananas grow very well. This is due to the potassium in the husks.

### Soil mining

When farmers harvest cocoa pods and beans and take them away from the farm, they are removing nutrients taken from the soil. This is because the cocoa beans and the pods contain nutrients. The table below shows how many kilos of each nutrient is removed from the cocoa farm with each ton of dry cocoa beans.

Kilograms of nutrients in cocoa beans and husks removed from the field with each ton of dry cocoa beans, West Africa

	<b>Nitrogen</b>	<b>Phosphorous</b>	<b>Potassium</b>	<b>Magnesium</b>	<b>Calcium</b>
<b>Kilograms</b>	34-40	11-15	60-103	11	5-12

Over many years, if nutrients are not added back to the soil, a process called “mining” (removing nutrients from the soil without replacing them) takes place. Soil mining is like removing gold or other precious minerals from the soil without putting anything back. It leads to low yields. While soil mining may not cause nutrient deficiency problems this season or next season, over time the soil will become deficient in one or more critical nutrient.

Besides nutrients, other things in the soil contribute to making the soil healthy. These include the level of organic matter in the soil, soil pH and the number of microorganisms.

### Soil organic matter

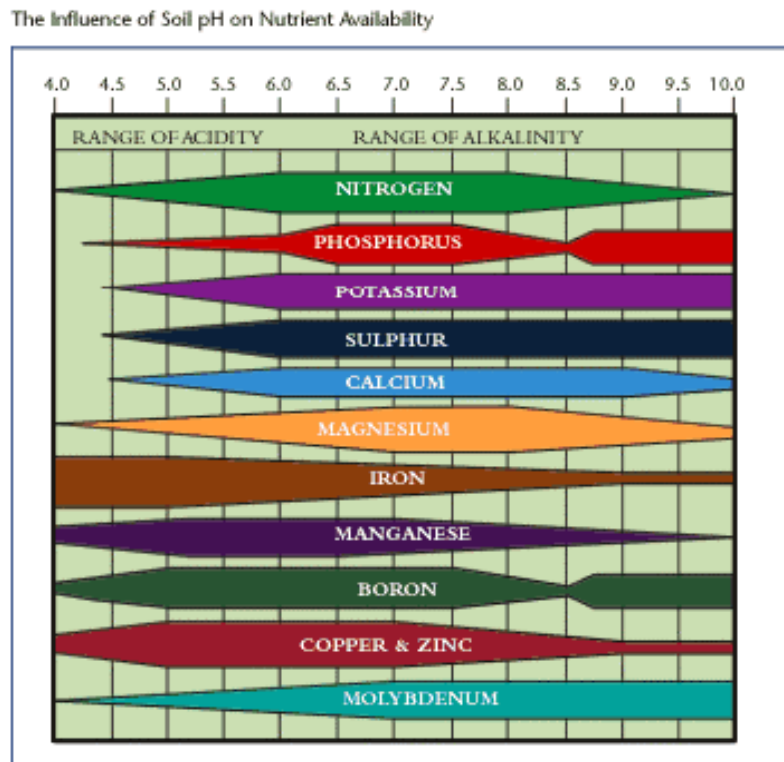
When plants and animals die, their remains are incorporated into the soil. These form what is called soil organic matter which gives soils their dark color. Soil organic matter is very important for the level of nitrogen in the soil.

### Soil pH

To understand how nutrients affect plant growth, you have to understand the role played by soil pH. The “pH” of a soil tells how “**acid**” the soil is. PH is measured in numbers from 4 (very low or acidic) to high or 10 (very high or **alkaline**)

Soil acidity does not hurt the plants directly, but rather, it affects the **availability** of nutrients to the plant. Availability means the ability of the plant to take in the nutrient. This means that when soils are very acidic, some nutrients are nor readily available to plants.

As the table below shows, some nutrients are more available to the plant when the soil is more acidic. Others such as nitrogen, potassium, are more available when the soil is more alkaline.



Source: J. Joffre

Cocoa trees need a pH of 5 and above for good nutrient intake. Organic matter helps to prevent pH from going too low.

### Microorganisms

Microorganisms are tiny things that live in the soil. They play an important role in making nutrients available to plants by helping to decompose organic matter. Plants do not take up organic forms of nutrients. They can only take up nutrients in mineral forms. Microorganisms play the role of breaking down organic matter which can then be taken up by plants. To understand how nutrients become available to plants, it is important to know that only when microorganisms die are the nutrients from their decomposing bodies broken back down into small molecules and freed into the soil to be taken up by the plant roots.

## Applying fertilizer to cocoa trees

### Importance

Fertilizers can increase cocoa yields. If applied correctly in the right place, in the right dosage, fertilizers can:

- Substitute (take the place of) missing food nutrition
- Increase flowering and pod growth
- Help to make and keep a tree healthy and promote tree growth

### Types of fertilizers

Fertilizers are used to address different types of soil nutritional deficiencies. They also put back in the soil the nutrients removed when we harvest the field.

There are two main categories of fertilizers: those made by factories (**inorganic** or **mineral** fertilizer) and those made from plant or animal products such as manure or compost (organic fertilizers). Fertilizers for cocoa are applied to the ground (see field guide xxx).

There are three categories of inorganic fertilizers:

**1. Single fertilizer.** Some examples of single fertilizers are: urea, ammonium sulphate, super sulphate (SP36), TSP for Phosphorous, KCL for Potassium, Calcium Nitrate. This type of fertilizer should only be used if you know exactly what type of nutrient your trees need or if a single fertilizer has been recommended by a fertilizer company or extension agent for your local area.

**2. Mixed or bulk blended fertilizer.** This type of fertilizer consists of a mix of two or more single fertilizer and should only be used if you know exactly what type of nutrients your trees need. Popular mixed fertilizers include: Urea + KCl, KCl + SP 36, Urea, KCl, SP 36. For cocoa, this type of fertilizer provides phosphate (P), potassium (K) Calcium (Ca) Sulfur (S) Magnesium (Mg) and Zinc.

**3. Compound fertilizers:** These fertilizers are mixed by fertilizer factories. Well known compound fertilizers include: Nitrogen, Phosphate, Potassium (NPK) or Nitrogen (N), Phosphate (P), Potassium (K) and Magnesium (Mg) in various dosages. In some countries, a special cocoa fertilizer is available. This fertilizer contains:

- Phosphorus (P), written on the bag as P205
- Potassium (K), written on the bag as K2O
- Calcium (Ca), written on the bag as CaO
- Sulfur (S)
- Magnesium (Mg), written on the bag as MgO



Chicken, goat or cow manure are all good fertilizers for cocoa trees because they provide many kinds of nutrients. However they are not very concentrated in strength and it is difficult to get a large quantity for the whole farm.

Compost, a type of fertilizer made from leaves, branches, food left-overs, animal manure, is also good for cocoa trees. See the field guide “Making compost” to learn how to make compost.

The main disadvantage of using compost to fertilize cocoa farms is the amount of labour required to prepare and transport it and the large quantities needed for cocoa farms. It may also be very difficult to obtain the amount of manure needed to fertilize an entire cocoa farm. Compost and manure are therefore recommended for use on small cocoa farms.

### **Choosing the right fertilizer and the right application time**

Some farmers waste fertilizer by applying the wrong type at the wrong time using dosages that are too small for maintaining soil fertility.

Apply fertilizer at the start of the rainy season. Rain dissolves fertilizers and brings them into the soil, near the roots, where they can be absorbed by the trees. Never apply fertilizer during the long dry season. If there is no rain, fertilizers cannot be absorbed by the roots.

It is advisable to apply cocoa fertilizer twice a year:

- ✓ Start of the rainy season (April-May): Apply half of the recommended quantity. Cocoa trees grow new branches and leaves at the start of the rainy season. Several nutrients are important at this stage.
- ✓ Start of pod production (late August-early September): Apply the second half of the quantity. When trees start producing pods after the short dry season, they need more potassium.

If it is not possible to apply cocoa fertilizer twice, use one application at the start of the rainy season (April-May)

### **Calcium Nitrate**

This type of fertilizer should only be applied if the farmer has applied special cocoa fertilizer and is implementing good management practices such as pruning, weeding, sanitary harvesting etc. Never mix base fertilizer and calcium nitrate.

It is advisable to apply calcium nitrate in July, during the short dry season. This type of fertilizer dissolves with the moisture in the air at night.

## **Fertilizer dosage and application**

The right dosage of fertilizer is different for each farm, as it depends on the age, size and health of the trees, how fast they grow, how many pods they produce, the shade regime of the farm, the soil health and fertility, the rainfall pattern etc. At the same time, the farmer can make the decision to adjust the level the dosage according to his/her farming practice.

The recommended dosage for cocoa fertilizer is 3 bags per acre.

Carefully read the label and instructions on dosage and timing of application or ask an extension agent for information. Remember, if you use more than the right dose you are wasting money, because the tree won't be able to absorb all the fertilizer. If you are not sure what dosage to use on your farm best, use the recommended dosage given on the fertilizer bag.

The best way to measure how much fertilizer you need, is to use a can (use the same can every time) to measure fertilizer. Find out how many grams of fertilizer fit in the can. Measuring by handful is not precise.

Never apply fertilizer close to the trunk of the tree but use the ring method (see field exercise applying fertilizer) or broadcast the fertilizer, taking care to broadcast under the tree's canopy.

Never mix ammonium-based fertilizers (ZA) with SP36 or other single fertilizers. Never mix Calcium Nitrate and TSP.

**Never** allow children to be involved in applying fertilizers.

Always store fertilizer in a dry place. If possible, use all of the product at one time. If some remains, keep the bag closed to prevent air coming in contact with the fertilizer.

## Harvesting, pod storage and breaking

### Importance of correct harvesting practices

- Harvesting is the start of the post-harvest process that determines the quality of the beans to be sold, which will be used by the cocoa and chocolate industry. Getting any of the post-harvest steps wrong can lead to poor quality beans.
- If you harvest too early, or too frequently, you are likely to collect unripe pods. Pods that are still green or partly green have more solid pulp (with less sugar content) and the beans may be hard to break up. Unripe pulp gives rise to clumps of beans and leads to poor fermentation.
- Harvesting early in the season and at the end can mean that you will not have not enough pods/beans to make a good fermentation heap
- Harvesting too late leads to the pulp drying up, and in extreme cases, the beans may start to germinate. Lack of pulp will not give a good fermentation. Also, germinated beans will not ferment well, and the hole caused by the emerging shoot will allow mould inside the bean.
- Before fermenting, you can store unopened pods for no longer than 5- 7 days as storage allows the pulp to increase in sugar content, which causes faster fermentation. Storing pods for longer than 7 days may allow mould to damage the beans and/or encourage the beans to germinate.

### Farmer practices

- Some farmers harvest pods too early for various reasons including the desire to sell their cocoa quickly to get money. This leads to poor fermentation. Other farmers delay harvesting due to lack of labour, waiting for the rains to stop or for other reasons. Harvesting late may lead to poor fermentation and loss of beans as a result of mould and germination. Leaving over-ripe pods on trees also encourages disease.
- Some farmers damage the beans when using a machete for pod breaking by cutting too deeply. Damaged beans should be thrown away.
- Children should never use machetes to break pods, as they may injure themselves. They may be involved in pod breaking after school, using a short stick.
- Many farmers store pods for too long which may cause the beans to start to germinate.

## Fermentation

### Importance

- Proper fermentation is important because it stops germination and gives the beans a good taste when roasted.
- Fermentation is necessary to begin the process of developing the cocoa/chocolate flavour needed by chocolate manufacturers. Cocoa/chocolate flavour develops fully when beans are roasted. When you roast unfermented beans, the beans taste horrible!
- Flavour development begins when the temperature of the beans is raised to a high enough level during fermentation.
- The level of heat required to start the flavour development process only occurs in fermentation heaps with at least 20 kg of wet beans. The temperature does not get high enough to start flavour development in a fermentation heap with a smaller quantity of beans.
- Ferment beans for a total of 5-6 days.
- Fermented cocoa must be dried. Drying cocoa beans reduces the growth of mould and helps improve the flavour. Dried cocoa beans are easier to store and to transport.
- A properly fermented and dried bean should be brown in colour when you cut the bean in half.



Photo credit: Martin Gilmour

- The table below shows the relationship between colour, degree of fermentation and flavour.

<b>Colour of beans</b>	<b>Degree of fermentation</b>	<b>Flavour on roasting</b>
Brown	Fully fermented	Strong cocoa flavour, balance of acidity, astringency and bitterness
Brown/purple	Partly fermented	Good cocoa flavour, higher acidity, astringency and bitterness
Purple	Low fermentation	Low cocoa flavour, strong acidity, astringency and bitterness
Greyish or black	Unfermented	Absence of cocoa flavour, predominantly acid, astringent and bitter. Overall sour flavour

### **Farmer practices**

- Some farmers don't ferment their cocoa at all and simply dry the beans in the sun. Others ferment for only 1 or 2 days. They may do this because they are impatient and want to sell their beans quickly. From the outside you can't tell whether a bean has been fermented. You can only tell if a bean has been fermented by cutting it open and looking at the colour.
- Some farmers use black plastic sheets to cover the fermentation heap. They may do this because they think black plastic is more "modern", plastic sheets can be reused, or because there aren't any banana trees around.
- Black plastic should not be used as it almost "seals" the heap and doesn't allow air to circulate during fermentation. This causes rotting rather than fermentation and does not allow the flavour development process to take place. By contrast, banana leaves allow air to penetrate into the heap.
- Some farmers ferment in wooden boxes or in plastic trays. The use of wooden boxes does not give rise to the ideal temperature or conditions necessary for fermentation. Boxes or trays are better than nothing, but banana leaves are best!

## Grading, storage, farmer quality checks

### Importance

- After putting so much effort into producing cocoa, farmers should make sure that the quality of their beans is good. This can be done by sorting the beans, storing them well and doing simple quality checks.
- Grading means sorting out bad material from good beans before selling it. Bad beans include those that are black, diseased, flat, broken etc.
- An important reason why farmers should sort their beans is to increase their chances of negotiating a better price. In some countries, beans are graded by buyers into good and sub-grade quality, and farmers receive a higher price for sorted, good quality beans. Even where this system does not exist, some buyers may pay a higher price for good quality.
- Sorting should be done at two main stages: before fermenting take out all the obvious black, diseased, flat, broken beans you see and do the same again during and after drying the beans.
- Proper storage affects the quality of the beans. It is important to keep dried beans away from moisture to avoid mould development and away from smoke to prevent them from developing a smoky flavour.
- Beans should be stored on the farm for no longer than 2 weeks to ensure good quality.
- After putting so much effort into producing good quality beans, you should do simple checks to find out the quality of your beans. This helps maintain quality standards and when you are sure of the quality of your beans you can negotiate better with buyers.
- To make sure your beans are the best quality, take a sample to check how dry they are and whether or not they are well fermented.
- To check for dryness, take a handful of beans in your hand and squeeze. They should make a cracking sound and snap when broken.
- Take a few beans and cut them open to see whether they are brown.

## Child labour in cocoa production

### Introduction

- Child labour is work that, by its nature and/or the way it is carried out, harms, abuses and exploits a child or prevents a child from going to school.
- The term “child labour” does **not** include all work performed by children under the age of 18. Child labour is **not** children doing small tasks around the house, nor is it children participating in work appropriate to their level of development and which allows them to acquire practical skills and learn responsibility. This type of work is called light or casual work.
- The minimum age that a child is legally allowed to work is determined by laws in each country and can be set at 14, 15 or 16 years. The International Labour Organization of the United Nations (ILO) recommends 16 as the minimum legal age for working.
- Most countries have signed international agreements with the ILO that state that children aged 12-15 are permitted to carry out "light work" which is not likely to harm their health or development or attendance at school (ILO Convention 182).
- Child labour takes many different forms but the worst forms of child labour includes “*Work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children*”. This type of labour is also called “hazardous or dangerous labour”.
- In cocoa production, work that is dangerous for children includes handling and spraying pesticides, applying fertilizers, carrying heavy loads and using sharp farm tools such as machetes.

### Causes of child labour

- Children work in cocoa production mainly because their parents do not make enough to support the family or to send their children to school. Parents may also not be aware of the dangers of involving children in certain activities.
- Child labour creates a cycle of poverty, puts children at risk, and affects their future since they may be unable to go to school at all or may miss many days of school.
- The children of sharecroppers, migrant and seasonal workers are especially likely to work on farms, as their families may be poor and they may not attend school due to poverty or for other reasons, such as the not being able to speak the local language. Children of sharecroppers and seasonal workers often work as part of a family team, even though the parent is the only one directly employed on the farm.

### **Why cocoa farmers should be concerned about child labour?**

- Children are more likely than adults to have accidents while working because they have little work experience and knowledge of hazards and risks, and how to prevent them.
- Children's bodies are still growing and their minds developing. Heavy lifting and straining, for example, can permanently injure growing spines or arms and legs. Skin, eye, respiratory or nervous problems occur in children exposed to pesticides, and children are vulnerable to much lower levels of exposure than adults. There may well be chronic long-term health effects from exposure to pesticides that will not show up until the child is an adult.
- The aim of governments in cocoa producing countries is to ensure that farmers produce clean, good quality cocoa free of child labour. Cocoa producers may find it difficult to market their produce due to a global cocoa initiative against child labour.

### **What can be done about child labour?**

- All actors in the cocoa sector (farmers, traders, organizations, processors) need to be aware of issues related to child labour. The aim of sensitisation on child labour is to prevent the problem from occurring. Sensitisation can be done through farmer field schools and other approaches.
- Communities can organize themselves to monitor the existence of child labour.
- Individuals can report cases of child labour to the right authorities. It is important to identify these authorities and inform FFS participants of their obligation to report any cases of child labour.
- Local groups or organizations can assist families where children work to find alternatives by, for example, building schools, and providing school fees, income-generating opportunities.