



Learning about Sustainable Cocoa Production: A Guide for Participatory Farmer Training

1. Integrated Crop and Pest Management

Compiled and edited
by

Sonii David
March 2005 version

**Sustainable Tree Crops Program
International Institute of Tropical Agriculture**



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Correct citation

S. David. 2005. Learning about sustainable cocoa production: a guide for participatory farmer training. 1. Integrated crop and pest management. Sustainable Tree Crops Program, International Institute of Tropical Agriculture, Yaoundé, Cameroon. March 2005 version



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About STCP

The Sustainable Tree Crops Program (STCP) constitutes a coordinated and innovative effort made by farmers and producer organizations, industry and trade, national governments, research institutes, the public sector, policymakers, donors and development agencies to facilitate the improvement of smallholder agricultural systems based on tree crops in West and Central Africa. The goal of STCP is to improve the economic and social wellbeing of smallholders and the environmental sustainability of tree crop farms in West and Central Africa. STCP is hosted and managed by the International Institute of Tropical Agriculture.

About IITA

The International Institute of Tropical Agriculture (IITA) was founded in 1967 as an international agricultural research institute with a mandate for improving food crop production in the humid tropics and to develop sustainable production systems. It became the first African link in the worldwide network of agricultural research centers known as the Consultative Group on International Agricultural Research (CGIAR), formed in 1971.

IITA's mission is to enhance the food security, income, and well-being of resource-poor people in sub-Saharan Africa by conducting research and related activities to increase agricultural production, improve food systems, and sustainably manage natural resources, in partnership with national and international stakeholders.

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Contributors and acknowledgements

Financial support for this publication comes from the United States Agency for International Development (USAID) and the global chocolate industry, represented by the World Cocoa Foundation (WCF), individual chocolate companies and trade associations.

Many people contributed to the development of this manual. We acknowledge, in particular, STCP Master Trainers Jean Yves Couloud (Cote d'Ivoire), Mary Adu Kumi and Sylvanus Agorkorku (Ghana), Innocent Okuku (Nigeria), Dieu ne dort Njankoua Wandji and Simon Bassanaga (Cameroon), facilitators and field school participants in the four countries whose comments and contributions helped to refine the farmer field school curriculum. Janny Vos (CABI Bioscience), Roy Bateman (IPARC, Imperial College), Peter van Grinsven (Masterfoods, the Netherlands), Martin Gilmour (Masterfoods U.K) and B. K. Matlick (World Cocoa Foundation) provided expert technical advice in developing the technical bulletins and field guides.

The farmer field school curriculum contained in this manual was implemented, tested, evaluated, and improved within the framework of the STCP Pilot Projects. The STCP country managers, Jonas Mva Mva (Cameroon), Chris Okafor (Nigeria), Isaac Gyamfi (Ghana) and Robert Yapo Assamoi (Cote d'Ivoire), contributed substantially to this process with technical advice, methodological insights and supervision. Stephan Weise, STCP Regional Manager, made invaluable contributions to the FFS curriculum development process and this manual in many ways, including helpful comments on layout and design.

The discovery learning exercises contained in this manual are drawn from several sources. The proceedings of the STCP Curriculum Development Workshop held in Mbalmayo, Cameroon in March 2003 provided a basic set of discovery learning protocols. Jim Gockowski (STCP/ITA) and Janny Vos (CABI Bioscience) organized the workshop and compiled the first set of protocols. Contributors to that workshop included resource persons from the following institutions: Centre National de Recherche Agronomique (CNRA), Cocoa Research Institute of Ghana (CRIG), Cocoa Research Institute of Nigeria (CRIN), Institut de Recherche Agricole pour le Development (IRAD), CABI Bioscience, International Labour Organization (ILO/WACAP), ACDI/VOCA, SOCODEVI, Winrock International and the International Institute of Tropical Agriculture (IITA).

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Graphics

We gratefully acknowledge contributions by:

- Pierre Tondje, IRAD, Cameroon
- ACDI-VOCA, Indonesia

Photo credits

- Cover photos by Sonii David
- Photo of fermented beans by Martin Gilmour
- Photos of drying platforms by Jean Yves Couloud

Preface

While cocoa has been grown in West and Central Africa since the early 1900s, using participatory approaches to train cocoa farmers is relatively new in this region. Cocoa extension programs have used traditional top down approaches such as the training and visit approach based on the “technology transfer” model. Typically, the results have been disappointing, with relatively few farmers adopting the promoted practices. By the 1990s, most national cocoa extension systems had collapsed.

A basic premise of the Sustainable Tree Crops Program (STCP) is that, to produce cocoa sustainably, small-scale farmers need to develop knowledge of biological processes and understand interactions in the cocoa agro-ecosystem to be able to make sound management decisions. To meet the objective of training farmers to become “experts” in their own fields, STCP has pioneered farmer field schools (FFS) on cocoa in Cote d’Ivoire, Ghana, Nigeria and Cameroon since 2003. The objective of FFS training is to allow farmers to make their own discoveries about management practices that reduce their dependence on costly inputs such as pesticides and improve their understanding of crop and pest management. Farmer training focuses on integrated crop and pest management (ICPM) with specific emphasis on good crop husbandry, pest and disease management, rational pesticide use, farm renewal and cocoa quality. Farmers also learn about social topics such as responsible labour practices and HIV/AIDS and how to work in groups.

This publication was developed by STCP as a guide for trainers involved with participatory training of cocoa farmers. Trainers may be extension agents or farmers who have gone through a comprehensive training of trainers (ToT) program on participatory training of cocoa farmers. The discovery learning exercises contained in this manual, developed and field tested in STCP farmer field schools, should be treated as guides to be used flexibly and creatively by trainers.

The manual is divided into three sections. Section one contains bulletins that provide trainers with technical information on key topics related to sustainable cocoa production. Section two consists of discovery learning exercises for use in participatory farmer training. Section three provides guides for field activities in cocoa production. The content of this manual, particularly the discovery learning protocols in section two, should be adapted to the context and situations of farmer training by, for example, changing the names of case study characters, currencies etc.

Materials contained in this manual were developed by national and international cocoa researchers, national extension staff, and field staff from the global chocolate industry. The discovery learning exercises have been field tested, reviewed by farmers and technical experts and further revised. Nevertheless, this manual is very much a “work in progress” as we seek to improve our training curriculum. Feedback and comments on this publication are therefore warmly welcome and should be sent to:

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As we integrate new material, this manual will be periodically updated.

Sonii David
Yaounde, March 8, 2005

Glossary of technical terms

Cambium	The layer of tissue between the wood and the innermost bark of a tree
Canker	A spot where the bark and cambium tissue is damaged or dead because of an infection caused by black pod fungus
Chupon	Vertical stem or shoot
Epiphyte	A type of plant (e.g. some mosses and ferns) that grows on another plant or object but is not rooted in soil. It does not directly harm the other plant.
Imago	The sexually mature stage of an insect's life cycle
Integrated crop and pest management	The best mix of pest management techniques which includes crop management methods, use of improved planting material/varieties, preserving and/or manipulating biological agents and the use of chemical pesticides
Jorquette	The point at which the vertical chupon stem changes to fan growth
Larva (pl. larvae)	Any young insect from the time that it hatches from the egg until it becomes a pupa, or chrysalis
Natural enemy	A living organism that kills, injures or causes disease in other living organisms
Nymph	The pupa of an insect
Pest	A living organism that we consider harmful because it attacks and damages crops
Pesticide	Any poison that kills a living organism. This includes insecticides (to kill insects), fungicides (to kill fungi) and herbicides (to kill weeds)
Predator	An animal that hunts and eats other animals. This is one type of natural enemy
Spore	Disease "seeds" of a fungus
Stag head	An abnormal tufted growth of small branches on a tree or shrub caused by fungi, insects or other physiological disturbance
Systemic fungicide	Fungicides that are absorbed by the cocoa tree

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.

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 become 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.

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.

How can farmers use pesticides more efficiently?

There are three methods that farmers can use:

1. Select the least dangerous pesticides available

Pesticides are classified into 3 classes that tell how poisonous they are. The table below indicates how some widely used products are classified. Class 1 pesticides are the most poisonous, class 2 are moderately poisonous, while class 3 pesticides are slightly poisonous. We recommend that cocoa farmers use only class 2 and 3 pesticides.

Commonly used pesticides

Common name	Active ingredient	Class indicating how poisonous the product is
<u>Fungicides</u>		
Kocide	Copper hydroxide	3
	Copper sulphate	1
Nordox	Copper oxide	3
Ridomil 72 WP	Metalexyl and copper oxide	3
<u>Insecticides</u>		
Thiodan 50 EC		
Thionex	Endosulfan	1
Gammalin	Lindane	2
Basudin	Diazinon	2 or 3, depending on formulation
Confidor	Imidacloprid	2 and 3
Decis 25 EC	Deltamethrin	3
Actara 25 WG	Thiomethoxam	3
Bassa 500 EC	Fenobucarb	2
Unden 75 WP	Propoxur	1 or 2, depending on formulation

Class 1=most poisonous class; class 2=moderately poisonous; class 3=slightly poisonous

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? (Use the table above)
- How much should I mix into my spray tank?
- Are there any other important precautions I should take?

Do not use pesticides that do not have a label or if you are uncertain of the origins.

1. 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”).

2. 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").

Protective clothing

- To reduce health problems caused by pesticides, always wear protective clothing when using pesticides. These include, long trousers and sleeves, closed shoes, preferably rubber boots, an eye or face shield to avoid pesticide splash and drift and a hat.
- After spraying, wash your clothes and yourself thoroughly so that any spilled pesticide is removed and does not enter your system and make you ill.

Basic sprayer maintenance and repair

1. Use a robust sprayer. A cheap sprayer may not save you money in the long run if it does not last long.
2. 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.
3. 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.
4. 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.
5. Check straps and fixings to make sure they are comfortable and not broken. Repair/replace as necessary. This is important and can make the spray operation much easier.

Good practices when mixing and applying pesticides

1. Select your target – what are you trying to control? Where does the spray deposit need to go?
2. Select the right nozzle for the job. For a sprayer fitted with variable hollow cone nozzle, decide what setting should be selected. Squirtting 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!

3. 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?
4. Use proper application technique. Be systematic about treating trees. Are all the pods being sprayed effectively?
5. Watch for dripping from the pods or leaves. This means you are wasting pesticide.
6. 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.

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 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.

Applying fertilizer to cocoa trees

Importance

- Cocoa production can often be increased by using fertilizers. If applied correctly in the right place in the right dosage, fertilizers can:
 - Substitute missing food nutrition
 - Increase flowering and pod growth
 - Help to make and keep a tree healthy and promote tree growth
- Use fertilizers when you notice a drop in production despite good management of your trees and farm.
- When soils in a cocoa farm are very fertile, and yields are good, do not use fertilizer as trees will not produce more, and there is a risk that the balance of nutrients in the soil, or the microbial activity, will be disturbed.

Types of fertilizers

- There are two main categories of fertilizers: those made by factories (inorganic or chemical fertilizer) and those made from plant or animal products such as manure or compost (organic fertilizers).
- Fertilizers are used to address different types of soil nutritional deficiencies. There are three categories of inorganic fertilizers:
 - Single fertilizer: This type of fertilizer should only be used if you know exactly what type of nutrient your trees need. Some examples of single fertilizers are: urea, ammonium sulphate, super sulphate (SP36), TSP, KCL.
 - Mixed 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
 - 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 manganese (Mg) in various dosages.
- Fertilizers can be applied to the ground (ground fertilizer) or to the leaves of a cocoa tree (foliar fertilizer). The advantage of fertilizers that are applied on the leaves is that they are absorbed more quickly than those applied to the ground.

Choosing the right fertilizer at the right time

- Many farmers waste fertilizer by applying the wrong type at the wrong time using the wrong dosage.
- There are two key times for applying fertilizer to cocoa trees:
 - Start of the wet season: Cocoa trees grow new branches and leaves at the start of the wet season. Several nutrients are important at this stage. Nitrate helps growth of leaves and phosphorus helps flowering. Potassium is useful to the tree for many reasons. This combination of nutrients is found in a commonly used 'compound fertilizer' called NPK.
 - Start of pod production: When trees start producing pods after the short dry season (late August), they need more potassium. This is the time to apply Potassium Chloride (KCl) or a compound fertilizer with potassium.
- Never apply fertilizers when there is no rain, as they may cause a 'burning' effect on the leaves and the fertilizer will not be taken up by the tree. Rain dissolves fertilizers and brings them into the soil, near the roots, where they can be absorbed by the trees. If there is no rain, fertilizers cannot be absorbed by the roots.
- Chemical fertilizers can have a negative effect on soil fertility and soil structure if used over a long period of time many years. Healthy soil contains many microorganisms that help break-down vegetative matter such as leaves, branches and pod husks.
- Chicken, goat or cow manure are all good fertilizers for cocoa trees and do not have the negative effects on soil that chemical fertilizers have.
- 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 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.

Dosage, use and timing of fertilizer use

- 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.
- Carefully read the label and instructions on dosage and timing of application or ask an extension worker 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.
- Be careful when applying fertilizers as some fertilizers can damage the trees or the leaves if they come in direct contact with them. If you want to fertilize the canopy directly, you can use 'foliar fertilizer'.
- Never mix ammonium-based fertilizers (ZA) with SP36 or other single fertilizers.
- **Never** allow children to be involved in applying fertilizers.
- Always store fertilizer in a dry place.

Rehabilitating, regenerating and replanting a cocoa farm

Importance

- Many cocoa farms in West and Central Africa are old (more than 40 years) and have low yields due to the age of the trees, as well as other factors such as poor maintenance and pest and diseases.
- A healthy cocoa tree produces 25 pods per year that results in approximately 1 kg of dry cocoa. As a guideline, yield per year can be divided into:
 - Good (20 or more pods per tree)
 - Average (15-18 pods per tree)
 - Poor (10 or less pods per tree)

This means that trees producing 10 or less pods a year are unproductive and you should think about what you need to do to improve their productivity (see "Deciding to rehabilitate or renew a cocoa farm").

- There are three approaches to improving cocoa production:
 - Rehabilitation: This is defined as any method or activity that can bring existing trees into better production. Rehabilitation of cocoa trees involves pruning of cocoa (see "Pruning older cocoa trees") and shade trees, removing all diseased and pest-infected pods, dead and diseased branches, mistletoe, chupons, controlling weeds, and disease and pest control. Rehabilitation may also involve cleaning out clogged drainage ditches and adding fertilizer or organic matter to renew soil nutrients. Many of the discovery learning exercises in this manual focus on rehabilitation techniques.
 - Regeneration: Regeneration means grafting new genetic material onto the old root system.
 - Replanting: Cocoa trees are like humans: they wear out and need to be replaced.

Regenerating a cocoa farm

- Grafting is an important regeneration method but which requires a lot of skill and training to do successfully. Grafting involves taking a shoot from a tree with above average production ("super tree") or from improved material and grafting it onto a chupon of a non-productive tree. When doing top grafting, the graft is made on the top of the chupon, while in side grafting the graft is made on the side of the chupon. Both techniques can be done on small seedlings.

- Grafting involves several steps. First, it is important to select good grafting materials. Materials for top grafting can be obtained from existing “super trees” (trees with above average production) in farmers’ fields or from bud wood gardens. Governments or cocoa project usually plant bud wood gardens for the specific purpose of supplying bud wood for grafting.
- Next, identify the chupon of healthy, but non-productive cocoa trees for replacement with “super” shoot. Graft the “super” shoot onto the chupon and secure the union.
- Once the graft is well established, after about 6 months, cut the parent tree down for the graft to take over. The graft can be expected to start producing cocoa pods as early as 18 months after grafting.
- Do not attempt grafting unless you have received training on how to do it.

Replanting a cocoa farm

- The farm replanting plan described below allows a farmer to replant his/her trees, maintain income and does not need additional capital or credit.
- This exercise is based on a one-hectare size field. Divide the farm into 2, 3 or 4 sections or blocks based on tree productivity (see “Deciding to rehabilitate or renew a cocoa farm”). The number of blocks required will be determined by your ability to accomplish the tasks required. For this exercise, we will assume that you will carry out the renewal plan over a four-year period.
- One hectare will require 1100 trees; therefore one hectare divided into two blocks is 550 trees, three blocks 366 trees and four blocks 275 trees. You should therefore plant about 275 trees each year over a period of four years.
- After surveying the field, divide the area into four areas of approximately equal size based on productivity. Block one should be the area that has the least productive trees, block two the second lowest and so on.
- In year one, remove all the trees in block one, including shade trees. If large shade trees are not easy to remove or you are reluctant to remove them, remove the lower branches of shade trees up to the highest possible level to allow the maximum amount of sunlight to reach the ground. Line and peg the area of three meter x three meters and plant a temporary shade crop such as bananas or plantain. You may also plant other food crops such as maize.
- At the end of year one, establish a cocoa nursery. The nursery should produce enough planting material to supply block one at the beginning of the wet season of year two.
- At the start of the wet season of year two, plant cocoa seedlings in block one.

- Repeat the cycle of clear felling, planting temporary shade/food crops and cocoa for blocks two, three and four. Even if you have to skip a year in the plan for some reason, come back to the same cycle the following year.
- In a four-block renewal planting system, it will take approximately 67 years to fully replant and bring all the new trees into production. The result will be one hectare of new cocoa capable of producing a minimum of 1100 kg/year for the next 20-40 years.

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 postharvest 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 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.

Colour of beans	Degree of fermentation	Flavour on roasting
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.

Part II

Discovery learning exercises

Starting FFS

Discovery learning exercise 1: Cocoa cropping calendar

A cropping calendar is an important tool in farmer field schools as it serves as the guideline for activities carried out in the farmer practice plot. A cropping calendar must therefore depict current farmer practice and NOT recommended practice. For the ICPM plot, there is no cropping calendar, as decisions on the implementation of practices are based on regular field observations and the discoveries made over the course of the field school.

Learning objectives

- To develop farmers' capacity for making valid comparisons of their current practices with ICPM (integrated crop and pest management) practices
- Where appropriate, to introduce the topic of child labour in an unthreatening manner (see the protocol "An introduction to child labour issues")

NOTE: This exercise should be done twice: during community sensitisation and during the first or second FFS session.

Materials

- Flip chart paper
- Markers (three colours)

Procedure

A cropping calendar is a representation of all cocoa production tasks performed during a season. It is depicted as a timeline (X-axis) divided into monthly periods, with drawings of crop stages at the top of the matrix. Tasks are listed along the negative Y-axis, and the times these are applied are indicated as horizontal bars.

Ask participants to list all activities done in cocoa production. As this calendar will be used to implement practices in the farmer practice plot of the farmer field school, it is important to be specific and detailed. Go through the entire cocoa production cycle, including land preparation, seedling management, planting, weeding, removal of chupons, pruning, spraying, harvesting, fermentation, drying, storage etc.

Have participants fill out the calendar in as much detail as possible using different colours to indicate what work is done by men, women and children.

Example of a cropping calendar

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Land preparation												
Nursery preparation												
Planting												
Transplanting												
Gap filling												
Removal of chupons												
Weeding												
Spraying for mirids												
Spraying for black pod												
Harvesting												
Pod breaking												
Fermenting												
Drying												
Bagging												
Weighing/selling												

In addition to the calendar, which indicates the frequency of activities, write the following information on a separate sheet of paper:

- Type of fungicides/pesticides applied
- Quantity of fungicide/pesticide applied per hectare/acre
- Type of sprayer used
- Pruning practices and frequency
- Shade management and frequency
- Type of sanitary harvesting done and frequency
- How farmers dispose of diseased pods

When doing a cropping calendar with FFS participants, the calendar should reflect either the actual practices of the farmer owner or the common practice in the area (to be decided by participants) rather than practices that would be implemented if farmers had the resources.

Version: October 2004

Discovery learning exercise 2: Nine Dot Game

Learning objectives

- To make participants aware of FFS objectives and concepts
- To show how FFS objectives and concepts relate to farmers' problems

Duration

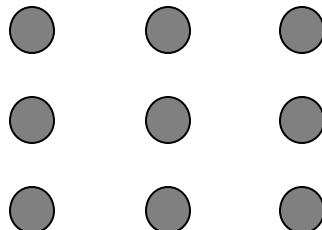
30-45 minutes

Materials

- Large sheet of paper
- Tape
- Pens

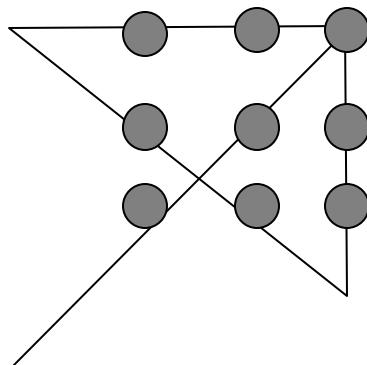
Procedure

Divide participants into small groups. Draw 9 dots up on large sheets of paper like this:



Ask participants to try to join all of 9 dots with only 4 straight lines without lifting the pen from the page.

Ask participants to share their results. The solution will be something like this:



Ask: Why was it difficult at first to find the way to do this exercise? How did we overcome the problem?

Discuss how this relates to solving other problems. Very often we need to look outside the things that we think are the problem, to understand the real causes before we solve them. In this game we had to look outside the square to find the solution.

Explain that the 9 dots can represent the 9 most important problems of farmers in this area. Ask participants to list all the problems they face that begin with the letter 'P'.

Classify the points raised into 9 categories, as in the following example:

- Pests and diseases
- Poverty (profits are low)
- Pesticides (poisoning)
- Programs (that are no good)
- Politicians (do not help us)
- Public health
- Pollution
- Provision of water
- Protection of forest

Use each of the 9 problems to lead into an explanation of some of the objectives and central concepts of the FFS program. Here are some examples of points you can make:

- "In the FFS, we explore ways to solve the problems of pests and diseases, low profits, pesticide resistance and pesticide poisoning".
- "The program is based on what farmers need and want to learn - farmers decide what we will do in the FFS".
- "The field school is based in farmers' fields and so looks at the real problems that are happening now".
- "We learn by exploring the problems together as a group. By working together we can discover how to address problems that are too big for one person."
- "By becoming a strong group we will be able to get more support and attention from local government or other organizations that we may want to influence".
- "The fields are a part of the local environment and the community, so we also look at the effects our actions have on things that are outside our fields".

Version: June 2004

Discovery learning exercise 3: Ballot box

Learning objective

To obtain information on FFS participants' level of knowledge before and after training

Materials

- "Ballot boxes"--boards on which are mounted a question and 3 answers with 3 compartments in which participants can cast their "votes"
- 2 m poles to form stations on which the ballot boxes are mounted
- Cocoa farm
- Vials, alcohol, live and dead pest specimens
- Cocoa pods or other materials with symptoms
- Spray nozzles
- Plastic bags for collecting specimen
- Whistle
- Strings of ballots for each participant indicating the participant's number (see example for participant # 1 in the drawing below). There should be as many ballots per participant as there are questions. For example, if there are 25 questions, each participant should have 25 ballots.

String of ballots

1	1	1	1	1	1	1	1	1	1
---	---	---	---	---	---	---	---	---	---

Procedure

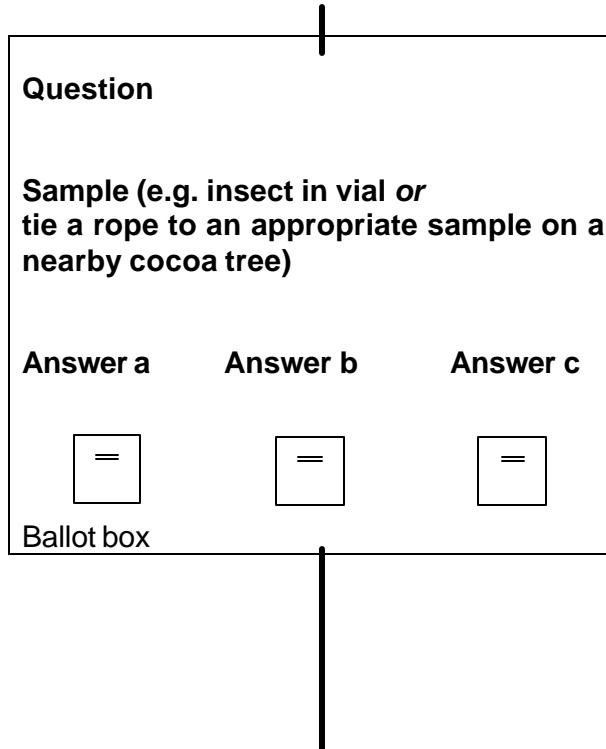
Preparing questions and stations

Facilitators (in small groups or altogether) should prepare questions with 3 multiple choice answers each that will gauge the knowledge level of participants. The categories and questions must be based on the prepared FFS curriculum. Categories of questions that may be considered include:

- Recognising pests
- Recognising beneficials
- Crop physiology and nutrition
- Pesticide use and spray application
- Regeneration
- Cocoa quality
- Child labour

Examples of questions are attached. Prepare as many questions as there are participants. For example, if there are 25 participants, prepare 25 questions.

Collect samples and prepare as many stations as there are participants, following the below design. The ballot boxes are small compartments that can hold the ballots, e.g. carton paper envelopes or cigarette boxes. To avoid cheating, consider putting dummy ballots into each ballot box. Tie each ballot box to a pole ('station') and post each ballot box station in the cocoa farm in a large circle, with at least 1 m between stations.



Implementation

Give each participant a number and record each participant's number and name somewhere for future use. Give each participant strings of paper ballots with their number on each ballot. Each participant should have enough ballots to answer all questions, using one ballot per question.

Explain to participants that they should cast a "vote" in the ballot box corresponding to the answer they want to give. To cast a "vote", participants should tear off a ballot from the string they have. Explain that the whistle will be blown to indicate when participants have to move to the next station to answer the next question. Participants should move in a clock-wise direction around the circle.

Invite participants to take one station each. Blow the whistle and keep time to 1 or 2 minutes per station. Continue the exercise until all participants have answered each question.

There are several ways to help illiterate participants do the ballot box exercise. The easiest way is to invite a few literate non-FFS participants to help illiterate participants by reading the questions and answer choices to them.

Analysis and use of results

Once participants have completed the exercise, collect all ballot boxes and start counting participants scores. Give 1 score for each correctly answered question per participant. Present the results in a list that indicates participants' numbers rather than names to avoid embarrassment.

Example of scoring table (underlined letters are correct answers):

Participant #	Q. 1 <u>(b)</u>	Q. 2 <u>(b)</u>	Q. 3 <u>(c)</u>	Q. 4 (a)	Q. 5 (c)	...	# correct answers	% correct answers = score
1	a	<u>b</u>	<u>c</u>	b	<u>b</u>
2	c	b	a	c	b
3	b	b	c	a	b

After the entry test, don't go through the correct answers with participants, as a similar test will follow at the end of the FFS. Ask participants similar questions during the exit test to determine whether the FFS training has improved their knowledge. At the end of the FFS training, present both entry and exit knowledge test score (see form), showing the change in score.

The entry test results will give facilitators a clear idea in which categories training is mostly needed. At the end of the training, the entry and exit test results will be compared and both participants and facilitators can see how much the knowledge of the participants has been improved, and therefore, how effective the training has been. The percent of change in score can be used to decide which participants should receive certificates.

Sample ballot box questions: (correct answers are indicated in bold)

Category	Sample	Question	Answers
Recognising pests	Vial with mirid adult in alcohol	What is this?	a. A farmer's friend b. A farmer's enemy c. A neutral
	Tie a rope to connect with cocoa pod with black pod symptom	What is this symptom caused by?	a. A bacteria b. A virus c. A fungus
	Vial with stem borer larva in alcohol	What is this?	a. A farmer's friend b. A farmer's enemy c. A neutral

Recognising beneficials	Tie a rope to connect with cocoa pod with mirid symptom	What is this symptom caused by?	a. A disease b. An insect c. Rain
	Tie a rope to connect with cocoa pod with black pod symptom	What is this symptom caused by?	a. A disease b. An insect c. Rain
	Tie a rope to a tree with initial symptom of die back Vial with spider in alcohol	What will eventually happen to this tree? What is this?	a. Recover b. Die c. Produce lots of pods a. A farmer's friend b. A farmer's enemy c. A neutral
	Vial with yellow weaver ant in alcohol Plastic bag with praying mantis	What is this? What is this?	a. A farmer's friend b. A farmer's enemy c. A neutral a. A farmer's friend b. A farmer's enemy c. A neutral
	Vial with syrphid fly larva in alcohol	What is this?	a. A farmer's friend b. A farmer's enemy c. A neutral
Crop physiology and nutrition	-	What should a farmer expect one campaign after maintenance pruning?	a. Less black pod b. More black pod c. No change in black pod disease
	-	With heavy shade, what do you expect?	a. Short trees b. Medium trees c. Tall trees
	-	With no or light shade, what do you expect?	a. Less black pod b. Less mirids c. Less weeds
	-	Which is the fastest method of regenerating cocoa?	a. Raising and planting seedlings b. Marcotting c. Grafting
Pesticide use and spray application	Tie rope to black pod infected pod	What is a major source of nutrients for the cocoa tree? What would you use to control this problem?	a. Animal droppings in the farm b. Rain water c. Leaf litter a. Fungicide b. Insecticide c. Mix of fungicide with insecticide

	Tie rope to mirid infected pod	What would you use to control this problem?	<ul style="list-style-type: none"> a. Fungicide b. Insecticide c. Mix of fungicide with insecticide
	Make drawings of farmers that are protected to various degrees against pesticide poisoning	Which of these farmers is well protected from pesticide poisoning?	<ul style="list-style-type: none"> a. Long-sleeved shirt, shorts, flip-flops b. Long-sleeved shirt, long pants, boots c. As in b. but add hat, mouth cover and gloves
	Nozzle for fungicide application	This nozzle should be used for:	<ul style="list-style-type: none"> a. Fungicide b. Insecticide c. Whatever pesticide
	-	For mirid control at the early part of the cocoa season (February, March) what type of sprayer should preferably be used?	<ul style="list-style-type: none"> a. Knapsack sprayer b. Pressurised sprayer c. Mist blower
	-	How can one improve the efficacy of a fungicide application?	<ul style="list-style-type: none"> a. Spray until run-off b. Spot application c. Soil drench
Cocoa quality	-	What is the optimum number of days for fermentation?	<ul style="list-style-type: none"> a. 3 days b. 6 days c. 9 days
	-	What is the best method to dry cocoa?	<ul style="list-style-type: none"> a. Sun-drying on jute mats on soil b. Sun-drying on bamboo matted platform with a plastic cover c. Using fire
Regeneration		What should a farmer do when he experiences declining cocoa yields over several years?	<ul style="list-style-type: none"> a. Abandon the farm b. Replant c. Make a decision after considering present yields, age and number of the trees, the cost of different methods that can bring existing trees into better production

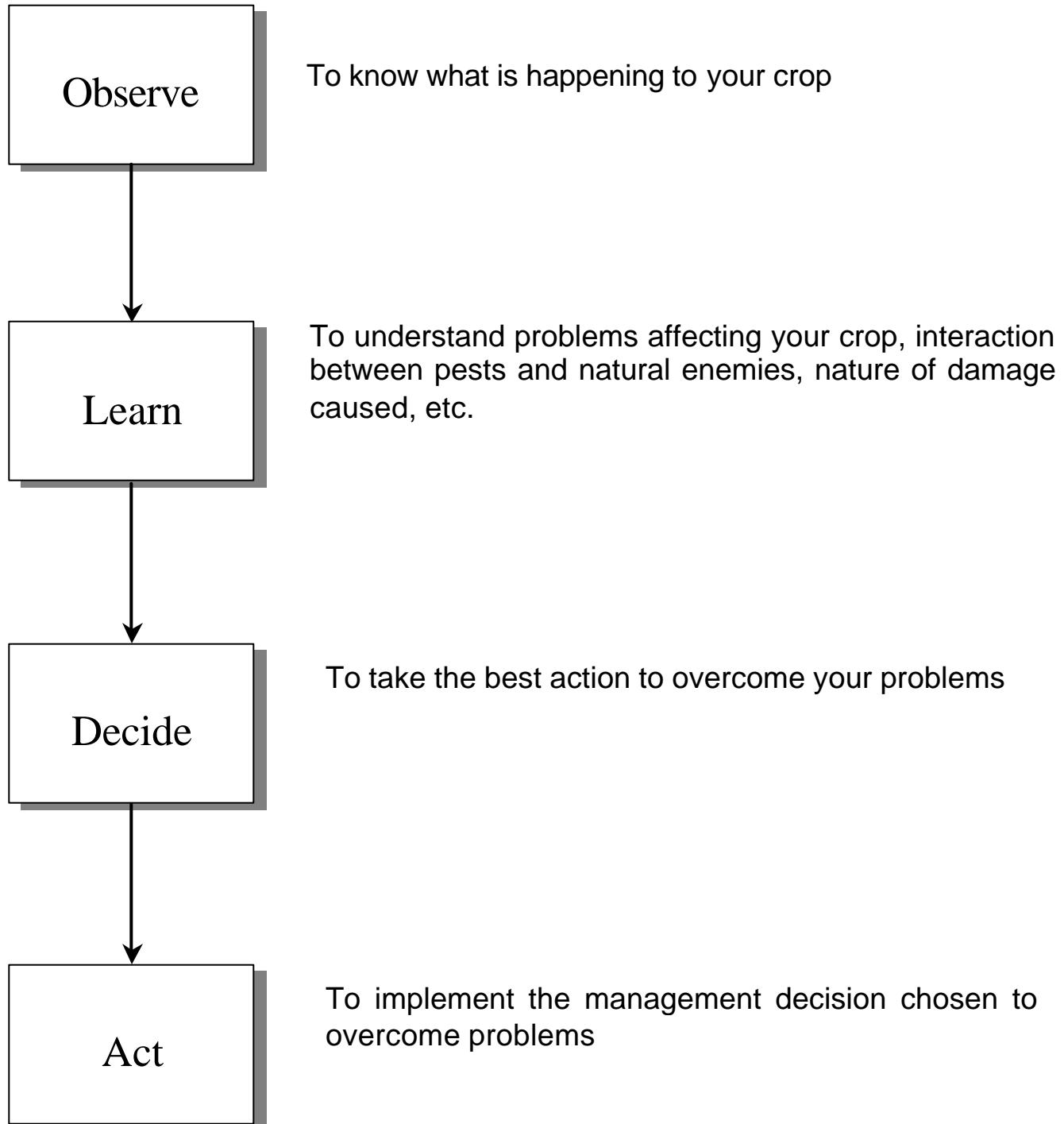
Child labour	-	What is the minimum age a person should be to apply pesticides? What kind of cocoa farm activities can under-15 year-olds do?	a. 15 years b. 18 years c. 21 years a. Open pods with machete b. Collect cocoa pods using a small pail c. Spray pesticides
	-	Which of these activities can a 12-year old help out with on a cocoa farm?	a. Cut ripe cocoa from trees b. Dry beans c. Collect cocoa pods using a large bucket
HIV/AIDS		What causes HIV/AIDS?	a. Witchcraft b. A virus c. A mosquito
		How do people get HIV/AIDS?	a. From sharing a glass with an infected person b. From touching an infected person c. From having sex with an infected person or coming in contact with blood from an infected person

Version: June 2004

Results of entry and exit ballot box test

Agro-ecosystem analysis

Agro-Ecosystem Analysis



Discovery learning exercise 4: Agro-ecosystem analysis

Learning objectives

- Improve participants' observational skills and decision-making abilities
- Teach farmers the need to make management decisions based on close observation of the agro-ecosystem

Materials

- Measuring wooden ruler
- Crayons
- Pencils
- Markers (3 different colours)
- Sharpeners
- Erasers
- Alcohol
- Vials or plastic bags
- Sweep nets
- Hand lens
- Note book
- Machete
- Pins
- Wooden backing board
- Masking tape
- Paint or other material to label trees

NOTE: It is important to bring AESA presentations from the previous FFS session

Procedure

Preparing to start AESA

The FFS learning field has 2 plots. One plot shows farmers' normal practice (farmer practice plot or FP) and the other one, the ICPM plot, is where decisions are made about crop management based on the agro-ecosystem analysis (AESA). AESA data are collected from the two plots to learn about the impacts of new practices. Identify and mark these plots during the first FFS meeting.

Divide participants into work groups of 4-5, depending on the total number of participants. Each work group can make observations in both ICPM and FP plots. But to make the working time as shorter as possible, if you have 5 work groups, 3 groups can make observations in ICPM plot and two groups in FP plot. These work groups

should be maintained throughout the training period, but the plot they observe should be changed from time to time. Each group selects one person to record all data (this task can be rotated among group members).

Next, randomly select and tag 5 trees to be observed by each work group. For example, if you have 5 work groups, select 25 trees, 15 trees for the three groups working on the ICPM plot and 10 trees for the two groups working on the FP plot. Throughout the field school, participants observe these same trees for agronomic characteristics (these are called selected fixed trees). Work groups should randomly select an additional 5-10 trees for pest observations.

During the first AESA, start by doing a rapid field walk in the FFS plots and beyond. Record the following information on cocoa trees in the two plots and the whole farm (see AESA record sheet)

- Varieties
- Estimated age of trees (indicate range)
- Topography (flat, gentle, steep)
- Drainage (good, medium, poor)
- Shade coverage (heavy, medium, light, unshaded)
- Soil fertility (high, medium, low)
- Average number of stems per stand
- Average number of main branches
- Average spacing of cocoa trees to other trees
- Presence and size of open spaces (large, small, none)
- Average number of shade trees per hectare/acre

Agro-ecosystem observation

Observations need to be made early in the morning (about 7 a.m.). Working in groups, the participants enter the FFS learning fields to observe and make note on general field conditions, weather, plant physiology, type and number of insects and diseases, attack symptoms, environmental conditions around the field and to gather live specimens. They should collect the data indicated on the AESA record sheet from the sets of five trees that were selected. For convenience and due to problems with using ladders, most observations are made up to 2 meters high in the tree, but observations on rodent damage should be made above 2 meters.

Environmental conditions

At each session, record the following conditions at the time you made the observations:

- Weather (sunny, cloudy, rainy)
- Temperature (cold, lukewarm, hot)
- Soil moisture (dry, moist, wet)

Selected fixed trees

Record the following agronomic observations each session from the selected fixed trees:

- Number of small pods
- Number of large, immature pods
- Number of ripe pods
- Number of chupons on the main branch
- Number of basal chupons
- Presence of new flushes (none, light, medium, heavy)
- Presence of creepers and mistletoes (none, low, medium, high)

After the first AESA, record the following observations only when relevant changes have been made on the FFS plots:

- Shade coverage (heavy, medium, light, unshaded)
- Soil fertility (high, medium, low)
- Average number of stems per stand
- Average number of main branches
- Average spacing of cocoa trees to other trees
- Presence and size of open spaces (large, small, none)
- Average number of shade trees per hectare/acre

At each session, carefully observe the selected trees for insects and diseases. Count all insects you can find and indicate whether they are a pest or beneficial. Collect any insects that you do not know in bottles or plastic bags and take them back to the meeting place to see if other participants can identify them. If you recognize the disease, record them. If you don't recognize them, collect them in bottles or plastic bags and take them back to the meeting place.

Record the following pest and disease observations:

- Number of pods damaged by pests (above two meters for rodents)
- Number of natural enemies
- Number of pods affected by disease

After counting the total number of insects and diseased pods found on the five trees, calculate the average for each tree, that is the total number found divided by 5.

Randomly selected trees

For each of the randomly selected trees:

Carefully observe and count all insects you can find and indicate whether they are a pest or beneficial. Collect any insects that you do not know in bottles or plastic bags and take them back to the meeting place to see if other participants can identify them.

Carefully observe 5 leaves and pods (if present) on each branches on the selected trees and the branches themselves, recording disease and other symptoms. Observe and record how many of the leaves and pods are diseased. If you recognize the disease, record them. If you don't recognize them, collect them in bottles or plastic bags and take them back to the meeting place.

Count the number of trees where major pests and diseases are found.

Record the number and species of any weed on or around tree. If you are not sure whether a plant is a weed, collect it in a polythene bag and take it to the meeting place to see if other participants can identify it.

Agro-ecosystem drawing

In a shaded area close to the field, each group draws all the observations made in the field on flip chart paper. Draw a single representative cocoa tree at its present state of growth, with the sun or clouds symbolising weather conditions. Show weeds found and indicate the number and species. To the right of the tree draw the natural enemies found and indicate the number or abundance. To the left of the tree, draw the insect pests and the disease symptoms found and indicate the number or abundance.

Agro-ecosystem analysis

After a discussion, group members analyze and interpreter field information. They discuss the growing stage of the plant and compare the number of pods, chupons, presence of new flushes and creepers, mistletoes etc. between the observed trees. They also compare the diseases observed and the number and type of pests and natural enemies. The group draws conclusions about the overall situation compared to the previous AESA. They list observations of specific problem areas in the AESA drawing and indicate the possible causes.

Agro-ecosystem decision-making

The final stage of the AESA is the decision-making. Group members should ask:

- What do we need to do to address the observed problems?
- If something needs to be done, how, when and what will be the impact on the agro-ecosystem?

Some examples of action decisions are:

- We are not sure what a mirid looks like. We need to make an "insect zoo" to identify mirids and their damage.
- The field is clean, so no need to weed it.
- We don't understand how black pod is transmitted. Let's do an exercise on this.
- We heard that spraying a salt solution can control moss. Let's experiment to find out if this works.

Action decisions can include:

- Field work or crop management operations (for example, weeding, sanitary harvesting, removal of chupons spraying etc.)
- A discovery learning exercise to learn about a topic—the “special topic” (for example, insect life cycle)
- Conducting an experiment to try out something new and untested

List action decisions under the group recommendation column in the AESA drawing.

Small groups report

A representative of each small group presents its findings and conclusions to the whole group for further discussion, questioning and refinement. To save time, one alternative is to have one group each that made observations on the ICPM and FP plots present and invite other groups to make additional contributions. Participants are encouraged to challenge and ask the presenting group questions. Sometimes, the decision made by a group is modified or rejected by the rest of the school.

An important role of the facilitator is to draw out differences observed between the FP and ICPM plots by asking, for example:

- Is there a difference in the average and total number of small/large/mature pods counted on trees in the FP and ICPM plots? How do we explain this difference?
- Is there a difference in the number of pods affected by disease? How do we explain this difference?
- Is there a difference in the number of pods damaged by pests? How do we explain this difference?

After presentations, the school must come to a consensus on what action decisions to be implemented and when. These decisions are implemented during the following FFS session.

Implementation of agro-ecosystem analysis decisions

The decisions made during the previous FFS session are usually implemented just after field observations and data collection or as the special topic. Some important decisions may be executed within the week before the next session. It is important, however, to realize that not all topics identified by AESA can be addressed during the FFS training cycle. Participants may pursue some topics, for example those requiring long-term research or demonstrations, after the FFS training cycle.

Version: October 2004

Record sheet: General, environmental and agronomic data

Date:

Group:

Village:

Type of plot (ICPM, FP):

General information on school plots and wider farm (to be collected at first AESA)					
Varieties					
Estimated age of trees (indicate range)					
Topography (flat, gentle, steep)					
Drainage (good, medium, poor)					
General information on school plot and wider farm (to be collected at first AESA and when changes have been made)					
Shade coverage (heavy, medium, light, unshaded)					
Soil fertility (high, medium, low)					
Average number of stems per stand					
Average number of main branches					
Average spacing of cocoa trees to other trees					
Presence and size of open spaces (large, small, none)					
Average number of shade trees per hectare					
Environmental data (to be collected every session)					
Weather (sunny, cloudy, rainy)					
Temperature (cold, lukewarm, hot)					
Soil moisture (dry, moist, wet)					
Agronomic parameters (to be collected every session)					
	Selected cocoa trees				
	1	2	3	4	5
No of small pods*					
No of large, immature pods*					
No of ripe pods *					
No of chupons on the main branch*					
No of basal chupons*					

Presence of new flushes (none, light=25% < of canopy; medium=most branches; heavy=nearly all branches)							
Presence of creepers and mistletoes (none, low, medium, high)							
Crop health	Number of pods damaged by pests (above 2 m for rodents only)						
List pests: 1. 2. 3. 4.							
	Number of natural enemies						
List natural enemies 1. 2. 3. 4.							
	Number of pods affected by disease						
List diseases: 1. 2. 3. 4.							
List weeds: 1. 2. 3. 4.							

* Up to 2 meters

Design of agro-ecosystem analysis recording sheet

Group name:

Type of plot: ICPM or FP

Date:

AESA No:

Agronomic data & General information

(refer to record sheets)

Weather (Draw the weather at the time when you made your observation)

(refer to record sheets)

Left of the tree	Draw one large picture of cocoa tree	Right of the tree
Draw the insects pests and the diseases symptoms found and indicate the number or abundance <i>(refer to record sheets)</i>	At the base of the plant draw the weeds found and indicate the number and the species. <i>(refer to record sheets)</i>	Draw the natural enemies found and indicate the number or abundance <i>(refer to record sheets)</i>
Observations	Possible Causes	Group recommendations

Crop husbandry

Discovery learning exercise 5: Impact of shading on humidity in a cocoa farm

Cocoa in much of West Africa is grown in a mixed crop system with shade trees. Many of these shade trees include economically valuable species such as the African plum (*Dacryodes edulis*), kola nut (*Cola nitida*), and guava (*Psidium guajava*), as well as several timber species (e.g. *Chlorophora excelsa*). Others are left for their compatibility as shade species. There is, however, a trade-off between shade and pest and disease management. Shade has been shown to suppress the level of attack by mirids while, on the other hand, increasing the incidence of black pod disease, because of the effect on humidity.

Learning objective

To help farmers understand the relationship between shade and humidity in a cocoa farm and its relation to specific cocoa pests

Materials

- Cocoa farm with different shading levels
- Small hand sprayer
- Water
- 3 watches
- Flip chart paper
- Markers

Procedure

In the cocoa farm, select three niches with different shading levels:

- Excessive shading
- Moderate shading
- Little or no shading

Divide participants into 3 groups and assign them to one of the shade niches. One person in each group should have a watch.

Spray cocoa pods with water using a hand sprayer until the water forms a droplet on the tip of the pods. Ask each group to record the time it takes for the cocoa pods to dry in each niche.

While waiting for the cocoa pods to dry, ask each group to describe the neighbour tree species present in the each niche by making the following observations:

- Neighbour trees density (spacing)
- Neighbour trees height
- Neighbour trees crown shape
- Neighbour trees leaf area/Neighbour tree species
- Determine the cocoa density/spacing
- Describe the cocoa crown shape and canopy cover
- Estimate the weed pressure

Ask each group to estimate the intensity of important pests and diseases in each niche.

At the end of the exercise, return to a central location in the cocoa farm and note the collected data on poster paper.

Guide questions for discussion

Which cocoa pods were the first to dry?

To what do you attribute this/those differences:

- Neighbour tree density?
- Neighbour tree height?
- Neighbour tree crown shape?
- Neighbour tree leaf area?
- Neighbour tree species?
- Other factors?

Did you observe any differences in pest infestation levels within the three niches?

Did you observe any differences in the black pod disease infestation levels within the three niches?

Is it possible to manipulate the shade situation on this farm so that pest and disease infestation levels are reduced? If yes, how?

Version: May 2004

Discovery learning exercise 6: Pruning older cocoa trees

Learning objective

To help farmers understand and implement pruning of cocoa trees more than 5 years old

Materials

- Un-pruned cocoa trees
- Machete/cutlass, small saws (use pruning saws if available) or other pruning tools such as pruning shears and extended pruning shears on a stick with pull rope for reaching higher branches
- Ladder
- Flip chart paper
- Markers
- Paint or other material to label trees

Procedure

Discussion

Start a discussion on local practices, knowledge and beliefs on pruning.

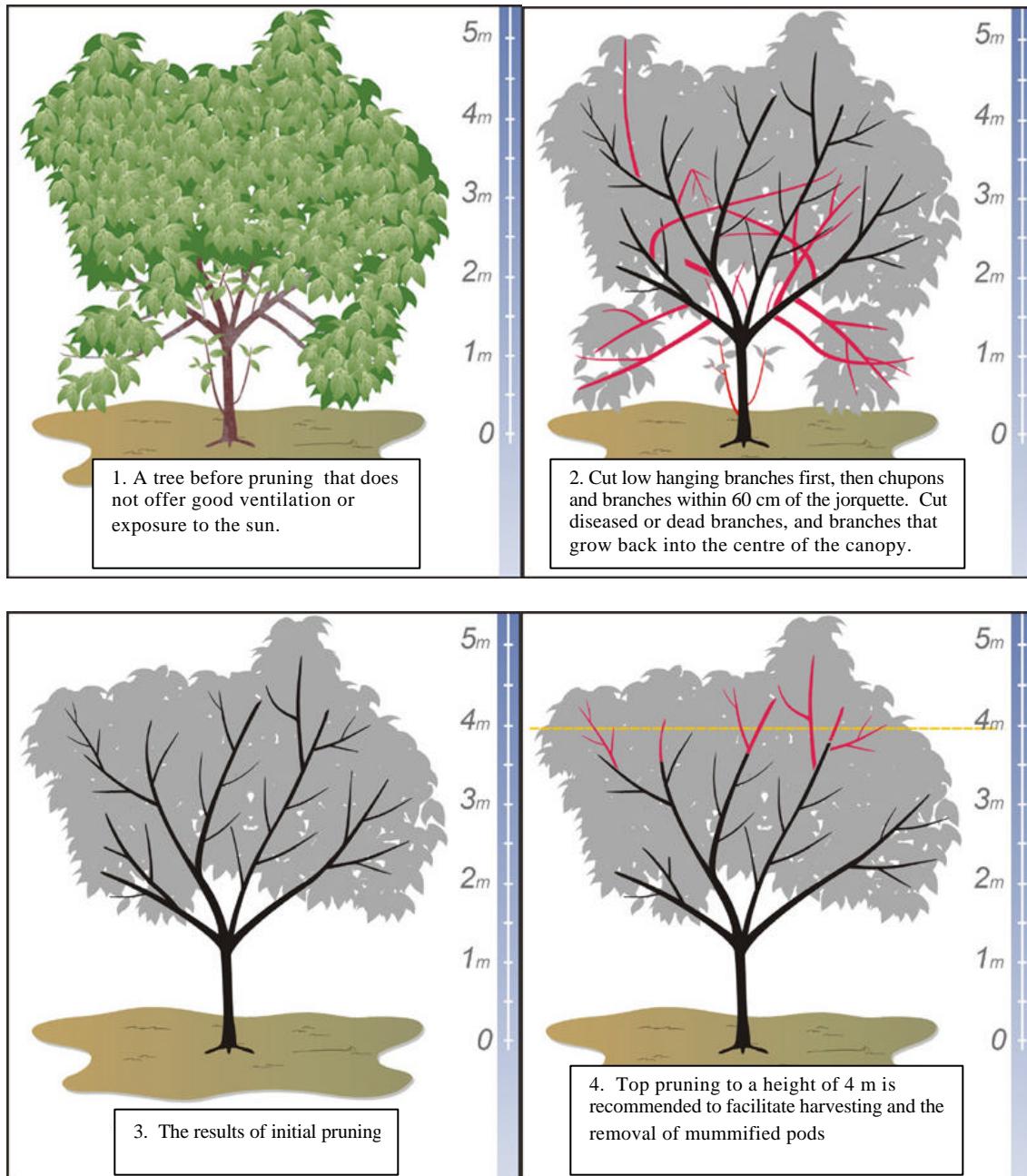
Guide questions for discussion:

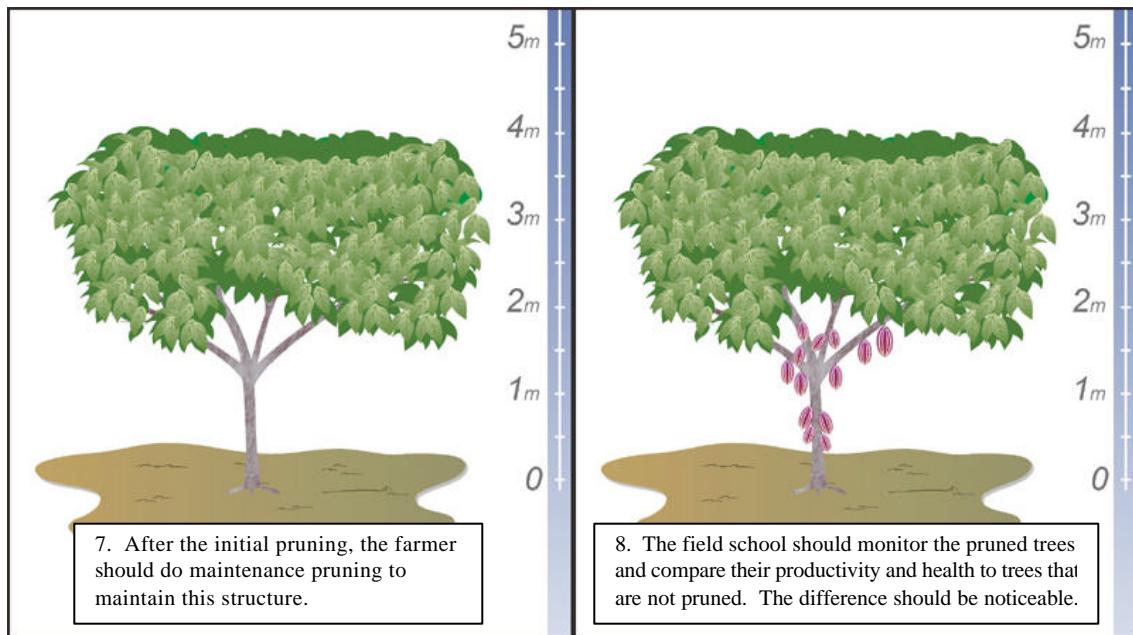
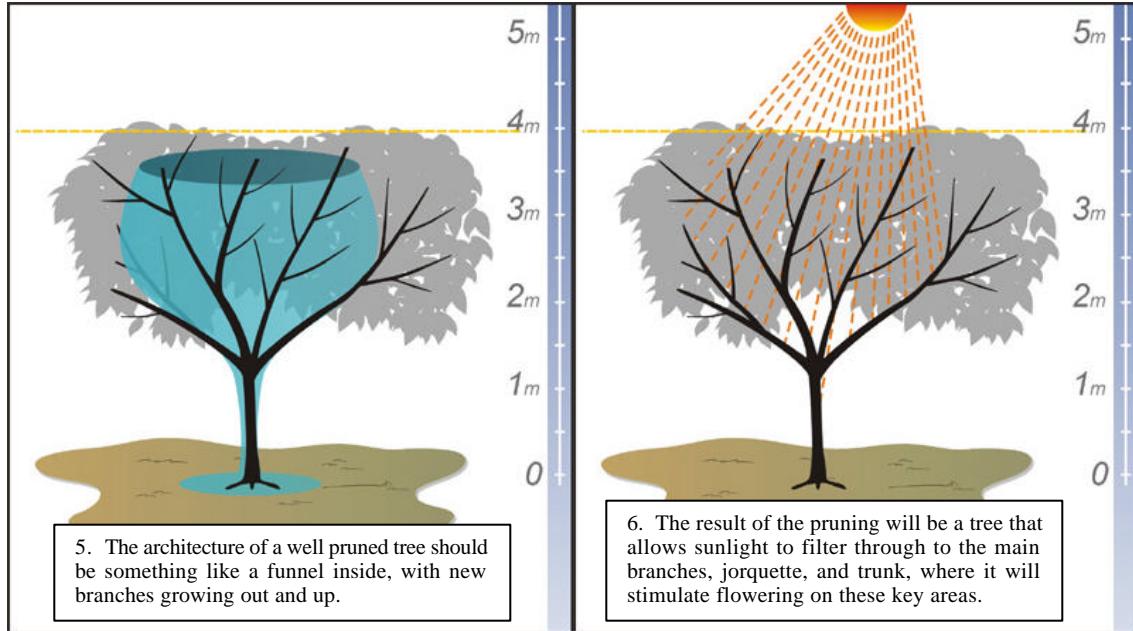
What is pruning? Why would you prune your trees? What benefits does pruning offer? What are the hazards or problems you have experienced? How do you prune your trees? When is the best time to prune? What tools have you used? How did you learn to prune your trees?

Write responses on a flip chart. This recognizes the farmers' existing beliefs, knowledge, and experience regarding pruning. It also gives the facilitator a baseline idea of the pruning capabilities of participants.

Farmer decision making

For trees that have not been pruned before, farmers need to determine which branches should be cut off. Look at the following series of eight pictures to learn how to determine which branches to prune.





Source of illustrations: ACDI/VOCA, SUCCESS Project

Look for the following branches to prune:

- Branches that curve, crossing from one side of the crown to the other
- Branches that have large rotting parts or that are heavily wounded

After pruning, sunlight should penetrate the trees so that it is seen on the ground like spots on a leopard's skin.

Activities in the cocoa farm

In the ICPM plot, identify a cluster of 10 neighbouring cocoa trees to be pruned and label them “pruned”. In the farmer practice plot (but near the ICPM plot), identify another cluster of 10 neighbouring trees that will serve as the un-pruned control and label them “un-pruned”.

Establish in the ‘pruned’ area, which twigs and branches need to be cut off to allow the sunlight to penetrate the canopy. Refer to the diagrams. Assess how much land space is needed per tree to not compete with other trees for light, water and nutrients.

Perform the pruning in the “pruned” area using the correct method. The pruning wound to the tree should be smooth and at the base of the limb to be pruned. This can be easily shown by comparing the wound made by a pruning saw (see picture below) with a typical machete pruning wound.

A Pruning Saw



Observations

Observe the two plots during all future agro-ecosystem analysis specifically for:

- Flower and cocoa pod production
- Tree health
- Humidity within the plot (for example, observe how quickly dew dries in the pruned versus the unpruned plot?)

Guide questions for discussion

1. Considering the amount of labour involved in pruning, do you think it is a worthwhile exercise? Why/why not?
2. What will be the consequences if the farmer does not prune his/her trees?
3. Can the farmer expect a high yield if he/she is not able to perform pruning?
4. What diseases or insects are able to enter the rotting wounds created by the decaying pruning stumps?
5. If a farmer feels that he/she does not need to invest any energy or capital in his/her farm, do you think this is sensible or not? Why/why not?

Version: May 2004

Discovery learning exercise 7: Deciding whether to rehabilitate or replant a cocoa farm

Many cocoa farmers in West and Central Africa have old farms inherited from their fathers, while others have abandoned their farms for various reasons including low cocoa prices, low production, lack of labour or farm ownership disputes. They are faced with the difficult decision of how to improve cocoa productivity. Farmers need to make a series of decisions based on systematic observations of their farms to improve productivity.

Learning objective

To help farmers make decisions on renewing cocoa farms based on a systematic process that considers tree performance and income goals

Note: As a general guideline, this protocol should be covered toward the end of an FFS cycle and after farmers have learned about pruning and top grafting.

Materials

- Cocoa field
- Calculator (if available)
- Paper/flip chart

Procedure

Conduct an interactive session and a field exercise to collect information on age of the trees, production per area (hectares or acres) and yield. This protocol may require two sessions to complete.

Calculating cocoa productivity and income

Start a discussion about productivity of cocoa farms, listing all factors that contribute to it. These include: age of trees, production per area (acre/hectare), pests and diseases, quality of farm management (as indicated by number of times the farm is brushed, frequency of pruning, frequency of removing of damaged, diseased pods and parasitic plants), field drainage, presence of other trees for shade, fruit and other uses. List all responses on a flip chart. Ask farmers how they make decisions about replanting and discuss the positive and negative aspects of their decision making process.

Estimate annual yield of the field per area (acre or hectare) or pods per tree. Note that a healthy cocoa tree produces 25 pods per year that results in approximately 1 kg of dry cocoa. As a guideline, yield per year can be divided into: good (20 or more pods per tree), average (15-18 pods per tree) and poor (10 or less pods per tree).

Ask farmers to set an average income goal for a 1-hectare/acre farm for use during this exercise based on desirable yields and farm gate price. For example, a fully planted hectare of land planted in 3 meter x 3 meter spacing will have approximately 1100 cocoa trees. 1100 trees at 800 grams/tree (in this example we assume 20 pods per tree) results in 880 kg/ha (0.80×1100). With a farm gate price of \$1.00/kg the farmer income would be \$880/year.

Compare this desirable income with farmers' average income based on farmers' records of the sacks sold, weight sold or gross income from cocoa sales.

Calculate size of the cocoa field by using the most appropriate method. Determine the number of productive trees by counting the trees in a hectare/acre that produce 10 or more pods just before the main harvest (October in most West African countries). Do not count small underdeveloped trees, diseased trees etc. By knowing the field size and the number of productive trees, you can determine the number of productive trees per land area (hectare or acres).

Write up all the above results on the flip chart.

Making the decision to replant or rehabilitate

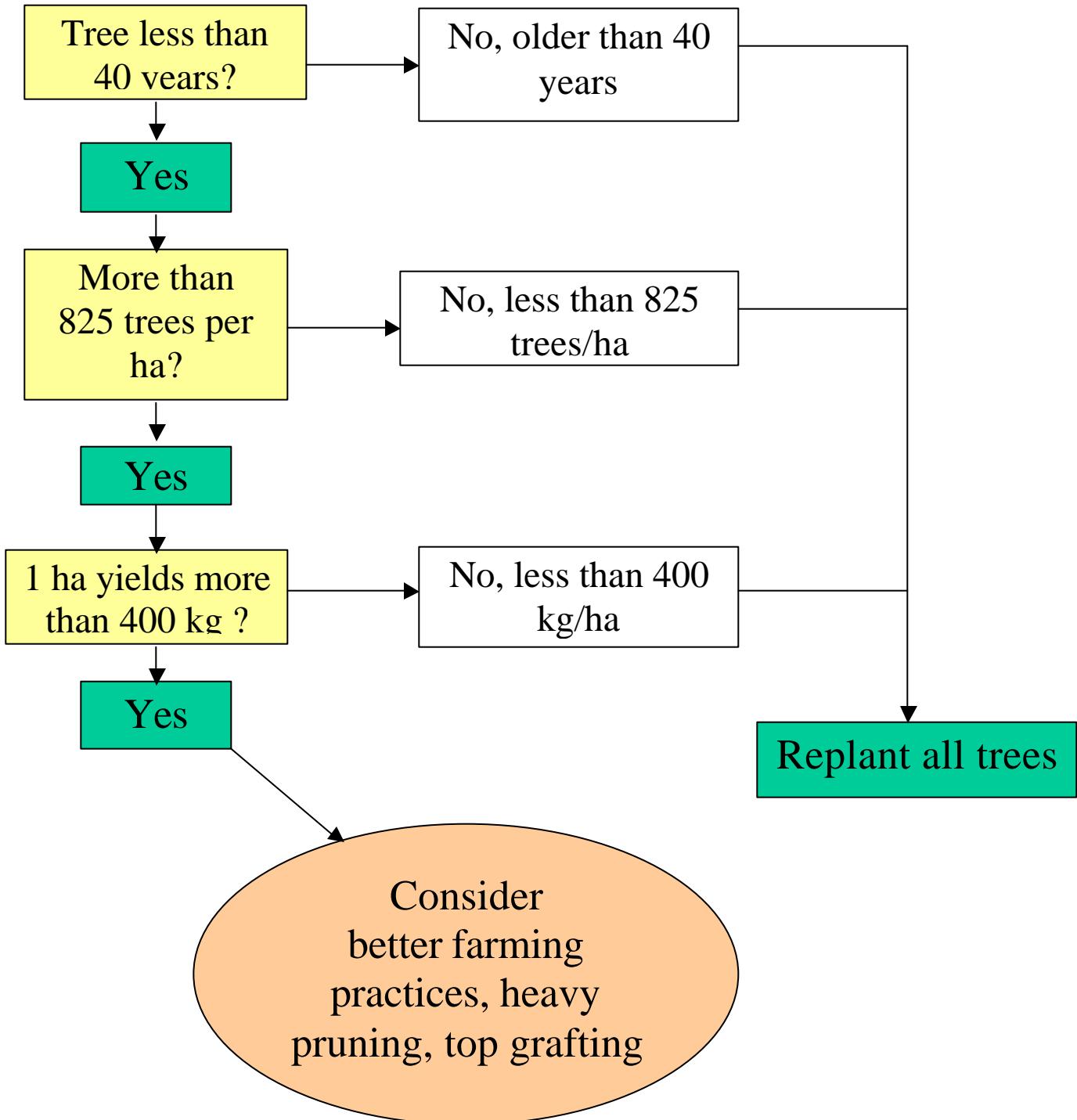
Ask farmers what they do when they notice a reduction in production.

Referring back to the discussion on what factors contribute to cocoa productivity, point out that the most important factor determining productivity of a farm is good farming practice. Others include the age of trees, the number of productive trees per land area and yield per tree.

Using the information collected when calculating cocoa productivity and income, go through the following decision tree to decide whether to replant or rehabilitate the farm.

Since replanting is best taught using demonstrations, farmers who are interested in replanting should be directed to extension staff that have been trained on this topic.

Decision tree for replanting or rehabilitation



Making the decision to graft or do heavy pruning

Discuss what methods farmers already know that can bring existing trees into better production (the definition of rehabilitation).

List rehabilitation options that may include top grafting on chupons of mature trees and heavy pruning (see “Pruning older cocoa trees”) and list the requirements of each method.

Heavy pruning

- Skill
- Machete, small saw or other local pruning tools
- Ladder

NOTE: Pruning should always be done about 3 months before grafting.

Top grafting on chupons of mature trees

- Skill and knowledge
- Tools (sharp knife, pruning shears, sharpening stone)
- Cotton thread or other local twine (raffia palm)
- 75 g fungicide
- 50 cl alcohol
- Clear plastic bags
- 2 plastic pails (5 litres)
- Clean water
- Cotton balls

Evaluate each method by estimating the time and cost of grafting and pruning different numbers of trees, as in the following example:

Number of trees	Time needed and frequency	Cost (labour, materials etc)
100 trees		
500 trees		
1000 trees		

Guide questions for discussion

1. Why do some farmers not take care of their cocoa farms?
2. What factors affect the productivity of cocoa trees?
3. What do farmers do when they notice a decline in cocoa productivity?
4. When should a farmer replant a farm?
5. How do farmers make decisions about replanting? Can this decision making process be improved? How?
6. Is replanting worthwhile, considering the cost? Why/why not?
7. Where can farmers get training or information on replanting techniques in this area?
8. Compare replanting with heavy pruning and top grafting. Which is better? Why?
9. Considering the costs and time involved in top grafting, do you think this is a worthwhile exercise? Why/why not?

Version: March 2004

Managing cocoa diseases and pests

Discovery learning exercise 8: Impact of humidity and the role of diseased pods in spreading black pod

Learning objective

To demonstrate the impact of humidity on black pod disease development and the role of diseased pods in spreading black pod

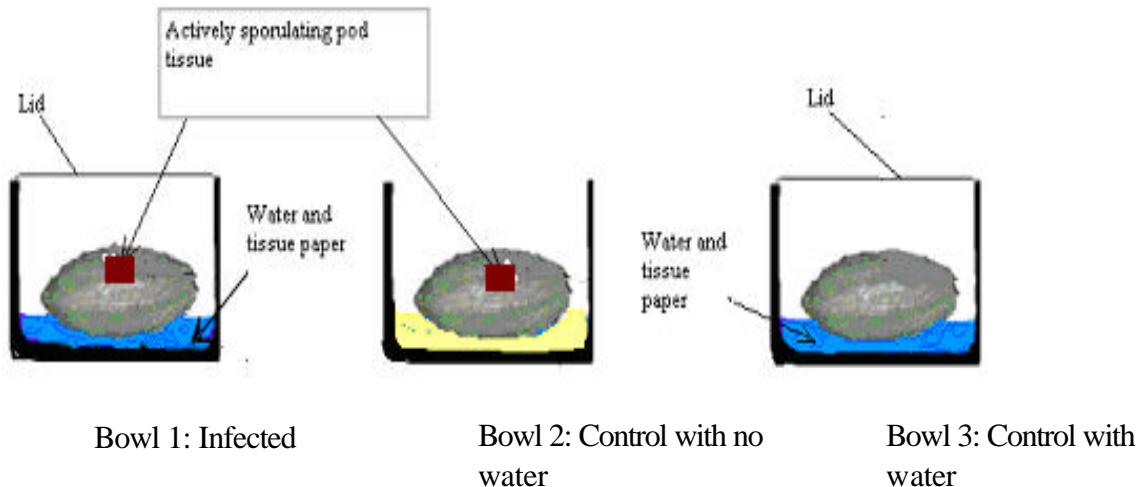
Materials

- 3 plastic bowls/containers with lids
- Knife
- Tissue paper
- 3 healthy green cocoa pods
- Actively sporulating cocoa pods (infected pods with disease seeds =spores) If you cannot find sporulating cocoa pods, take an infected pod and put it in a plastic bag with wet tissue and keep it in a shaded place for a day or two until white powdery spore masses form
- Water
- Labels and marker
- Notebook and pen

Procedure

Place tissue paper at the bottom of three plastic bowls. Wet the tissue paper in two of the three bowls with water to create a humid atmosphere. Label one bowl “infected”, the second bowl “control with no water” and the third bowl “control with water”.

Put a healthy green pod in each of the three bowls. With a knife, cut two small portions of the actively sporulating infected pod (portion of pod with white powder –seeds of the disease). Place one each of the cut diseased portion on the pods in the bowls labelled “infected” and “control with no water”, making sure that the diseased surface is in direct and close contact with the healthy pod. Cover the bowl labelled “infected” and “control with water” to create a humid environment. Leave the bowl labelled “control with no water” open.



Source of illustration: P. Tondje

Observations

Observe the set up daily for 5 days.

- Check for growth of emerging infected areas on the pods. Measure the diameter of the infected areas, noting how many cm it grows each day.
- Check for development of white powdery spore masses.

Guide questions for discussion

1. Is there a difference between the growth of emerging symptoms in the three bowls? If yes, why? What does the difference mean for black pod development in a cocoa farm?
2. Is there a difference in the starting time of sporulation between the bowls? If yes, what does this mean for the spread of black pod disease in a cocoa farm?
3. Are there any methods to reduce humidity in a cocoa farm? If yes, what kind of impact would you expect on the development of black pod if humidity is reduced?

Version: October 2004

Discovery learning exercise 9:Cocoa disease infection study

This exercise has been developed for black pod but can be applied to other cocoa pod diseases

Learning objective

Better understanding of the transmission of black pod and the importance of phytosanitary harvest in controlling the disease

Materials

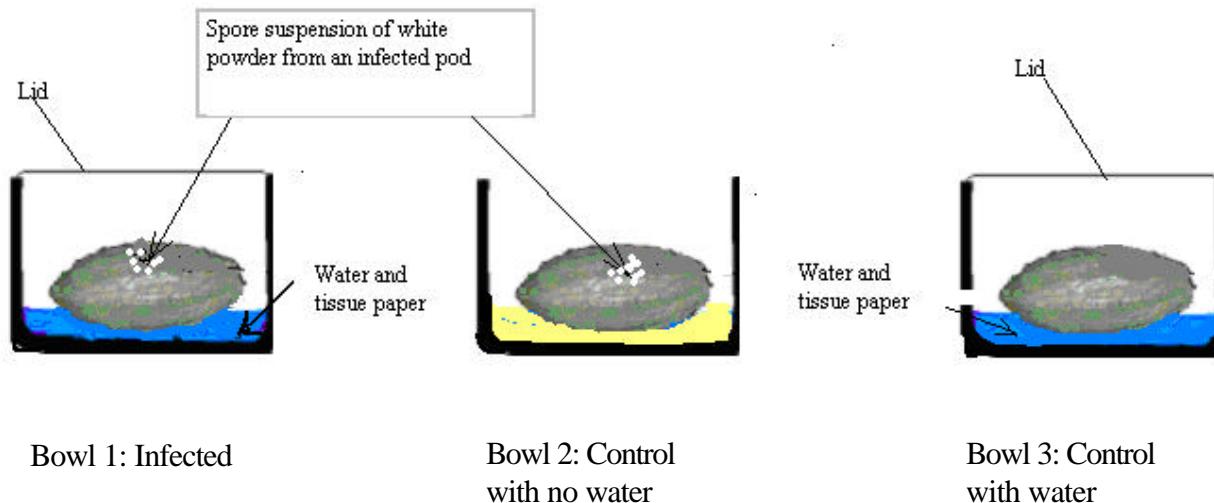
- 3 large plastic bowls/containers with lids
- Knife
- Tissue paper
- 3 healthy green cocoa pods
- 1 actively sporulating cocoa pod (infected pod with disease seeds =spores). If you cannot find sporulating cocoa pods, take an infected pod and put it in a plastic bag with wet tissue and keep it in a shaded place for a day or two until white powdery spore masses form
- 3 clean soft paint brushes
- Dry, clean stick
- Water
- 2 cups
- Labels and marker
- Notebook and pen

Procedure

Line the bottom of the three plastic bowls with tissue paper. Wet the tissue paper in three bowls with a similar amount of clean water to maintain a humid atmosphere. Wash and dry the 3 healthy cocoa pods. Put a pod in each of the three bowls. Label one bowl “infected”, the second one “control with no water” and the third bowl “control with water”.

Take the sporulating cocoa pod and wash the white powder of the sporulating area into one cup with the aid of the paintbrush. Label the cup “infected water”. Stir the suspension in the ‘infected water’ cup with the dry stick for 5-10 minutes and leave for 30 minutes.

Fill another cup with clean water and label the cup “clean water”. Using the paintbrush, put drops of the “infected water” on the healthy pod in the “infected disease zoo”. Using the other clean paintbrush, put drops of the “clean water” on the healthy pod in the “control with water disease zoo”. Using the third clean paintbrush, add spores on the pod contained in the “control with no water” disease zoo. Cover the bowls labelled “infected” and “control with water” to create a humid environment.



Bowl 1: Infected

Bowl 2: Control
with no water

Bowl 3: Control
with water

Source of illustration: P.Tondje

Observations

Observe the set up daily for 5 days. Check for:

- Growth of emerging infected areas on the pods, noting how many days after set-up you can see these emerging.
- Development of white powdery spore masses, noting how many days after set-up you can see these emerging.

Guide questions for discussion

1. Why did we include an uninfected ‘control’ disease zoo (bowl 3)?
2. Why did we include a control disease zoo with no water?
3. How long did it take for the symptoms to develop in the infected disease zoo?
4. How long did it take for the spore masses to develop?
5. Can we tell how long the disease cycle takes?
6. What do the results tell us about disease development in a cocoa farm?
7. What have you learned from this exercise?

Version: October 2004

Discovery learning exercise 10: Role of soil in the spread of black pod disease

The soil in cocoa farms is an important reservoir for black pod disease inoculation. These exercises illustrate the existence of this reservoir and the importance of avoiding water splash from the soil surface during rain.

Learning objective

To demonstrate the potential role of soil in the spread of black pod disease.

Version 1

Materials

- Six healthy cocoa pods
- Polythene bags
- Soil sample from farm heavily infected with black pod
- Cotton wool
- Hand atomizer
- Rubber bands
- 100 ml container (e.g. discarded water bottle with top cut off)
- Cool boiled water
- Stirrer

Procedure

Collect soil samples (top 5 cm) from a cocoa field heavily infested with black pod. Mixed the soil thoroughly with the cool, boiled water. Stir for 3 minutes and leave for 30 minutes. Spray the mixture on 3 healthy green pods. Spray another set of pods with boiled water. Cover all the sprayed pods with polythene bags containing 20 ml of water.

Observations

Check the set-up daily for 5 days for:

- Growth of infected areas, noting how days after set-up these infected areas emerge
- Development of white powdery spore masses, noting how many days after set-up these emerge

Version 2

Materials

- Watering can
- Water
- 2 sheets of poster paper
- Marker

Procedure

Choose a location in the cocoa farm where there is a thick layer of leaf litter. Make sure that the soil is dry. Remove the leaf litter from a portion of the location (about $1 \times 2 \text{ m}^2$).

Fill the watering can with water. Ask one participant to hold a sheet of poster paper vertically from the bare soil, with the bottom of the paper resting on the soil. Ask another participant to water the soil using the watering can to create the effect of rain.

Observe soil splash onto the poster paper. Use the marker to indicate the highest spot of soil on the poster paper.

Do the same thing, using a clean sheet of poster paper and a plot with leaf litter. Again, observe the soil splash onto the poster paper and use the marker to indicate the highest spot of soil on the poster paper.

Compare and discuss both results.

Guide questions for discussion

1. How important is soil in black pod development?
2. How can soil splash be prevented in cocoa farms?
3. What lessons have you learned?

Version: October 2004

Discovery learning exercise 11: Black pod disease zoo in the field

This exercise allows farmers to discover that black pod development is slowed down when shade is reduced from heavy to light. A similar exercise can be used to compare disease development on different cocoa varieties (instead of selecting pods in differently shaded areas, select pods of different varieties).

Learning objective

To show the impact of reducing shade on black pod development

Materials

- Cocoa farm with areas of heavy and moderate/light shade where there are pods at an early stage of black pod infection
- Waterproof markers
- Ruler
- Tags/labels

Procedure

Walk through the cocoa farm. Identify an area with heavy shade and an area with light shade. Divide participants into groups. Ask each group to identify 5 pods of the same size and stage that have initial black pod symptoms (e.g. 1 spot of about 5 cm in diameter per pod) in both the area with heavy shade and the area with light shade. Make sure to select sizable pods.

Label the identified pods, noting on each label the date, the area (heavy shade or light shade) and the name of the group of participants. Trace with the waterproof marker the periphery of the black pod rotted surface.

Observations

Observe the labelled pods after 5-7 days. Measure, using a ruler:

- How much the black pod rot has grown beyond the traced periphery.
- The diameter of the white sporulating area.
- Compare observations between the heavy shaded and light shaded areas.

Guide questions for discussion

1. Is there a difference in growth of the black pod rot areas? Why?
2. Is there a difference in sporulation of the black pod? Why?
3. What do the answers to above questions mean for the spread of black pod in a farm with heavy shade compared to light shade?
4. Are there any other advantages/disadvantages of heavy shade in a cocoa farm?
5. Are there any other advantages/disadvantages of light shade in a cocoa farm?
6. Which cultural methods are available to slow down the spread of black pod disease? Which of these shall we apply to the ICPM plot in our field school?

Version: August 2003

Discovery learning exercise 12: Insect zoo I - symptom development

Some insects are pests, feeding on plant parts. Some feed on insect preys, others live inside other insects, while others come from weeds or neighbouring crops, and are simply resting on the crop. This insect zoo demonstrates the symptoms of insect pests on cocoa pods and/or cocoa seedlings in polybag.

Learning objective

To study insect feeding patterns and understand which insect causes which damage symptoms

Materials

- Small plastic vials or empty water bottles containers
- Plastic bags
- Plastic buckets (transparent if available), large enough to hold cocoa pods of various sizes
- Cocoa pods and leaves
- Tissue paper
- Camel or fine hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Optional: insect collection box and pins

Procedure

Introduce and discuss the concepts of pests (“enemy of the farmer”), natural enemies (“friends of the farmer”) and neutral (“a visitor”). Have participants carefully collect unknown and known insects from the FFS plot using a sweep net or by capturing them in plastic vials/bottles. Be careful when handling the insects that you want to study, as they won’t feed if they have been roughly handled. Ask participants to study the insects and give the local name of each. Discuss what insects might feed on.

To set-up zoos, line the plastic buckets with tissue paper to avoid condensation. Put one cocoa pod and/or some leaves in each bucket and label each bucket with the (local) name of the insect that you want to study. Put different insect species in different “zoos”. Participants can be divided into groups to observe the different zoos.

To find out whether an insect is a pest, put it on a cocoa pod or a sapling (young cocoa tree) in a bucket and cover the bucket with muslin cloth / screen, secured with a rubber band / piece of string. Keep the buckets out of direct sunlight. Observe whether the insect feeds and the feeding symptoms. Check again after some time; how long does the insect survive?

Another way to build an 'insect zoo' is to sleeve cocoa pods or branches on the tree in the field with plastic bags that have screen windows (make sure that there are no holes in the plastic or screen windows). Insert the insects that you want to study and observe the zoo daily.

At the end of the exercise, participants should present their observations to the wider group.

It is a good idea to build up a reference collection of some pests and natural enemies during a field school training cycle. To make a reference collection, pierce or glue studied, dead insects on insect pins or fine tailor pins (pierce the pin through the thorax--the middle part of the body). Add a small paper label with details of the collection date, place and crop. Very small insects may be kept in glass vials with alcohol.

Observations

- Have participants record the local names of the arthropods that were collected, the location where they were collected and describe their observations on poster paper.
- Participants should explain in presentation session:
 - Insect(s) collected
 - Where they collected them
 - What they fed on
 - Whether they changed development stages
 - How long they remained in certain development stages

They should illustrate their observations with drawings.

Guide questions for discussion

1. Did the insect feed in the zoo? If no, why not (was the insect damaged, not hungry, or is the insect not a cocoa pest)?
2. How long did the insect survive in the zoo?
3. Was the insect a 'friend' of the farmer, a 'visitor' or an 'enemy' of the farmer?
4. How could the information about feeding patterns help you in managing pests?

Version: May 2004

Discovery learning exercise 13: Insect zoo II—symptom development

Some insects are pests, feeding on plant parts. Some feed on insect preys, others live inside other insects, while others come from weeds or neighbouring crops, and are simply resting on the crop. This insect zoo demonstrates the symptoms of insect pests on cocoa pods, leaves and branches and insect feeding patterns.

Learning objective

To study insect feeding patterns and understand which insect causes which damage symptoms

Materials

- Small plastic vials, empty water bottles containers or plastic bags
- Labels
- 3 plastic buckets (transparent if available), large enough to hold cocoa pods of various sizes
- Cocoa pods and leaves
- Tissue paper
- Camel or fine hair brush
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Masking tape
- Marker or pen
- Hand lens
- Optional: insect collection box and pins or glue and paper

Procedure

In the previous session, explain the objective of the exercise and ask participants to collect insects from their own farms, either the night before the session or early in the morning before the session. Give participants two or three plastic bags, vials or empty water bottles in sets of three, with each container labelled “branches”, “pods”, “leaves”. Participants should collect insects from branches, pods and leaves and place them in the appropriately marked container. The facilitator should also collect insects and ensure that he/she collects the insect(s) participants are interested in studying during the exercise, in case participants are unable to identify that insect(s). Be careful when handling the insects that you want to study, as they won’t feed if they have been roughly handled.

At the start of the session, introduce and discuss the concepts of pests (“enemy of the farmer”), natural enemies (“friend of the farmer”) and neutrals (“a visitor”). Ask participants to study the insects collected and give the local name of each. Discuss what the insects might feed on. Ask participants to categorize the insects collected by species and location found and decides on which species to include in the insect “zoos”.

To set-up zoos, line three plastic buckets with tissue paper to avoid condensation. Put a clean cocoa pod in bucket one, some cocoa leaves in bucket two and pieces of a branch in bucket three. Select one insect per species and put it in the appropriate bucket. Put different insect species in each “zoo”. Label each bucket with the local name of the insects being studied. Keep a sample of all insects in the “zoos” by gluing dead insects on a piece of paper (one piece of paper corresponding to each “zoo”). Remember to indicate the local name of the insect (if known).

It is a good idea to build up a reference collection of some pests and natural enemies during a field school training cycle. To make a reference collection, pierce or glue studied, dead insects on insect pins or fine tailor pins (pierce the pin through the thorax—the middle part of the body). Add a small paper label with details of the collection date, place and crop. Very small insects may be kept in glass vials with alcohol.

Observations

Divide participants into 3 groups to observe the “zoos”. Each “zoo” should be kept by one participant in a place out of direct sunlight and observed regularly every day for 3-4 days for the following:

- What they fed on
- What the damage symptom looks like
- Number and type of insect that survived
- Number and type of insect that died
- Possible cause of death (lack of food? killed by another insect?)

At the end of the exercise, groups should describe and draw their observations on poster paper and make a presentation to the whole school.

Guide questions for discussion

1. Did the insect feed in the zoo? If no, why not (was the insect damaged, not hungry, or is the insect not a cocoa pest)?
2. How long did the insect survive in the zoo?
3. Was the insect a 'friend' of the farmer, a 'visitor' or an 'enemy' of the farmer?
4. How could the information about feeding patterns help you in managing pests?

Version: November 2004

Discovery learning exercise 14: Insect zoo - predation exercise

Farmers do not always recognize the role of predatory insects in controlling other insect pests. Sometimes mistaken knowledge can lead farmers to use pesticide that kill beneficial predatory insects.

Learning objective

To discover the importance of beneficial insects and their role in controlling pests

NOTE: This exercise may be done after the insect zoo on symptom development to identify which of the insects used in that exercise are predators.

Materials

- Small plastic vials, empty water bottles containers or plastic bags
- Plastic buckets (transparent if available), large enough to hold cocoa pods of various sizes
- Cocoa pods and leaves
- Tissue paper
- Camel or fine hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Optional: insect collection box and pins

Procedure

In the previous session, explain the objective of the exercise and ask participants to collect insects from their own farms either the night before the session or early in the morning before the session. Ask participants to study the insects and give the local name of each. Discuss what the insects might feed on: cocoa or other insects.

To set-up zoos, line the plastic buckets with tissue paper to avoid condensation. Put one clean cocoa pod and/or some leaves in a bucket and label each bucket with the local name of the insect you want to study.

Place an expected predatory insect (a “natural enemy” or “farmer’s friend”) together with an expected prey insect in a “zoo” (for example, lady beetles with aphids or praying mantis with a leaf feeding caterpillar). Make sure that you don’t put different species of predators together as they might attack each other. Label each bucket with the local name and number of insects in each zoo.

It is a good idea to build up a reference collection of some pests and natural enemies during a field school training cycle. To make a reference collection, pierce or glue studied, dead insects on insect pins or fine tailor pins (pierce the pin through the thorax--the middle part of the body). Add a small paper label with details of the collection date, place and crop. Very small insects may be kept in glass vials with alcohol.

Observations

Divide participants into 3 groups to observe the "zoos". Each "zoo" should be kept by one participant, in a place out of direct sunlight, and observed regularly every day for 3-5 days for the following:

- Number of surviving pests and preys in each zoo
- Development of pest symptoms in the zoo with predators and the zoo without predators

At the end of the exercise, groups should describe and draw their observations on poster paper and make a presentation to the whole school.

Guide questions for discussion

1. Was the studied insect(s) a 'friend' of the farmer or an 'enemy' of the farmer?
2. What do you expect might happen to the farmers' 'friends' when insecticides are used to control pests?
1. How can you conserve farmers' 'friends' in the field?

Version: May 2004

Discovery learning exercise 15: Insect zoo - life cycle development

Increasing farmer knowledge about the life cycle of insect pests will lead to better integrated pest management approaches against insect pests. This exercise should focus on mirids and cocoa stem borers, given their economic importance in West and Central Africa.

Learning objective

To study insect life cycles, recognize and learn about their development stages

Materials

- Small plastic vials or empty water bottles containers
- Plastic bags
- Plastic buckets (transparent if available), large enough to hold cocoa pods of various sizes
- Tissue paper
- Camel or fine hair brush
- Labels
- Muslin cloth or fine mesh screen
- Rubber bands/pieces of string
- Hand lens
- Optional: insect collection box and pins

Procedure

Carefully collect eggs or larvae of mirid, stem borer or other cocoa pests by capturing them in plastic vials/bottles.

To set-up zoos to study life cycles, line the plastic buckets with tissue paper to avoid condensation. Put one cocoa pod and/or some leaves in each bucket and label each bucket with the (local) name of the insect that you want to study. Participants can be divided into groups to observe the different zoos.

Rear the collected insects in the zoos until the adult stage. Feed the larval stage on appropriate food (leaves, pods, stems) every day and observe them during development. Monitor the duration of each development stage. It is important to always keep checking the tissue paper lining the buckets; when it is wet, replace it with dry tissue paper.

Another way to build an 'insect zoo' is to sleeve cocoa pods or branches on the tree in the field with plastic bags that have screen windows (make sure that there are no holes in the plastic or screen windows). Insert the insects that you want to study and observe the zoo daily.

At the end of the exercise, participants should present their observations to the wider group.

Observations

- Have participants observe the insects in the zoo as often as possible, or at least every two days. They should try and describe a complete life cycle.
- Participants should note and explain the following in presentation sessions:
 - Name of insect
 - Where collected
 - What they were feeding on
 - Whether they changed developmental stages
 - How long they stayed in each developmental stage
 - What takes place in each developmental stage (is it moving, is it still feeding, is it laying eggs)

Participants should illustrate their observations with drawings of each development stage. They should try to do a complete cycle.

Guide questions for discussion

1. What did you learn about the insect you studied in the insect zoo?
2. How can the information about duration of development stages help you in pest management?

Version: May 2004

Discovery learning exercise 16: Determining mirid damage threshold for essential insecticide application

In many cocoa-growing communities, farmers control mirids by a calendar-based blanket application of insecticides. This practice is often uneconomical and not environmentally friendly. The use of damage thresholds in determining the need for insecticide application ensures that insecticides are applied only when they are needed, thus protecting the environment from avoidable contamination, as well as saving farmers unnecessary expenditure on insecticide

Learning objective

To help farmers understand the concept of mirid damage threshold, its application and its benefits

NOTE: This exercise should be conducted after the protocol on insect zoo symptom development to ensure that participants can recognize mirids and their various damage symptoms

Materials

- Cocoa field (at least 1 ha) with sections obviously infested with mirids and sections free of mirids
- Record book
- Pens
- List of recommended insecticides for mirid control and their current local market prices
- Guideline on deciding whether to spray or not (see below)

Procedure

Before the FFS session, facilitators should walk through the FFS farm (beyond the FFS plots) to identify locations with obvious mirid damage. Divide the farm into 4-5 equal parts (each part with at least 100-200 trees) with different levels of mirid infestation.

Facilitate a discussion on the importance of mirids as a pest. Ask participants what they do to control mirids.

Ask participants to list the mirid damage symptoms they know. These should include: fresh mirid lesions on pods, fresh lesions on chupons and fan branches, pockets of dry/wilted chupons or fan branches, formation of stag heads and fresh cankers on trunks/branches or the presence of nymphs/adult mirids. Note that farmers may not be able to recognize some of these symptoms as mirid damage. If

they are able to identify mirid lesions either on pods, chupons or fan branches, this should suffice as the other symptoms occur only in very severe damage situations.

Lead a discussion on the concept of threshold by asking the following questions:

- Is it necessary to spray insecticide every time you notice mirids or mirid damage symptoms damage on your cocoa trees?
- How do we determine whether we need to spray and how much to spray?

Agree on the definition of damage threshold as the level of mirid damage at which it makes economic sense to spray insecticide.

Review the following guidelines on whether to spray or not.

**Guidelines on whether to spray or not (based on observation of 100 trees)
(Idowu et al.)**

Keep a score of the number of infected trees by using 100 pebbles kept in a small bag/bowl/can as counters. Drop one counter in a can for every uninfected tree found. Drop one counter in your pocket for every infested tree until all counters are finished. The number of counters in your pocket gives a sensitive measure of the level of damage as a percent of trees. Based on the percent of damaged trees, use the following guideline to decide about spraying:

Less than 5% damage: do not spray

5-25% damage: Spot spray

Higher than 25% damage: blanket spray

If a high proportion (70-75%) of pods on infected trees are already mature, do not spray. Do not spray also if harvesting is due in less than 13 days or if more than 85% of crop is already harvested.

Divide participants into as many groups as you have divided the farm.

Assign each group to a section of the farm. Ask groups to count the number of trees in their section. Groups should observe the trees for mirid damage symptoms. Each group should record the following information:

- Number of trees with mirid damage symptoms.
- The percentage of trees infested=
- Number of infested trees _____ $\times 100$
- Total number of trees in section

Using the guideline on whether to spray or not, each group should decide whether they need to spray or not. Bring participants together for group presentations and discussion.

Using the list of recommended insecticides and their local market prices, ask participants to estimate what it will cost if they were to spray each type of insecticide on the plot each group worked on. Each group should also estimate the monetary value of cocoa beans that will be lost in each plot if they do not spray.

Guide questions for discussion

1. What differences exist in the level of mirid infestation within each plot and between the plots?
2. What are the advantages or disadvantages of using damage thresholds to make a decision about spraying?
3. At what stage can spraying save an infected pod from further damage?
4. If you spray now in the plot that you observed, are you likely to save the infested pods from damage?
5. What have you learned from this exercise?

Version: April 2004

Rational Pesticide Use

Discovery learning exercise 17: Calibration and performance of sprayers

Cocoa farmers are often not aware of the implications of nozzle performance and flow rates for high expenditure on pesticides. Less wastage of pesticide during spraying and more attention to nozzle settings can save farmers money.

Learning objective

To raise farmers' awareness of nozzle performance and how spraying can be wasteful

NOTE: This protocol should be covered in two sessions.

Materials

- Two sprayers belonging to participants (or to the school)
- Either two different types of nozzles if available on the local market OR similar variable cone nozzles at two different settings: wide cone and jet
- 2 buckets
- 2 litre measuring cup
- Rolls of kitchen wiping paper or poster papers that have a smooth reverse side
- Watch (measuring seconds)
- Non-toxic dye, preferably red dye (use 1 tablespoon per 15 litres)
- 30 litres of water

Session 1

Learning objective

To show differences in flow rate between nozzles and introduce the problem of "run-off"

Procedure 1

Divide participants into two groups and give each group a sprayer. Ask group 1 to fill the sprayer with water and set the nozzle at a wide cone setting. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing your readings by 2. Record your results.

Ask group 2 to fill the sprayer with water and set the nozzle at a narrow jet setting. Ask a volunteer to spray into the two-litre measuring cup for 2 minutes. Repeat the procedure to make sure the measurement is accurate. Calculate the flow rate in ml/min by dividing your readings by 2. Record your results.

Ask each group to change the nozzle setting (group 1 should now use narrow jet setting and group 2 should use wide cone setting) and repeat the exercise.

Procedure 2

Divide a section of the FFS plot into three sections of about 25 trees each. Divide participants into three groups, allocate one sprayer to each group and select one participant per group to spray. Place paper around the base of the trees in the three sections of the farm.

Ask each group to mix water with the dye and fill up the sprayer tank. Ask spray operators to spray trees according their normal methods until the tank is empty. Discuss the results using the guide questions.

Guide questions for discussion

1. Is there a difference in the number of trees sprayed per tank load between different operators? What is the reason for this?
2. What is the difference in the amount of run off and the amount of liquid on the paper between the operators? What accounts for this difference?
1. Are there intermediate settings that are more appropriate? If so, repeat the exercise using that setting and evaluate.

Session 2

Learning objective

To show how wastage can be reduced with improved spraying techniques

Procedure

Mix two batches of 15 litres of water with the dye and fill tanks with the water and dye mixture. Select a large area (with more than 100 cocoa trees), preferably in an area outside the FFS plots. Cover the base of 25 trees with paper.

Divide participants into two groups. Group 1 should set the nozzle on wide cone setting. Group 2 should set the nozzle on a narrow-jet setting. Ask a volunteer from each group to spray the 25 trees, each using farmers' normal practice. If it is common practice to use variable nozzles in the narrow-jet "squirting" mode to reach higher branches, ask the operator from group 2 to spray pods at shoulder height.

Observations

Each group should observe:

- The amount of leakage from the tank and lance assembly (trigger valve, joints, etc.)
- Rate of operating pump lever (if using a knapsack sprayer)
- The amount of run-off from pods
- The amount of liquid falling on the paper
- Amount of residue in each tank after spraying

Guide questions for discussion

1. Does the output of a nozzle change with different settings? If yes, why?
2. Is the output of the different nozzles similar at similar cone angle settings?
3. Did the operators operate the pump ever at the same rate? What difference does this make?
4. What have you learned from these exercises and how will you apply what you learned?

Version: November 2004

Discovery learning exercise 18: Improved spraying practices for mirid control

Cocoa farmers who do not spray at the beginning of the season often mix insecticides with fungicide sprays for black pod control during the rainy season, sometimes making up to 16 applications. Farmers can control mirids more effectively by reducing mirid populations at the beginning of the season with 2-3 targeted sprays for control of eggs in soft tissues and early instar nymphs.

Learning objective

To improve targeting of insecticide spray procedures for mirid control and raising awareness of insecticide safety issues.

Timing

Multi-stages. This protocol should be done after a mirid insect zoo and the mirid damage threshold protocol.

Materials

- A “typical” cocoa farm (FFS plots)
- Two manual sprayers
- Sufficient insecticide for two tanks (no class I or II formulations) and insecticide information sheet
- Protective clothing for two operators

Procedures

Start a discussion about the timing of mirid attacks (remind participants of mirid insect zoo observations) and the most suitable parts of the cocoa tree to spray during the key mirid seasons. Discuss what insecticides and tank mixtures farmers normally use, the reasons for their choice and the safety of the insecticides.

Divide participants into two groups: one to cover the FP plot and the other to cover the ICPM plot. Ask the FP group to spray the plot as usual.

Ask the ICPM group to inspect the plot and spray according to action threshold.

Observations

In addition to the normal observations made during each AESA, record the following observations:

- Quantities of pesticides (both insecticides and fungicides) used in the two plots during the season using the input record sheets
- Number of sprays in each plot and costs

Guide questions for discussion

1. At what times of the year do mirids attack cocoa?
2. Which parts of the plant are attacked at the different times?
3. Which parts of the plant are attacked at this time?
4. Which insecticides are available and recommended by pesticide salespeople? How dangerous are they?
5. Is mixing of insecticide and fungicide necessary at this time? Why or why not?

Version: November 2004

Discovery learning exercise 19: Pesticide specificity

Farmers may not be aware of the disadvantages using chemical pesticides. They may not know that in addition to the target, pesticides kill beneficials such as natural enemies and antagonistic fungi.

Learning objective

To evaluate the effect of sprayed leaves on the survival of natural enemies

Materials

- A cocoa farm, preferably unsprayed
- Plastic bags and small containers to collect insects
- Small soft brush
- Tissue paper
- 4 buckets (preferably transparent)
- 4 pieces of muslin or mosquito screen cloth with rubber bands, to cover the buckets
- Labels
- Marker
- Notebook,
- Pen
- 4 small hand sprayers (0.5 l), shared between groups
- Water
- Small amounts of different insecticides (including broad spectrum and selective, if possible, a bio-pesticide and botanical e.g. neem)
- Gloves and masks

Procedure

Prepare 4 hand sprayers before the FFS session. If a sprayer has been used before, wash it thoroughly with soap. Fill the first hand sprayer with water. This will be a control. Prepare and fill 3 hand sprayers with commonly used pesticides at field rate concentration. Use gloves and masks. Label the hand sprayers to avoid confusion.

Collect several cocoa leaves (3 per spray treatment). Spray each set of leaves with a selected spray solution and let the leaves dry. Use gloves and masks.

Transfer the dried leaves to the buckets (one leaf per bucket) using gloves. Label the buckets. Divide participants into 4 groups. Each group should have one bucket of

each spray treatment (4 buckets in total). Try to get the leaves to lie flat on the inside surface of the bucket.

Have participants collect pests (for example, mirids or leaf eating caterpillars), predators (for example, spiders or syrphid larvae) and unknowns or neutrals from the cocoa farm. Try not to touch the insects by using brushes to collect them in jars or bottles. Carefully transfer them to the treatments so that there is one of each species per bucket. If possible, use the same insect species in all treatments and make sure they are of similar size. Cover the bucket with the muslin/mosquito screen cloth and secure with a rubber band.

Observations

Check and record the conditions of the insects hourly for 4 hours, after 8 hours and after 24 hours. Count the number of dead insects. It may be necessary to touch the insect with a pen or pencil to determine if it is dead. If it does not walk off in a normal manner, then record it as dead.

Guide question for discussion

1. What happened to the insects in the different jars? Why?
2. Did you observe any differences in the behaviour of the insects?
3. Which of the insects would you prefer on your farm? Why?
4. What happens in the field when a farmer sprays against a certain pest?
5. What will happen in a field 1,2, 3 weeks after spraying?
6. What other options do you have, besides the spray solutions tested, to manage cocoa pests, while conserving natural enemies?

Version: October 2004

Discovery learning exercise 20: Spray dye exercise

Learning objectives

- To create awareness of farmers' direct exposure to pesticides when spraying
- To demonstrate drift to non-target organisms
- To initiate discussion on wastage during spraying

Materials

- Various knapsack sprayers, including a farmer's sprayer
- Buckets
- Measuring can
- Water
- Non-toxic dye, e.g. food colorant, preferably red
- White flip chart paper or paper kitchen towels or toilet paper
- Masking tape
- Cocoa farm
- A few volunteers

Procedure

Prepare 5 litres of dye solution for each sprayer.

Wrap up the volunteers completely (except for the eyes) in white flip chart paper and/or paper kitchen towels or toilet paper, securing with masking tape. Ask each volunteer to fill his/her sprayer with the dye solution and then spray cocoa trees for 10 minutes as though using a pesticide.

Ask the rest of the participants to watch and make notes.

After spraying, remove the sprayer and observe how much dye is on each part of the sprayer's body (none, a little, a lot).

Examine the sprayed cocoa trees and observe how far the spray has drifted and whether or not there is run-off from the cocoa pods.

Measure back the amount of dye solution in each of the sprayers and check which sprayer has been most economical in its output.

Guide questions for discussion

1. How much spray has ended up on the operator?
2. What are the dangers of pesticide contamination to the health of the person spraying?
3. What sort of protective clothing should sprayers use (discuss hats, shoes, boots, long sleeved shirts etc)?
4. How far did the spray drift? Under what conditions would the drift be greater? Under what conditions would it be less?
5. Was there any run-off? What does this mean with regard to cost of application and spray efficiency? What does this mean for the cost of spraying? How can farmers improve the efficiency of sprayers?

Version: October 2004

Discovery learning exercise 21: Botanical pesticide screening

Learning objective

To show farmers a method for evaluating botanical pesticides

Materials

- An hand sprayer
- Water bottles (cut off)
- Muslin or mosquito screen tissue
- Rubber bands
- Markers
- Camel brush
- Tissue paper
- Sweep-net
- Plastic bags for collecting insects
- Water
- Plastic gloves
- Masks
- Protective clothes
- A pair of boots
- Several potential botanical pesticides (e.g. neem seeds, papaya leaves)
- Cocoa leaves
- A measuring cup
- Soap

Procedure

In the previous session, start a discussion on what botanical pesticides participants use or know about. Discuss the composition of each pesticide identified by participants, how effective it is and what possible negative effect, if any, it may have on human health. Ask participants to bring a sample of two or three botanical pesticide mixtures (200 ml) to the next session.

The day of the session, pluck healthy mature cocoa leaves (5 per botanical pesticide to be tested and another five to serve as control). Place the leaves on the ground, about 5 meters apart. Using the hand sprayer, spray each set of leaves with one insecticide and the last set with water. Be careful to prevent any cross-contamination. Wait until the leaves dry up.

Have participants collect different kinds of insects and place in plastic bags. Be sure to collect what farmers think of as pests and natural enemies. Place one treated leaf with three insects of the same species in a water bottle. Cover the water bottles with muslin cloth and clamp with rubber band. Label each bottle with the name of botanical and insect.

Observations

Make hourly observations noting differences in insect behaviour and death by type of pesticide and insect species.

Guide question for discussion

1. What differences do you observe between the different bottles (treatments)?
2. Did you observe any differences between the behaviour of the insects?
3. Did the botanicals kill all insects exposed to them or only some insects?
4. Which botanical would you prefer to use on your farm? Why?
5. Is it possible to control pests while conserving natural enemies? How?
6. What did you learn from this exercise that you can apply to your own farm?

Version: October 2004

Discovery learning exercise 22: Pesticide resistance role-play

When pesticides are used on a frequent basis, there is risk of build-up of pest resistance against pesticides. Serious outbreaks of pests have been documented in several countries after intensive use of chemicals, resulting in the reduction of natural enemies, and meanwhile building up pest resistance to pesticides. At the same time, farmers tend to increase the frequency and dosage of pesticide application when crop health problems persist. As farmers get caught in the ‘pesticide treadmill’, costs of production escalate. This role-play shows how the build-up of pest resistance reduces the effectiveness of insecticide.

Learning objective

To understand how insect populations become resistance to insecticides.

Materials

- Tissues to cover noses of “super insects”
- 1 hand sprayer filled with water (“poison sprayer”)
- 6 chairs or stools to represent cocoa trees (you can decorate them with leaves and pods)
- Prepared script of the story

Procedure

Organize participants for the mime role-play. You will need the following volunteers:

1 participant to be the Story Teller

1 participant to be the Farmer (who will keep the “poison sprayer” with him/her)

7 participants to be “Ordinary Insects”

14 participants to be “Super Insects” who cover their noses with tissues

A group of “observers” (all remaining participants who will take notes of what happens).

Ask the “Ordinary Insects” to stay on one side and the “Super Insects” on the opposite side. The middle area is the cocoa farm. You may draw a boundary on the ground for the two sides of the “farm” using chalk. Put 6 chairs or stools as cocoa trees in the area representing the farm.

The story teller starts reading the script, while the acting participants mime the role-play (instructions in italics).

Story teller: "In the first week of the cocoa season, a farmer went to his farm and found five insects. He complained bitterly about the presence of these insects because he regularly sprayed the farm in the last season. He did not know it, but one of these, a Super Insect, was resistant to the pesticide that he usually used. All the others were Ordinary Insects".

(1 Super Insect and 4 Ordinary Insects go into the farm and settle, feeding on the cocoa trees. After that, the farmer comes in and acts as though he is observing the crop and complaining about the insect population)

Story teller: "The farmer became very worried that his cocoa pods would be eaten by the insects, and he decides to spray poison immediately. He went home to get his poison sprayer and sprayed the farm. One lucky Ordinary Insect managed to escape the poison by hiding behind a cocoa pod."

(The farmer brings the poison sprayer into the farm and sprays all except one Ordinary Insect. All Ordinary Insects die while the Super Insect covers his nose with a tissue. He/she shows to the public how his nose cover protects him/her and smiles)

Story teller: "All but one of the Ordinary Insects died of the poison but the Super Insect happily survives because of the resistance he/she has against the poison. Now the Farmer was happy, so he went away for a week. In that week, the surviving insects gave birth to babies. Each adult insect makes 3 babies so that in the next generation, there were 3 Ordinary Insects and 3 Super Insects. After mating and making babies, the adult insects died."

(Surviving insects get babies by inviting 3 more Ordinary Insects and 3 more Super Insects into the field, then fly away and die)

Story teller: "The next week the farmer came to the field and found 6 insects. Of course, he did not know that among the 6, there were 3 Super Insects that were resistant against poison. Again he was worried and he decided to spray. This time he mixed the poison a bit stronger and took care to cover all areas of the trees where the insects could be hiding."

(Farmer looks around carefully and sprays all insects, not excluding anyone)

Story teller: "All Ordinary Insects died of the poison spray but the Super Insects survived."

(Ordinary Insects die, while the Super Insects again show their nose covers to the public and smile)

Story teller: "Again the remaining insects (3 Super Insects) make babies. As before, each adult made 3 babies, flew away and died. Because the parents were Super Insects, the 9 new babies were all Super Insects".

(Surviving Super Insects get babies by inviting 9 more Super Insects into the field, then fly away and die. Farmer takes the poison sprayer, looks around carefully and sprays all the insects, not excluding anyone. The Super Insects again show their nose covers to the public and smile. The farmer looks puzzled.)

Story teller: "What should the farmer do now?"

(End of the role-play. All players stand up and all observers clap)

Guide questions for discussion

1. What did you observe in the role-play?
2. Why did some of the insects die during the spraying? Why did some not die?
3. How many insects died out of how many in each generation?
4. How and why did the numbers change between the generations?
5. What do you think would have happened if the farmer continued spraying pesticides?
6. What else could the farmer try to do?

Version: October 2004

Cocoa quality

Discovery learning exercise 23: Impact of harvesting time on fermentation and cocoa quality

Several factors account for the poor quality of cocoa produced by some farmers. These include poor pesticide application, poor fermentation and drying methods and harvesting pods at the wrong time. Farmers harvest cocoa pods at the wrong time for many reasons including the desire to get income quickly, lack of knowledge about the quantity of fresh beans needed for fermentation and the relationship between harvesting time and quality.

Learning objective

Improve understanding of the maturation stages of cocoa pods and the physical aspects of cocoa quality

Materials

- Flip chart paper
- Markers
- 30-40 kg of fresh cocoa beans, preferably of the same variety, collected from the following types of pods:
 - 1st lot: immature, green pods
 - 2nd lot: Ripe pods, that is, pods that are half or 3/4 yellow
 - 3rd lot: Over ripe pods, that is pods that are orange
 - 4th lot: Pods attacked by black pod disease

Note: It is preferable to use beans from participants' own farms rather than from the FFS plots so as not to affect the harvest data

- Materials usually used for fermentation
- Fresh banana leaves
- Four trays
- 1 very sharp pocket knife
- Labels for the four fermentation lots
- Materials usually used for sun drying, for example, a cement or raised platform

Procedure

At harvest time, tour the FFS plot with participants, asking them to point out which pods are ready for harvesting and which are not.

Return to a central place. List on a flip chart the factors farmers consider when deciding when to harvest. Discuss to what extent each factor provides flexibility for harvesting later.

Cover the four lots of beans to be fermented with the banana leaves and place heavy objects on top of each pile.

Ferment and dry as usual for the specific varieties.

After drying, randomly select 100 seeds from each lot and put them on the four trays.

With the pocket-knife, cut each bean longitudinally and observe physical aspects.

Observations

- Take a handful of dried beans from each lot and squeeze between your fingers. Note which beans make a cracking sound.
- Observe and compare the difference in colour between the different lots of cocoa.
- Observe and compare the physical aspect of the cut seeds, and determine the number/percentages of:
 - Brown/purple or purple, compact beans
 - Germinated beans
 - Flat beans

Guide questions for discussion

1. Are there colour differences between the beans from the different lots? What is the difference?
2. Which lots have the worst quality beans?
3. What do you think explains the defects that you observe?
4. Do the differences between the lots of cocoa affect price? How?
5. What have you learned from this exercise?
6. What is the ideal amount for a fermentation heap? Why is the amount in a fermentation heap important?
7. What can farmers who harvest small quantities at a time do to increase their fermentation load?

Version: November 2004

Discovery learning exercise 24: Drying cocoa on a raised, covered platform

Proper drying is important for ensuring good cocoa quality. While drying on cemented floors is common among cocoa farmers in West Africa, the process can be improved through simple technologies such as using raised, covered platforms.

Learning objective

To dry cocoa faster and protect drying cocoa from contamination, dew and rain

Materials

- Cemented floors (at least 2 m x 2 m size)
- 2 raised platforms (at least 2 m x 2 m size raised 1.2 m from the ground and made of finely woven rafters/palm fronds). One of the platforms should be equipped with two 1.70 metres high stands that support the traverse beam for a black plastic sheet to be used in covering the beans at nights and when it rain. (See pictures below)
- About 100 kg. of well fermented cocoa beans
- 3 cocoa beans mixing paddles
- Flip chart and markers
- 1 black plastic sheet

Procedure

Introduce the subject of drying and the objectives of the exercise.

Ask participants to form three groups. One group will work with drying on cemented floor, another will work with drying on a raised platform without a cover, while the third group will work on the raised platform with a black plastic sheet for covering at night and during rains.

Ask each group to spread out at least 25 kg of beans (with a thickness of 3-4 cm) to dry using the relevant method. During the first two days, each group should mix the beans every hour, and, three or four times per day thereafter. Ensure that the group working with the covered platform covers the beans with the plastic sheet if it rains and at night.

After spreading out the beans, facilitate a discussion of the benefits, ease of use and potential problem of each drying method.

Over the next two weeks, each group is responsible for drying the beans until they are fully dried. Groups should note any problems or observation related to the drying process, as well as the time it takes to fully dry the beans.

After 2 weeks, ask each group to report on the method they observed. Facilitate a discussion by the whole school on the three methods.

Guide questions for discussion

1. What are the differences between the three drying methods used?
2. Which method dried the beans faster?
3. Which method best protects the beans from contamination or damage?
4. How much does each method cost? Which method is easier and cheaper to use?
5. What are the limitations of each method and how can they be overcome?



Uncovered drying platform



Covered drying platform

Version: March 2004

Economic analysis

Discovery learning exercise 25: Estimating the profitability of ICPM practices

Learning objective

To enable participants to draw conclusions about the differences in costs and returns between existing and new crop and pest management practices

NOTE: This protocol should be done at the last FFS session

Materials

- Completed harvest record sheets for both ICPM and FP plots
- Completed input record sheet
- Flip chart paper
- Markers
- Calculator (if available)

Procedure

Explain the objectives of this exercise and the steps involved. Ask participants to identify all of the major field activities carried out in the two learning plots and list them, as the following table shows:

	ICPM practice plot		Farmer practice plot	
	Yes/No	Number of times	Yes/No	Number of times
Pruning	✓	2	✗	
Spraying against mirids	✓	2	✓	1
Removal of chupons	✓	1	✗	
Weeding	✓	3	✓	2
Spraying against black pod	✓	2	✓	5
Removed mistletoe	✓	1	✗	
Sanitary harvesting	✓	5	✗	
Removal of shade trees	✓	1	✗	
Harvesting	✓	4	✓	3

Indicate which activity was carried out in each plot and the number of times it was done. Before making calculations it is important to verify that the number of trees in the two plots are the same. If the number of trees is different, you will need to standardize the numbers by dividing the bigger number of trees by the smaller number. For example, if the ICPM plot has 50 trees and the FP plot has 40 trees,

divide $50/40 = 1.25$. Multiply all calculations for the FP plot by 1.25 before comparing with results from the ICPM plot.

Estimate labour use and costs

For each activity, ask participants to estimate the number of hours or days (a day=7 hours) it took to complete the task on each plot, as in the following table:

	ICPM practice plot			Farmer practice plot		
	Yes/No	Number of times	Labour (days)	Yes/No	Number of times	Labour (days)
Pruning						
Spraying against mirids						
Removal of chupons						
Weeding						
Spraying against black pod						
Removed mistletoe						
Sanitary harvesting						
Removal of shade trees						
Harvesting						
Total amount of labour used						
Labour costs						

Next, ask participants to calculate the total amount of labour used and to estimate the cost of labour. Calculate the cost of labour by agreeing how much it would cost to hire someone to do the work.

Calculate yields and value of yields

Get the yields (weight of sorted dried beans) from the ICPM and FP plots from the harvest record sheet. Agree on a price per kg and multiply the yield in each plot by that price:

Value of yield= Yield from ICPM plot x price of cocoa

Value of yield= Yield from FP plot x price of cocoa

Calculate cost of inputs

Get the total cost of inputs used during the season in the ICPM and FP plots from the input record sheet.

Calculate the net benefit of the new practices

Calculate the net benefit for each plot as follows:

Net benefit of ICPM plot= value of yield from ICPM plot – (cost of inputs on the ICPM plot + labour cost on the ICPM plot)

Net benefit of FP plot= value of yield from FP plot – (cost of inputs on the FP plot + labour cost on the FP plot)

Compare the net benefit from the two plots. This tells the profitability of implementing or not implementing ICPM practices.

Calculate the average rate of return (ARR)

The average rate of return is a more powerful indicator of the profitability of ICPM practices. It is an indicator that compares net return to the funds invested. It is the ratio (expressed as a percentage) of the additional net benefit to the additional costs resulting from switching from farmers' normal practice to ICPM practices.

Calculate the ARR by doing the following:

ARR= (Net benefit of ICPM plot– Net benefit of farmer practice plot) / (total cost of inputs from ICPM plot + total cost of labour from ICPM plot) - (total cost of inputs from FP plot + total cost of labour from FP plot)

Step 1: Calculate the costs of inputs and labour for the ICPM plot + the cost of inputs and labour from the FP plot

Step 2: Subtract the net benefit of the ICPM plot from the net benefit of the FP plot

Step 3: Divide the figure obtained in step 2 by the figure obtained in step 1

An ARR of 90%, for example, means that investing one thousand francs will yield a profit of 900 francs. Remember that an ARR of 40% or higher is considered good.

Compare the ARR to the interest rate in the village (example rate of loan in the village). The ARR should be higher than the village interest rate. If the cost of loans in the village is, for example 40%, giving a loan of 1000 francs would yield a profit of 400 francs.

Conclusions

Use the guide questions to facilitate a discussion about conclusions that participants can draw from the calculations made.

Guide questions for discussion

1. What is the difference between the ICPM and FP plots in the number of pods lost to black pod? Mirids? Rodents? Other pests and diseases?
2. What is the difference in the quantity of pesticides (both insecticides and fungicides) used in each two plots?
3. What is the difference in the number of sprays done in each plot?
4. What is the difference in the cost of pesticides (both insecticides and fungicides) used in each plot?
5. What is the difference in the yield of each plot?
6. What is the difference in the amount of labour used in each plot?
7. What difference have you observed in ease of spraying in the FP and the ICPM plots?
8. Are ICPM practices more or less profitable than farmer practice?
9. What are the advantages of ICPM practices over farmer practice? What are the disadvantages?
10. How could the ICPM practices be adapted to better suit farmers' needs and their profits from cocoa production?

Version: November 2004

Input record sheet

Name of school	
Month school started:	
Field area:	Cocoa varieties
ICPM plot:	
FP plot:	

Farmer practice plot

ICPM plot

Date	Inputs			Remarks
	What input	Amount used	Monetary value	
Session 1				
Session 2				
Session 3				
Session 4				
Session 5				
Session 6				
Session 7				
Session 8				
Session 9				
Session 10				
Session 11				
Session 12				
Session 13				
Session 14				
Session 15				
Session 16				
Session 17				
Session 18				
Total	-----			
Total expenses on inputs:				

Harvest data record sheet

Date:

Group:

Village: Type of plot (IPM, FP):

Harvest number	Harvest date	Harvest from IPM plot	Harvest from farmer practice plot
		No. of ripe, healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____	No. of ripe healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____
		No. of ripe healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____	No. of ripe healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____
		No. of ripe healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____	No. of ripe healthy pods: _____ No. of ripe pods that cannot be used: _____ (Note reason for damage e.g. black pod, rodents etc) Weight of sorted dried* beans: _____ Weight of waste: _____

Discovery learning exercise 26: FFS impact evaluation

Objective

- Identify the strengths and weaknesses of the FFS
- Plan activities that will be done after the end of the FFS

Materials

- Flip chart paper
- Markers

Procedure

1. Observing change after applying new practices and knowledge learned in the FFS (participatory monitoring)

Present the flip chart with the results of the exercise “observing change” done at the start of the school. Go over the objective of monitoring and review the indicators that participants agreed to monitor. The indicators correspond to the following questions as well as others identified by participants at the start of the school.

Question	What to write
1. How many bags of cocoa did you produce this year from all your farms? (NOTE: you will need find out how much the average bag weighed in kilos to answer question 2)	Exact number
2. How many kilos of cocoa did you produce this year from all your farms?	Less than 100 kg, 100-300 kg; 301-499 kg; 500-800; 801-1000; more than 1000 kg
3. Did you spray fungicide on your cocoa this year?	Yes/no
4. How many times did you spray fungicide this year?	1-2 times, 3-5 times, 6 or more times)
5. How much fungicide did you apply to your cocoa farms this year? NOTE: participants must agree on the units to be	Exact amount and unit

used by everyone, for example, 75 g packets

6. Did you spray insecticide on your cocoa this year? Yes/no

7. How many times did you spray insecticide this year? 1-2 times, 3-5 times, 6 or more times)

8. How much insecticide did you apply to your cocoa farms this year? Exact amount and unit

NOTE: participants must agree on the units to be used by everyone, for example, 75 gram packets

Place a new flip chart paper next to the old sheet showing the indicators for each participant at the start of the school. Go through each question with each participant. If it is not yet the end of the cocoa season, and participants are unable to answer some questions for the whole year, agree to provide answers up to now or to estimate for the whole season. Discuss the results using the guide questions.

Guide questions for participatory monitoring

1. What positive changes have participants experienced? What contributed to these positive changes?
2. What negative changes have participants experienced? What contributed to these negative changes?

2. FFS impact evaluation

Lead a discussion about how participants benefited from the FFS training process using the guide questions to lead the discussion. The discussion should cover the following broad topics and provide the following information:

- Topics of most interest (number of participants)
- Most important knowledge and skill learned (number of participants)
- Use of new practices of own farm (number of participants)
- Practices being implemented (number of participants) (use the form who is practicing ICPM practices)
- What knowledge and skills was shared (list those shared with non-FFS farmers)
- Shared new knowledge/skills (number of participants)
- Reason for non-attendance of FFS
- Suggestions to improve the FFS

Write up the results of the discussion on a flip chart.

Guide questions for discussion

1. Which topics in the cocoa FFS did you find interesting and which did you find uninteresting?
2. What is the most important thing you have learned in the cocoa FFS?
3. What skills have you learned or improved during the cocoa FFS?
4. What practices learned in the cocoa FFS have you already implemented on your own farm? Which practices do you plan to implement on your farm in future?
5. Have you shared knowledge or skills learned in the cocoa FFS with other farmers? What have you shared?
6. What were the reasons for the absence of participants during certain meetings?
7. What suggestions do you have to improve the cocoa FFS?

Planning FFS follow-up activities

Facilitate a discussion on what activities participants would like to carry out as a group or in sub-groups after the end of the FFS. Some suggestions include

- Research
- Learning about topics not covered during the FFS
- Group marketing of cocoa
- Forming work groups to implement new skills (for example, pruning or grafting) learned in FFS on other farmers' fields

Guide questions for discussion

1. Have we defined exactly do we want to do?
2. What is the purpose of the activity? How will it benefit us?
3. For how long do we want to work together (a month, a year)?
4. Do we need a facilitator or resource people or can we work on our own? If we need others, how to we contact them?
5. How often should the group meet? Where should we meet?

6. How should we organize ourselves (do we need to appoint officers)?
7. What do we need to get started?

Version: October 2004

Who is practicing integrated crop and pest management (ICPM) practices?

NOTE: Participants together with the facilitator should decide on the practices to include in the table.

Area covered: Indicate the area covered by the new practice as follows: Whole farm; Most of the farm (50-99 %); Much of the farm (20-50%); Very little of the farm (less than 20%) or use symbols like a smiling face.

Social topics

Discovery learning exercise 27: An introduction to child labour issues

Farmers need to understand why and how working in the agricultural sector can be hazardous and risky for both adults and children. Learning how children can be unwillingly put at risks in cocoa farms, and in agriculture in general, will help farmers identify hazardous activities from which children should be excluded, and use alternatives to child labour available in their communities.

Learning objectives

- To identify hazards and risks in cocoa farms which are detrimental to children's health and safety
- To sensitize participants to the causes and consequences of child labour (economic, physiological, physical, psychological, social, emotional) on children, families, communities and countries
- To identify alternatives to child labour

Note: this exercise can be done separately or as part of the cropping calendar exercise.

Materials

- A flip chart board and paper
- Markers

Procedure

Ask participants if they have ever had or heard of any accidents or are aware of the risks involved in growing cocoa. Select two or three to tell their stories. Note the answers on flipcharts.

Ask the group to list all the activities involved in growing cocoa.

Divide the participants into small groups. Have each group work on 2-3 activities and provide the following information for those activities:

- Person or group involved
- Tools or materials used
- Whether the activity is hazardous (dangerous) or not
- Why the activity is hazardous and who is the most vulnerable person/group
- Identify alternatives or what can be done to reduce the danger

Activities	Persons or groups involved	Tools or materials used	Hazardous or not hazardous? Why hazardous?	Most vulnerable group	Alternatives

Have each group present their results to the whole school. If the exercise is properly facilitated children should come out as the most endangered group. Discuss possible hazards to children doing the listed activities, including physical, emotional and even psychological hazards.

Introduce the concept of child labour, its causes and consequences by mentioning the following:

- Difference between light/casual work done by children as part of training them for life (socialization) and child labour.
- Because of accidents, compensation rates can be higher if children are employed, and how productivity can be affected by relying on children.
- Child labour is not allowed by international and national laws
- Cocoa producers may find it difficult to market their produce due to the global cocoa initiative against child labour
- Our aim is clean, good quality cocoa free of child labour.
- If anyone hears of or sees a situation involving child labour, report it to the proper authorities.

Guide questions for discussion

1. Why do some people use their children to work on cocoa farms?
2. Do you know of cases of children working on cocoa farms? What are the effects on the children?
3. What can be done to avoid children working on cocoa farms?

Version: October 2004

Discovery learning exercise 28: Children carrying heavy loads in cocoa production

Carrying loads is a normal part of life in rural Africa. Farmers may not be aware that when children carry heavy loads, they run the risk of damaging their still growing bodies. The purpose of this protocol is to sensitize farmers on the potential dangers of having children carry heavy loads and to help them find alternative means of transportation.

Learning objectives

- To sensitize participants to the negative effects on children of carrying heavy loads
- To develop appropriate ways for farmers to identify weights that children below 15 can safely carry
- To explore alternatives to reduce or eliminate load carrying by children

Materials

- Flip chart paper
- Markers
- Objects of different weights (2, 5, 10 kg)
- Case study

Procedure

Read the case study presented below (several times if necessary) ensuring that all the participants understand. Participants can also be asked to recite the story.

Case study

There was a cocoa farmer named Chief Adeniyi who had an 8-year-old son named Kolawole. One day Chief Adeniyi, accompanied by his son, went to his cocoa farm to harvest the cocoa. After harvesting and breaking the pods, Chief Adeniyi loaded cocoa beans into two bags of 50 kg each. Chief Adeniyi carried one of the bags and gave the second bag to Kolawole. Although the cocoa was too heavy for Kolawole, he did not complain since his father, a chief, was carrying another bag. He also felt he should obey his father out of respect. Kolawole didn't complain as he struggled with the heavy load. Some time after this incident, Kolawole's neck began to ache. Still he did not complain and he continued to help his father carry heavy loads of cocoa beans. After some time, one day while carrying a load, Kolawole collapsed. Chief Adeniyi quickly chipped

his load, picked the boy up and rushed him to the clinic. . The doctor examined Kolawole and found that he had a sustained spinal injury. Thereafter, Kolawole could not walk and has been using crutches ever since. Kolawole is 20 years old today and still walks with crutches.

Use the guide questions to discuss the case study, the issue of children carrying heavy loads and what can be done about it.

Present the different weights. Introduce the subject of light work done by children and child labour to show that load carrying by children moves from light work to child labour when the weight of the load is too much for the child.

Guide questions for discussion

1. What was the role of the father in the case study?
2. What was the experience of the child in the case study?
3. Do you know of similar experiences?
4. What do you think can be done to prevent such occurrences?
5. What lessons have you learnt from this story?
6. At what age should children be involved in carrying loads? Why?
7. What is the maximum weight of load for a child of under12 or over 15 to carry?
8. What kind of things should children be allowed to carry?
9. What arrangements can be made to avoid children carrying heavy loads?

Version: June 2004

Discovery learning exercise 29: The use of pesticides and chemicals by children on cocoa farms

Farmers often consider pesticides (cide means to kill) as ‘medicine’ for plants, not understanding that pesticides can be dangerous for their health and well-being. The aim of this protocol is teach farmers that, while very effective in controlling pests, pesticides are poisononous and dangerous to humans. Understanding this basic fact will help farmers protect themselves and appreciate why children should not be involved in pesticide application, or even nearby when pesticides are being used.

Learning objectives

- To sensitize participants to the dangers of involving children in the mixing, loading and application of pesticides and the handling and maintenance of application machinery
- To explain the consequences of pesticide and chemical applications on children’s health and safety
- To discuss appropriate protective measures for farmers and children

Materials

- Flip chart paper
- Markers
- Case study

Procedure

Ask participants to describe how they use, apply and store pesticides (materials used, type of products, frequency). For each activity, ask who is involved, noting the specific activities done by children and their specific ages. List all answers on the flip chart.

Read the case study presented below (several times if necessary) ensuring that all the participants understand. Participants can also be asked to recite the story.

Case study

Moussa has a cocoa farm. He has two children: 8 year old Wandja and 15 year old Seydou. After school, the two children usually helped their father to spray

pesticides in the cocoa farm. One day, while mixing and spraying pesticides, a few drops of the product splashed into the eyes of the two boys.

At the age of 12, Wandja began having difficulties reading on the blackboard. The doctor detected that he had eye problems and was gradually losing his sight. Wandja had to abandon school and remain at home.

After graduating from university at the age of 24, Seydou decided to sit for the police entrance examination in order to become an assistant superintendent of police. He passed the written exam, but during the medical test the doctor detected that he had an eye problem. This problem was traced back to exposure to pesticides. Seydou therefore could not be admitted into the police school. He therefore returned to the village and shared his misfortune with members of his family and community.

Using the guide questions, facilitate a discussion on the case study and generally on pesticide use by children.

Guide questions for a discussion

1. What can you say about the case study and the role played by each actor?
2. What lessons can you draw from this case study?
3. How do pesticides penetrate the body?
4. Why are children more vulnerable to risks in pesticide application?
5. What safety measures can be used during application and cleaning of spray equipment to reduce the negative effects of pesticides?
6. What comparison can you make between what happened in the case study with your own practices?
7. What other arrangements can be made to avoid children applying pesticides or cleaning spray equipment?

Version: October 2004

Discovery learning exercise 30: The use of sharp farm tools by children in cocoa cropping activities

Rural people consider the use of the machete and other sharp farm tools as a part of their everyday lives, using them for many different purposes. However, sharp tools used in cocoa production are potentially dangerous when used by children.

Learning objectives

- To identify the risks and dangers associated with the use of sharp tools by children in cocoa production
- To explore alternatives to the use of sharp farm tools by children

Materials

- Flip chart paper
- Markers
- Case study

Procedure

Read the case study presented below (several times if necessary) ensuring that all the participants understand. Participants can also be asked to recite the story.

Case Study

Adjobi is the 9 year old son of Assielou, a cocoa farmer. He has used machetes since the age of 6 to weed and clear land. Assielou, confident of his son's apparent ability to use the tool well, asks Adjobi to help him break cocoa pods. While working, Adjobi hurts himself ; the machete cuts two veins in his hand and he loses a lot of blood. Adjobi can no longer normally use that hand.

Facilitate a discussion using the guide questions.

Guide questions for discussion

1. What comment can you make about this case study?
1. What do you think of the role of the father, Assielou, in this case study?
2. What do you think about what happened to Adjobi?
3. What lessons did you learn from this case study?
4. For which other tasks do children use sharp tools in cocoa production?
5. What other less dangerous tools can be used by children in breaking cocoa pods and doing other tasks in cocoa production?

Version: November 2004

Discovery learning exercise 31: Raising awareness about HIV/AIDS

HIV/AIDS is affecting high numbers of rural Africans. The disease is having a major effect on agriculture generally and could negatively affect cocoa production in future. It is everyone's responsibility to make sure that farmers are informed about this deadly disease and know how to protect themselves against it.

Learning objective

To raise awareness of the HIV/AIDS disease and how it affects cocoa production today and in future.

Materials

- Flip chart paper
- Markers
- Case study

Procedure

Read the case study presented below (several times if necessary) ensuring that all the participants understand. Participants can also be asked to recite the story.

Case study

Ngozo, a 45 year old cocoa farmer, lives with his wife, Binta, aged 30, and 3 children ranging in age from 14-6. His village is on the highway leading to the capital city and is an important stop for trucks transporting goods between the capital and other parts of the country. Due to the high number of truck drivers who stop in the village, there are many prostitutes. Ngozo learns from conversations with friends in drinking spots that there is a new disease in his village called AIDS that kills people. There are many rumours in the village about the disease. Some say you can get it by being bitten by mosquitoes, other say you get it from sharing a glass or food with someone who has the disease, while other say that you can tell just by looking at someone whether or not they have the disease. Most people in the village think that AIDS is caused by witchcraft.

In 2001, Binta goes to spend 6 months in her village to look after her sick mother. While she is away, Ngozo gets very lonely and befriends a young woman from the village named Mary. After some time, Ngozo begins to sleep with Mary, which goes on until Binta comes back home. Life continues as usual for a few years. In 2003, Ngozo starts to suffer from strange illnesses such as skin rashes and mouth sores. Local doctors are unable to treat this illness. At the same time,

Binta announces that she is pregnant. Ngozo, very worried by this time, goes to the nearest large town to seek medical attention. At the hospital, he is told that he has AIDS. Ngozo is shocked. He returns home and reluctantly tells his wife of this trouble. Ngozo becomes more and more weak until he is unable to cultivate his cocoa farm. He finds out that his friend Mary also has AIDS. Binta delivers the baby but notices that the baby is not well. When she goes to the hospital, she is told that the baby has AIDS. Binta also tests positive for the disease although she has no symptoms. She returns home and spends all of her time looking after her sick husband and baby and struggling to scrape enough money together to feed the family. The cocoa farm is abandoned due to lack of labour. Eventually, Ngozo dies at the age of 49.

Facilitate a discussion on the case study using the guide questions. At the end of the session, provide information to participants on where to get more information locally about HIV/AIDS.

Guide questions for discussion

1. Have you heard of HIV or AIDS? What is the local name?
2. What is HIV? What is AIDS? What is the difference between HIV and AIDS?
3. How do you get AIDS?
4. How do you think Ngozo got HIV/AIDS? (Brainstorm and list ideas)
5. How can people protect themselves against HIV/AIDS? Are condoms available in this village?
6. What are the symptoms of AIDS?
7. If someone gets AIDS, what should they do?
8. How should we act toward a person who has AIDS?
9. Could Ngozo have lived longer with the disease? How?
10. According to the story, what consequence does HIV/AIDS have for our families, children and our community?
11. What can we do as a community to fight against this disease?

Version: February 2004

Discovery learning exercise 32: HIV/AIDS risk map

HIV/AIDS is affecting high numbers of rural Africans. The disease is having a major effect on agriculture generally and could negatively affect cocoa production in future. Mapping areas of a village that are favourable to non-protected sex and other high-risk behaviour is an effective way to raise awareness about the disease and help prevent it.

Learning objectives

- To sensitize participants on high-risk behaviour and practices that encourage the transmission of HIV/AIDS and other sexually transmitted diseases
- Develop an action plan to stop the spread of HIV/AIDS that can be presented to local authorities or development agents for implementation by the wider community

NOTE: This protocol should be used together with the HIV/AIDS case study protocol.

Materials

- Flip chart paper
- Markers

Procedure

Before the start of the exercise there should be a discussion of the causes of HIV/AIDS and the kinds of behaviour that leads to contamination by HIV, using for example the protocol “Raising awareness about HIV/AIDS”. Explain that the purpose of the exercise is to identify areas of participants’ village(s) where the kinds of behaviour that lead to people contracting the disease take place.

If possible, divide participants by age and/or sex so that there are at least two groups. Ask each group to draw a map of their village. This map should show public places of importance. If participants come from a number of villages, you may divide them into sex/age groups or have people from several villages form a group. Where group members come from several villages, they can agree to draw one village that most people know or draw a typical village of the area.

Using the guide questions, have participants discuss and list places and occasions that are favourable to the spread of HIV/AIDS through non-protected sexual relations, as well as cultural practices such as scarification, circumcision

and excision. Participants should draw these locations on the map and indicate the specific behaviour or practice associated with each location.

In groups, discuss constraints to changing high-risk behaviour. Ask participants to propose solutions and identify the kinds of support that will be necessary for these solutions to work.

Have each group present their map to the wider group and work out an action plan with a calendar.

One or more participants should be asked to take the responsibility of presenting the action plan to local leaders and/or local programs working on HIV/AIDS.

Guide questions for discussion

1. How is HIV transmitted?
2. Which behaviours and practices encourage the spread of HIV?
3. Where in our villages do these behaviours and practices responsible for spreading HIV take place?
4. What needs to be done to reduce risky behaviours?
5. Who should be involved in efforts to reduce high-risk behaviour?
6. How can we develop a plan to reduce the spread of HIV/AIDS in our area?

Version: February 2004

Group dynamic and energizer exercises

Discovery learning exercise 33: Water brigade

Learning objective

To demonstrate the importance of cooperation

Duration

45 minutes, including the discussion

Materials

- Two pails
- Two large plastic buckets
- Water

Procedure

Divide the participants into two groups of equal sizes. Line up the members of each group away from one pail, located in between the two groups.

Game 1

Fill the pail located in the centre of the two groups with 6 litres of water.

Announce the following instruction to the two groups:

"You have to use your hands to pass the water from one person to the other. The last person pours the water into the bucket of his/her team. Everybody has to remain where he/she stands, and has to hand over the water only to the person standing right beside him/her. The team with the most water in the bucket at the end of this activity wins".

Start the game and watch to make sure that nobody cheats. There is no time limit, so let the teams pass water on through the brigades until the central pail is empty.

Measure the water in the three buckets to determine which team is the winner. The team with the most water in its bucket is the winner.

Note: Usually, teams spill a lot of water while competing for the common resource (water in the central pail). Show this to all of the participants.

Game 2

Maintain the same teams. This time, give each team its own pail containing 3 litres of water. Once again, announce the following instruction:

"You have to use your hands to pass the water from one person to the other. The last person pours the water into the bucket of his/her team. Everybody has to remain where he/she stands, and has to hand over the water only to the person standing right beside him/her. The team with the most water in the bucket at the end of this activity wins".

Once again, start the game and check that nobody cheats. After both teams have finished taking all the water from the pails placed in the centre and passed it from one person to the next into their bucket, measure the water in the receiving bucket of each of the teams and announce the winner.

Show the difference in the amount of water in the buckets from the two games. Ask participants to identify the difference between the first and the second game.

Debriefing questions

1. Why is the amount of water in the buckets from the second game more than that from the first game?
2. What was the time difference between the first game and the second game?
3. Were there any time limitations in the first and second games?
4. Why did everybody rush during the first game but perhaps did so less during the second game?
5. Why did the winning team win? Did they organize themselves prior to the second game or did they have a better team spirit and cooperated better? Was there a gender balance, if not, what gender were the members of the winning team? Why?
6. Does the game teach us something about how natural resources, such as how rainforests close to cocoa growing areas could be preserved?
7. Does this game teach us something about cooperation and how cocoa farmers can help one another?

Version: June 2004

Discovery learning exercise 34: Differences in perceptions: the story of Serwa

Non-formal adult education is faced with the problem that people differ widely in the way they perceive and process information. This is due to differences in age, gender, religion and ethnicity and to the uniqueness of every individual. In conducting farmer field schools, it is important that facilitators and participants recognize these differences and their implications for learning.

Learning objective

To develop an appreciation for the differences in the way information is perceived and implications for learning about complex topics such ICPM

Materials

- Flip chart paper
- Markers
- Story
- Paper

Procedure

Ask for seven volunteers to read aloud the seven paragraphs of the following story of Serwa.

The Story of Serwa

Once there was a young woman called Serwa. Serwa was only 19 years old and was very beautiful. She was also very poor. She lived in a village on the bank of a big river. Serwa was engaged to be married to a young man called Mensah who lived in another village on the opposite side of the river. The river was wide and fast flowing and contained many crocodiles.

One day Serwa heard that Mensah was very ill and might even die. She became very anxious. Serwa loved Mensah very much and wanted to be with him because he was sick and might die.

So she went down to the river where there was a ferryboat. A man called Yaro rowed the ferryboat. When Serwa told him that she wanted to cross the river, Yaro asked her to pay ¢500. Serwa said that she did not have ¢500 at that time but she would pay him later. Yaro refused. Then Serwa pleaded with him to take her because Mensah, her fiancée, was very ill and might die. Yaro again refused. Yaro later agreed to take Serwa across the river only on one condition: that she sleep with him first.

Serwa was very upset about this and went back to her village wondering what to do. On the way home she met her cousin, Baba, to whom she narrated the story. "That's nothing to do with me" he replied her. "That is your own problem. Do not involve me in it. I do not want to have anything to do with it" Then Baba went off leaving Serwa confused.

Serwa did not know what to do. She hated the idea of sleeping with Yaro, but she loved Mensah so much and thought that she might never see him again if he was to die of his illness. She had to get across the river somehow to see Mensah. So finally she went back to Yaro and slept with him. He then took her across the river and she rushed to Mensah's house.

At Mensah's house, Serwa nursed him and looked after him. Soon Mensah felt better and was out of danger of dying. After some time Mensah asked Serwa how she crossed the river and where she got the money to pay the ferryman. Serwa then confessed to Mensah what had taken place between her and Yaro. Mensah was furious. He shouted at Serwa and insulted her calling her rude names for having slept with Yaro. He told her that he would never marry her and that she should get out of his house forever.

Serwa went sadly away, down to the ferry again. On the way she met a neighbour called Nana. She narrated everything that had happened to Nana who was very angered at what he heard. He immediately rushed to Mensah's house, dragged him from his sick bed and beat him up very badly.

End of story

After reading the story, list the five characters of the story on a flip chart and ask all participants to rank the characters in terms of their moral character, from best to worst, on a piece of paper. Collect five of the rankings and write them on the flip chart.

Debriefing questions

1. What do we notice about the rankings? (Emphasize that there is no right answer)
2. What explains the differences in ranking?
3. What lessons have you learned from this exercise?
4. Based on the lessons learned, what are the implications for important discussions where there is a right answer?

Version: October 2003

Discovery learning exercise 35: Collector's items

Learning objective

To raise awareness about the importance of planning, collaboration and creativity when doing a collective assignment

Materials

Small pieces of paper with lists of the items to be collected (see below)

Duration

20-25 minutes

Procedure

Divide participants into small groups with an equal number of members (preferably 5-6 per group). The groups will compete to collect a list of items, some of which may be difficult or impossible to find. A list may contain the following, for example:

- A cocoa pod with black pod infection
- A handful of healthy soil
- A cocoa husk
- A village map
- A spider
- An empty fungicide sachet
- A cocoa leaf damaged by mirids
- A straw hat
- A broom
- A watch
- A basket

The list should be prepared in advance.

Explain the procedure of the game. The groups have a maximum of 10 minutes, but those finishing early will receive additional points. When the procedure is clear, distribute the lists to the groups and let them start.

After all groups have finished, check the items that have been collected and give points for correct items. Extra points should be awarded for creativity, for example, a village map drawn by the group itself. The group with most points for speed, completeness and creativity, is the winner.

Debriefing questions

1. What strategies did your group apply to divide the tasks and collect the items?
2. What worked well and what did not?
3. What can we learn from this exercise?

Version: November 2004

Discovery learning exercise 36: Whispering a message

Learning objectives

- To demonstrate how messages get changed when communicated
- To start a discussion on factors influencing communication

Materials

- 2 sheets of paper
- Pen

Procedure

Write a message related to the topic of the FFS on a piece of paper that is not shown to any of the participants in advance of the exercise. An example of a message is:

"A good ICPM definition should stress the ecological approach of pest management and the integrated manner of applying all control techniques available"

Participants are divided into groups of 5 to 8 persons and lined up in front of a flip-chart. The first person in the line receives the card with the statement and reads it softly (whispering) to the next person in line. You are not allowed to ask questions or ask for repeats. The person whispers what he/she hears to the next person in the line and so on until the last person in the line has received the message. The last person receives a marker and writes on the flip-chart what he/she has heard.

Once all groups have finished the exercise, compare the results among the groups and with the original message.

Debriefing questions

1. How much of the information was lost in each transmission?
2. How can we improve communication so that information is not lost?

Version: March 2003

Discovery learning exercise 37: Saboteur

Learning objective

To create a group strategy for recognising and dealing with sabotage (behaviour that may be harmful to the group)

Note: can be used as a group dynamic exercise or energiser

Duration

15 minutes or longer depending on the length of feedback

Materials

- Flip chart paper
- Markers

Procedure

The participants are divided into threes. Within each subgroup, they have to fill three roles – the speaker, the listener and the saboteur. The speaker and listener face each other to talk, while the saboteur can move about. The speaker is asked to describe some aspect of their work or life to the listener. The saboteur is asked to try to sabotage (i.e. disrupt) this discussion in any non-violent manner.

Roaming saboteurs can move between groups. These may be the facilitator, plus any others who did not join groups.

After two minutes ask participants to change roles. Change roles again after two more minutes, as it is essential for all participants to have the opportunity to play all three roles. Everybody should know what it feels like to be a saboteur and to be sabotaged.

Discuss the exercise using the debriefing questions. Write responses on how to deal with saboteurs on the flip chart.

This exercise and discussion may be especially useful if there are particularly disruptive members of the group. Such an exercise may be an opportunity for them to reflect on their behaviour and for the group to develop ways of dealing with disruption.

More important, however, it introduces the notion of sabotage to the whole group, as well as focusing on strategies to deal with it. During the FFS, it is likely that participants will self-regulate without any input from the facilitator. Any interruption will be greeted by calls of “sabotage”.

Debriefing questions

1. What was it like to be a saboteur or to be sabotaged?
2. Did you find it easy or difficult to disrupt the conversation?
3. What different types of saboteurs did you experience or have you experienced in the past? Examples include dominance, rigidity, interruptions (answers/questions), joking and not being serious, rudeness, silence, taking-over with enthusiasm and physical distraction by fidgeting
4. How have you or could you deal with saboteurs?
5. What are the ways groups can deal with saboteurs. Examples include: ignore politely, polite/clear interruption; stop the discussion, talk it out (publicly or personally); acknowledge and postpone; divert attention- form sub-groups or set task; use saboteur for debate; ask others for help; allow it; walk away.

Version: January 2004

Discovery learning exercise 38: Knotty problem

Learning objective

To demonstrate to participants that groups empowered to solve their own problems are much more successful than if instructed by outsiders

Duration

10-15 minutes

Materials

None

Procedure

Select one, two or three participants to act as managers. They are asked to stand aside (out of hearing distance), while the facilitator instructs the rest of the group.

Game 1

Divide the remaining participants into 1-3 groups. Ask them to hold hands in a circle and tie themselves into as entangled a knot as possible. They must not let go of each other's hand at any cost.

Tell the participants to follow the manager's instruction literally and not make it easier for them by doing what they have not been told to do.

Once the knot is complete, the managers are asked to return and to unravel the knot within three minutes using verbal instructions only.

Instruct the managers to hold their hands behind their back. They are not allowed to touch the group, only instruct them verbally.

The first attempt is generally not successful and sometimes even produces a more complex knot.

Game 2

Now repeat the exercise with the managers participating in tying the knot. When the knot is ready, simply instruct the participants "get out of the knot yourselves".

Debriefing questions

1. The second untying process is usually much quicker. Why? How does this apply to the real world?
2. What does the game tell us about the role of “outsiders/managers” and “insiders” in the knot?
3. What does the exercise tell us about the effectiveness of “outsiders/managers” in organising people?

Version: May 2004

Discovery learning exercise 39: The prisoner's dilemma

Learning objective

To demonstrate that groups can evolve competitive or cooperative strategies by exploring trust, the effects of betrayal of trust, the effects of competition and the process of developing cooperation

Duration

About 60 minutes

Materials

- Pens
- Paper

Procedure

Divide participants into an even number of teams. Explain that the objective of the game is for each team to maximise its own score.

The teams are paired (an A team and a B team playing opposite each other) and instructed not to communicate with the other team in any way, verbally or non-verbally, except when you tell them to. They can discuss amongst themselves to choose between Red strategy or Blue strategy. Red or blue is written on separate cards and each team gets one of each. Tell the teams how many points they will get in the situations outlined below.

Ten rounds are played in which each team chooses between Red strategy or Blue strategy. Set a time limit of three minutes for each round. When the time for a round is up, they hold up the appropriate card for everyone to see the team decision.

At the end of each round, the scores for each team are identified and recorded based on:

- Both groups choose red- both score 2 points
- Both groups choose blue- both score 1 point
- One chooses blue and the other chooses red- blue gets three and red 0.

At rounds four and eight, the teams are allowed to consult.

After the 10th round, a final score is calculated and a debriefing is held.

Comment

The normal result is that both teams agree to choose red to get maximum group allocation, and then one or both plays blue. The double crossers score three points and the one staying with red gets zero. Teams will thus try to get their double-crossing in first. There are two scenarios: (1) trust between the teams slowly decreases until each is determined to mislead and cheat; or (2) trust becomes enhanced and fixed by some form of mutual agreement.

At the end the trainer compares the scores of individual teams, the aggregate pair scores and the overall score. The maximum individual team score is 30 points; (if they choose blue every time and their paired team always choose red); the maximum aggregate pair score is 40 points (if each group chose red every time). Variations on this game include only having two teams, who send out representatives for negotiations at rounds four and eight, and announcing that the scores will be doubled at these stages.

Version: January 2004

Discovery learning exercise 40: Rope square

Learning objectives

- To explore how a group works as a group on a difficult task
- To show how people adopt different roles in a group

Duration

20-30 minutes

Materials

A piece of rope that is tied so that it forms a circle sufficiently long so that half the total group can hold onto it with both hands.

Procedure

Divide participants into two groups: the silent observers and the square-formers. Lay the rope in a circle on the ground. Ask the square-forming group to stand in a circle around the rope. The observers should stand back and watch in silence.

Ask the square-forming group to pick up the rope circle with both hands. Ask them to close their eyes and walk around in a circle, still holding the rope, so that they become somewhat disoriented. Then ask the group to form a perfect square with the rope (eyes still closed). Group members can talk to each other (in another version of this exercise they can remain silent). The other group should observe the dynamics without commenting. Change the roles of the groups and then debrief.

Debriefing questions

This is potentially a very powerful exercise, revealing a lot about the different types of actors within the group, including leaders, saboteurs etc. There are always too many leaders. Use these questions to draw these points out:

1. Who felt frustrated?
2. Were the instructions given by other group members clear?
3. How did you respond to contradictory orders or requests?
4. Who took the lead? Why? When?
5. Who played a bridging role?
6. Who kept quiet?
7. Who cross-checked and evaluated orders from others?

The point is not to make the evaluation personal, but to point out the range of qualities of members of the group and how they interact successfully and unsuccessfully in completing a difficult task.

Version: November 2004

Discovery learning exercise 41: Line up

Learning objectives

- To encourage participants to know more about each other with regard to physical and personal characteristics
- To encourage group collaboration

Duration

10 minutes

Materials: None

Procedure

The participants form two groups. If the number of participants is odd, the smaller group should be complemented by one of the facilitators.

The facilitator explains the rules of the game and checks to make sure that everyone understands them. The rules are as follows:

The two groups will compete to see which can line up most quickly according to personal or physical characteristics following the instructions of the facilitator.

After naming the characteristic and giving instructions for how to form the line (if, for example, the characteristic is height, line up from shortest to tallest), the facilitator will slowly count to 10. If a group finishes forming the line before the facilitator reaches 10, the participants should all squat or raise their hands (agree on the movement to be made) to indicate they have accomplished the task. The facilitator checks the first group to finish to see whether the sequence they made is correct.

The group that lined up most quickly and with the fewest errors is the winner.

Debriefing questions

1. Why did the winning group win?
2. Who became a leader in each group?
3. What did you learn from this exercise?

Version: November 2004

Discovery learning exercise 42: Follow me

Learning objective

Energizer

Duration

5 minutes

Procedure

Ask participants to stand up and imitate all your movements. Extend arms forward and begin clapping hands, first slowly but at increasing speed until everyone claps mechanically. Then suddenly stop. Notice how many participants continue to clap.

The exercise can be repeated by clapping above the head or with different movements.

Debriefing questions

1. Why did some people continue to clap when the person they were imitating stopped?
2. Why couldn't they imitate exactly?
3. What can be concluded from this exercise?

Version: November 2004

Discovery learning exercise 43: Releasing rope

Learning objective

To raise awareness about problem-solving strategies

Duration

15 minutes

Materials

Length of rope of 1 meter, as many as the number of participants

Procedure

Cut 1 meter length of rope and make loops at each end, wide enough for a hand to go through.

Ask participants to form pairs and give each pair two ropes. Each participant should move both hands through the two loops of a rope, but in such a way that the two ropes of a pair cross each other and the partners are tied together.

The two pairs should try to free themselves without removing the rope from their hand. If a pair is successful, ask them to show their solution to the others.

Debriefing question

1. What did you learn from this exercise?

Version: November 2004

Discovery learning exercise 44: Drawing a house

Learning objective

To raise awareness about collaboration and process control within a group

Duration

10-20 minutes

Materials

- Flip chart paper
- Markers

Procedure

Ask participants to form pairs. Both partners of a pair should hold the same marker in such a way that they are able to draw or write together.

Ask the partners to draw a picture of a house and write a title together on a piece of paper. They are not allowed to speak during the exercise.

Debriefing questions

1. How did you feel and react during the exercise?
2. What factors contributed to or constrained the process of joint drawing and writing?
3. What can we learn from this exercise? Have you ever experienced similar feelings or reactions in a real life situation? What constraints do we normally encounter in group collaboration?

Version: November 2004

Discovery learning exercise 45: Matches

Learning objectives

- To make everyone consider the value of their contribution
- To encourage a listening attitude in discussion

Duration

Up to you, but decide on the time before you start

Materials

Three to six tokens (such as matches or bottle tops) for each participant.

Procedures

Give each person the same number of tokens, the total of which depends on the time limit. Introduce a topic for discussion. Every time someone speaks to the group, they put one of their tokens in the centre. If they have no more tokens, they cannot speak.

Comments

As every remark is equally valuable, speakers must first evaluate their contribution and consider whether it is worth it in terms of its intrinsic value and relevance. Knowing that every speaker has made that evaluation, others are more likely to listen, though there is a danger that others will be so busy deciding whether to speak that they won't listen at all.

An alternative to putting the matches in the centre is for each speaker to give the match to the person they are speaking to.

Version: January 2004

Discovery learning exercise 46: The pillow game

Learning objectives

- To make a discussion more orderly and to encourage listening
- To uncover the roles played by people in a discussion

Duration

As long as the discussion takes

Materials

A soft object that can be passed or thrown around, such as a cushion, pillow, rolled-up pullover, or ball of newspaper

Procedure

The group sits or stands in a circle to hold a discussion related to the special topic. Tell the participants that they can speak only if they are holding the pillow, otherwise they should remain silent and listen to what is being said.

When an individual has finished talking they can pass the pillow on – either to someone with their hand raised who is requesting to speak, or to someone else.

Participants may place the pillow in the centre of the circle on the floor, from where it can be picked up by anyone in the group. This may exclude the shyer people. If someone receives the pillow and doesn't want to speak, they can just pass it on.

Debriefing questions

1. How does it feel to hold the object?
2. How does it feel to receive it unasked and to receive it when requested?

Comments

Those who were given the pillow without asking might have felt uncomfortable and have felt forced to participate.

The game encourages a listening attitude; it allows quieter members of a group the opportunity to speak. It also makes more dominant members conscious of the amount they are speaking since they are holding the pillow. Once the procedures are learnt and become automatic, many groups find this a very useful way of organising group discussions. It dispenses with the need for an authoritative chairperson as the rules are built in. It often helps with later plenary sessions, when participants will refer back to the pillow game to ensure that everyone has the chance to speak

One variation is to allow participants to turn their back on a speaker if they are bored with them, or find what they are saying irrelevant. This is a very direct act, which serves to stimulate discussion during the feedback session.

Version: January 2004

Discovery learning exercise 47: Finding one's group (animal sounds)

Learning objectives

- To demonstrate participants' need to feel accepted
- Entertaining way to form groups
- Energize participants

Materials

- Small pieces of paper, enough for each participant
- Pen

Procedure

Before the session, think of different kinds of animals that have their own sounds, for example, dog, cat, duck, pig, rooster. Divide the number of small pieces of papers into groups of 5 or 6. For example, if there are 25 participants/pieces of paper, you will have 5 groups with 5 pieces of paper each. Assign an animal to each group and write the name of the animal on each piece of paper in that group. Fold each piece of paper and mix all the pieces of paper together.

Ask each participant to pick one piece of paper. They should only open the paper when told to do so. Ask participants to look at what is written on the piece of paper in silence.

At your signal, ask participants to make the sound of the animal on their piece of paper. They should look around the group for others making the same sound and gather together with others making the same animal sound. Process the activity when each participant has found his group.

Debriefing questions

1. Did you enjoy the game?
2. How did you feel when you could not find your group?
3. Do you think participants will want to come back to the farmer field school if they feel they do not belong to the group?
4. How can we make others feel accepted in the field school?

Accept all answers as this encourages participants to share in the discussion and makes them feel respected. Emphasize individuals' need to belong and feel accepted.

Version: October 2004

Discovery learning exercise 48: The farmer's goat

Learning objectives

- Develop awareness of behaviour necessary for productive group interaction
- Develop debating and consensus building skills

Materials

- Flip chart paper or chalkboard
- Markers or chalk
- Masking tape

Procedures

Write the problem (see below) on the flip chart paper and read it aloud to the group several times. Ask participants to solve the problem individually, allowing 5 minutes for this task. Emphasize that there may be different answers to the problem. However, there is only one correct answer to the problem that all participants must agree on.

The problem

A farmer buys a goat at 10,000 cedis. He then sells it at 20,000 cedis. He buys the same goat later at 30,000 cedis, sells it again at 40,000 cedis.

The question is: Did the farmer gain or lose? If he gained, how much did he gain? If he lost, how much did he lose?

Ask participants for their answers and write them on the flip chart paper. All those with the same answer should group themselves together. Ask each group to explain and convince the other groups that their answer is the right one. Encourage groups to clarify their answers. By the end of the session, participants should arrive at a consensus as to the right answer to the problem.

Debriefing questions

1. Why did participants arrive at different answers to the same problem?
2. What did you learn from the exercise?

Version: January 2004

Discovery learning exercise 49: WAO CLAP

Objectives

- Energize participants
- Show appreciation of a specific participant

Procedure

All participants clap together: Pa-pa-papa-pa-Pa, then shout: WAO. WAO.WAO. Repeat two or three times

Version: June 2004

Discovery learning exercise 50: I have a hammer

Objective

Energize participants

Procedure

Teach participants this song:

I have a hammer. Hammer. Hammer.
I have a hammer that becomes two (2)

I have a hammer. Hammer. Hammer.
I have a hammer that becomes three (3)

I have a hammer. Hammer. Hammer.
I have a hammer that becomes four (4)

I have a hammer. Hammer. Hammer.
I have a hammer that becomes five (5)

I have a hammer. Hammer. Hammer.
I have a hammer that becomes six (6)

I have a hammer. Hammer. Hammer.
I have a hammer that becomes seven (7)

While singing, participants demonstrate with their hands, legs, head, neck etc as the numbering of the hammer continues, until every part of the body is involved.

Version: November 2004

Discovery learning exercise 51: In the lake, out of the lake

Objective

Energize participants

Procedure

Participants stand in a circle; one person is the leader. The leader explains that we are standing on the banks of a lake. The leader explains that participants must jump in and out of the lake to avoid being eaten by crocodiles.

The leader shouts “In the lake”, “Out of the lake”, in rapid succession, changing the order of the command. This is done for several rounds.

Participants who do the opposite of the command given (for example, jump in the lake when the command is “out of the lake”) are out of the game.

The game is won by the participant who remains in the game.

Version: June 2004

Part III

Guides for conducting field activities

Sanitary harvesting

- Sanitary harvesting means removing all diseased pods. The purpose of sanitary harvesting is to prevent the spread of diseases such as black pod.
- Sanitary harvesting should be done regularly. Begin inspecting cocoa fields at the start of the rainy season. After 2-3 days of continuous rainfall, check for pods with black pod symptoms. Move across the field in a systematic manner to make sure you inspect all trees.
- Remove all pods with black pod symptoms and old, black pods (mummies). Make sure to remove pods with only few spots as within days these will start forming spores and infect other pods.
- Collect the pods and burn them. You can also use the pods to make a compost heap, if you know how. Do not bury the pods, as the disease will spread from the soil with splashing rainwater. You can also spray attacked pods with fungicide before burying them to kill the spores or put the pods in a plastic bag before burying them.

Removing chupons

- Chupons are new branches that grow on the tree stem or the larger branches. Chupons grow fast, and will over time develop in new trunks or large branches.
- Chupons should be removed because they take food, water and energy from the tree, which reduces production.
- Remove chupons regularly and at any time of the year. Do not allow chupons to grow too big.
- Move from one end of your farm to the other, making decisions about chupons on each tree as you go.
- Cut chupons off close to their base. Using a sharp machete, make a “clean” cut at an angle.
- When the original stem is not healthy or damaged, you may decide to allow a new chupon growing low on the stem and below the area of stem damage to grow bigger and develop into a new trunk.
- You may decide to leave chupons if a tree needs more branches. A tree needs more branches when there are not enough branches to capture sunlight. Where there are not enough branches, you see a lot of sunlight coming through the canopy to the ground

Removing moss and epiphytes

- Moss often grows on cocoa tree stems and branches, especially when trees are old and there is a lot of humidity and shade in the farm.
- 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.
- You can remove moss and epiphytes from cocoa trees at any time of the year, but it may be easier to do it when you are pruning and weeding your farm at the beginning of the wet season.
- Moss should be removed from the tree by careful scraping with a machete, taking care not to damage the bark of the tree. Use a machete to remove epiphytes, taking care not to damage the bark.
- You can also control moss by applying sodium chloride or other herbicides used in the recommended doses and applications.
- Experiment with salt and other solutions to see if moss drops off. Prepare a salt solution of 1:10 ratio by mixing 10 cups of water with 1 cup of salt. Pour the mixture in a sprayer and spray on moss covered stems and branches.

Removing mistletoes

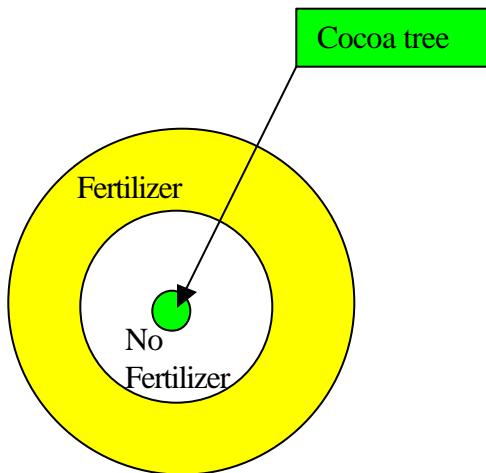
- Cutting out mistletoes is best done during the mistletoe flowering season, as then they are easiest to see.
- In heavily infested farms, cutting-out of mistletoes should be done each year until the infestation becomes more manageable.
- A machete can be used to cut out mistletoe plants from small, young cocoa trees. A pod-harvesting hook (a small sickle) tied to a long pole can be used for cutting-out young mistletoes. A long-handled pruner is needed for older mistletoes. Problems arise in very tall trees, as it may be impossible to reach mistletoe plants even with long-handled pruners.

Where to apply ground fertilizers

The best place to put fertilizer is in a circle about 75 cm away from the stem of the tree (see diagram below). The roots of a mature cocoa tree that absorb nutrients and fertilizer are about 75 cm meter away from the stem. This root system spreads roughly as far away from the stem as the canopy of that tree grows.

Many farmers think the best place to apply fertilizers is near the stem - but this is wrong. If you look at the root system of a cocoa tree, you see that near the stem there is only one long, thick root going straight down, sometimes as deep as a few meters. This root (the tap-root) does not have the tiny small roots (hair roots) near the surface that absorb food (nutrients) and fertilizer.

Diagram showing where to apply ground fertilizer



Making compost

Materials

- Plenty of plant material, both dry and green
- Ordinary top soil
- Animal manure or old compost
- Wood ashes and charcoal dust
- Several jars of water

Procedure

Select a location close to the place where the compost will be used. Make sure it is sheltered from the wind, rain and sun as the compost heap must not get too hot or dry.

Measure out an area one-and-a half meters to two meters wide and any convenient length depending on the available composting materials. It must be possible to work on the compost heap without actually stepping on it.

Loosen the soil where the compost pile will be made. The materials need close contact with the loose soil at the bottom. It is best to make a shallow trench about 30 cm deep. The topsoil obtained will be used in the compost. Therefore, put it on one side beside the trench.

Lay down a bottom layer should be of rough vegetation such as maize stalks or hedge cuttings chopped into short lengths. This layer should be about 30 cm thick.

The second layer should be manure or old compost or slurry. It should be about 10 cm thick. Sprinkle some of the topsoil on top of this layer so that it just covers the material. Do not put on too much soil, and only use topsoil.

The third layer should be made up of green vegetation about 15-20 cm thick. Use green weeds, grass, hedge cuttings or kitchen waste. If you have wood ashes, sprinkle some on top of the green vegetation. If wood ash is not available, use topsoil. Add water to the heap using a watering can or any other convenient container.

Add more layers by starting again with rough vegetation then manure or old compost, topsoil, green vegetation, ash or soil and finally water again. Repeat this process until the heap is 1-1.5 m. A well-made heap has almost vertical sides and a flat top. If you have a lot of material to compost, build several smaller heap (about 2 m in length).

Complete the heap with a 10 cm layer of topsoil. To prevent loss of moisture, the heap can be covered with dry grass or plant leaves. The heap needs to be moist, but not wet.

Check the progress of composting regularly by sticking a dry stick into the heap at an angle. The stick should be pulled out regularly to check whether it is warm, an indication that the composting process is still going on. Use the stick to tell whether the heap is still moist. If the stick is dry, add more water to the heap.

Check the stick regularly also for the presence of a fungus called "fire fang". Fire fang destroys the compost once the compost heap becomes dry. Fire fang turns the stick white, and if you detect it, add water immediately to the heap.

After about 3 weeks, the materials in the heap are likely to have decomposed. The stick should be cold. It is now time to turn the heap.

Make sure that while turning the bottom part of the heap ends up on the top. This is necessary because decomposition at the bottom goes slower than at the top. Do not add any fresh material during turning, except water if "fire fang" has developed.

After three more weeks the heap should be turned a second time. The heap should stay moist, not wet. Use the stick to monitor progress. When the stick is cold, decomposition is complete and the compost is ready for use.

The compost should have a fresh earth smell and no grass, leaves or animal droppings should be visible. Some woody branches or stalks may still be present as they take a long time to decompose.

If the planting season is still some time away, leave the heap where it is. Keep it well covered and moist, but not wet. Compost is wet when water drips out of a handful which is squeezed tightly.

Apply compost to your cocoa farm at the beginning, and any time during the wet season.

It is advisable to start a new compost heap with compost from an old heap.

Post-harvest activities

Harvesting

- Only harvest ripe pods: those that are completely bright yellow. You can also harvest some pods that are half or $\frac{3}{4}$ yellow, although make sure that these half yellow pods are not the majority of the pods you harvest.
- You can also tell if a pod is ripe enough for harvesting by shaking it. If the pod rattles, it is ripe because the pulp is soft, allowing the clump of beans to rattle against the pod wall.
- Make a clean cut with a machete (adults only), avoiding damage to flower cushions as this is where future pods will develop
- Avoid picking up pods with a machete as this can allow mould to enter pods
- Harvested pods can be stored on the ground for 5-7 days until there are enough to build a good fermentation heap.

Pod breaking

- Break pods no later than 7 days after harvesting
- Break pods using a machete (adults only) or a stick
- Throw away waste (the placenta) and select and throw away the following beans:
 - Germinating
 - Discoloured
 - Diseased
 - Broken
 - Flat

Fermentation

- Immediately after pod breaking, prepare the fermentation pile
- Place banana or plantain leaves at the bottom of where the beans will be fermented (a circle of leaves radiating out from the centre works well). Place the wet beans in the centre of the leaves and fold the leaves over the beans. Cover up any gaps with more leaves and weigh the leaves down with logs or large stones.

- The fermentation pile should be in the shade.
- Larger fermentation heaps are better than smaller heaps because with smaller heaps the temperature does not get high enough to allow favour development to take place properly. Ideally, each fermentation heap should contain at least 20 kg of wet beans but not more than 2000 kg.
- Do not mix the beans with cocoa waste
- Cover the beans with banana or plantain leaves; never use black plastic
- Before covering the pile, remove germinating, discoloured and diseased beans as well as any waste
- Make sure that the pile of beans is completely covered but make sure air is able to get in.
- Ferment beans for a total of 5-6 days.
- After 2-3 days, turn the beans to ensure a good fermentation of all the beans, including those in the middle of the pile. Turn the beans ONLY ONCE during fermentation.

Drying

- After 5-6 days of fermentation, place the beans in the sun to dry
- Remove germinating, discoloured and diseased beans as well as cocoa waste
- Never use fire to dry cocoa beans as it gives the beans a bad taste
- The best way to dry cocoa beans is on tables. This method allows the beans to be kept off the ground, preventing them from being mixed with soil and stones and allowing air to circulate underneath the beans.
- Cocoa beans should be placed on the drying tables and spread out in a layer no more than 8 cm (3 inches).
- In conditions of full sun, drying beans should be turned about once every 2 hours.
- During drying, protect the beans from moisture, dew or rain. At night or if it rains, cover the beans with a waterproof tarpaulin or plastic sheet.

- To avoid mould development, do not allow partly dried beans to get wet.

Sort the beans while drying by removing beans that are germinating or flat. Remove any waste or cocoa husks

- Continue drying until the beans are well dried. Beans are dry when they makes a cracking sound when lightly pressed

Storage

- After drying, sort the beans by quality
- Put beans of uniform quality into clean bags
- Store the bags in a dry, well ventilated area
- Make sure the storage place you use has no leaks and that rainwater does not run down the walls
- In the storage area, make sure the bags do not touch the ground
- Never store the bags where there is fire or where cooking is done