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Pests and Diseases

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Smallholder Oil Palm Handbook
Module 5: Pests and Diseases

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Module 5: Pests and Diseases

GOAL

To identify pests and diseases present in the plantation and deal with them effectively

After this section, farmers should:

- Be able to recognise the pests and diseases found in their plantation;
- Be aware of the available control measures;
- Be able to implement the available control measures correctly when necessary.

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1. BACKGROUND

Oil palm pests are animals, usually insects (such as caterpillars), or mammals (such as rats), which cause damage to the palms. Diseases on the other hand, are caused by micro-organisms such as fungi, bacteria and viruses. Pests and diseases can reduce oil palm yield, damage fruit bunches or the palms, and sometimes even kill the palm.

It is important to monitor the plantation at least every two months, to find pest and disease outbreaks as early as possible.

The most common pests and diseases of oil palm in Southeast Asia are:

- **Rats** *(cause damage to fruit bunches)*
- **Leaf-eating insects** *(cause damage to palm leaves)*
- **Rhinoceros beetles** *(cause damage to the leaves and the growing point of immature palms)*
- **Stem rot** *(a severe fungal infection of the trunk that can kill the palm)*

Good maintenance of the plantation helps prevent the outbreak of pests and diseases. There are several ways in which damage from pests and diseases can be limited, such as:

- Ensuring a healthy cover of soft weeds or legume plants which attract natural enemies of pests;
- Ensuring a clean plantation (e.g. no rotting palm trunks) helps prevent *Oryctes* outbreaks;
- Leaving snakes and other predators alive helps keep rats under control;
- Ensuring good access to the palms makes it easier to find outbreaks of pests and diseases in an early stage.

Pesticides should be used as little as possible, because they will do damage to the useful insects and animals living in and around the plantation. Farmers applying pesticides should always wear full protective clothing (see **Module 3**).

To carry out pest and disease control efficiently and effectively, the following sections can be used as a helpful guide.

2. GENERAL NOTES ON PESTICIDES

WARNING: Herbicides, pesticides and other chemicals are often toxic to humans, animals and palms, and should be used sparingly and with care

- Always follow the rules and regulations as set by the government
- Always read the label carefully before applying chemicals. If you don't understand entirely, ask the salesman or an extension worker
- When preparing chemicals, follow the instructions on the package carefully
- Application of chemicals should always be carried out wearing full protective clothing including rubber gloves, boots, mask, rubber apron, and safety glasses
- Spraying or trunk injection should be done only by workers who have followed a training course
- Spray equipment should be kept clean and in good shape
- All containers holding chemicals should be labelled according to their content (e.g. "Herbicide: [Name], "Pesticide: [Name]", etc.)
- **Never** store food in containers that were used for chemicals or fertilisers

For notes on how to use a knapsack sprayer, see **Module 3**, **Section 2**.

3. CONDUCTING A PEST AND DISEASE CENSUS

In order to find pests and diseases in an early stage, it is necessary to do a regular 'check' of the plantation. This check is called a 'census' [1].

Doing a census correctly requires extensive field training. An effective and simple way to do census in smallholder plantations is not yet available.

To learn how to carry out a pest and disease census correctly, discuss with local plantations or refer to: Rankine and Fairhurst, 1999, Oil Palm Field Handbook Mature [1].

Census is generally performed on all the palms in every tenth row. The key pests and diseases to check for when doing a census include:

- Rats: Damage to bunches in mature palms and young shoots in immature palms (see **Section 4**).
- Rhinoceros beetle: Round holes in leaf bases, deformed leaves with some leaflet tips missing (see **Section 5**).
- Leaf-eating caterpillars: Irregular holes in the leaflets and/or larvae on the lower fronds or the fresh fronds on the stack (see **Section 6**).
- *Ganoderma* (see **Section 7**).
- Spear rot, crown disease, bud rot (see **Section 8**).

On a score sheet or notebook, write down what pests and diseases have been observed and on which palms.

If signs of pests or diseases are observed, refer to the specific sections of this chapter to decide what to do next.

Data recording

Every pest census should be recorded in a log book as shown in the example below.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Pest census				1	2	20000

4. RATS

Background

Rats (*Rattus* spp.) are an important pest in oil palm plantations (see **Figure 1**). They eat the leaf bases of young palms, sometimes even killing the palms. In older palms, rats eat from the ripening fruits in the bunches, causing damage (see **Figure 2**). When these bunches are sold at the mill a deduction will be given because some of the oil is lost. Rats reproduce very fast, so a small population can become a large one in a short period of time. Therefore, it is important to keep the rat population under control.

Figure 1: Rat [2]

Goal

- To keep rat damage to fresh fruit bunches at a minimum;
- To keep rat populations under control.

Standard

- Rat damage to fruit bunches kept at less than 10 percent of the bunches damaged.
- **Note:** In smallholder plantations, rat baiting is useful only when neighbouring farmers also participate. Otherwise controlling rats by baiting is not effective.

Timing and frequency

- Monitoring of rat damage: once per two months.
- Rat baiting: when more than 10 percent of the palms/bunches are damaged, provided that neighbours are willing to participate.
- Installing barn owl boxes: Once, in the beginning of rehabilitation.

Labour time required

- Monitoring rat damage: As part of monitoring harvest quality.
- Rat baiting: 2 hours per hectare per round.
- Installing barn owl boxes: One day per five hectares.

Equipment and materials

- Barn owls, barn owl nesting boxes;
- Rat baits.

Who

Farmers and their families, in discussion with extension workers, cooperative and/or local plantation companies

Figure 2: Fruit bunch damaged by rats

How

Monitoring of rat damage

Step 1.	In immature plantings (less than 3 years after planting), the plantation should be visited regularly (at least once per month) to check for signs of rat damage and rhinoceros beetle damage.
Step 2.	When harvesting productive palms, check bunches for rat damage.
Step 3.	If rat damage is observed in a harvested bunch (see **Figure 2**), all the other bunches should also be checked, and the percentage of damaged bunches noted.
Step 4.	If more than 10 percent of the bunches or immature palms show signs of fresh rat damage, it can be decided to take control measures.

Biological control of rats

The cheapest, safest and easiest way to control rats is by biological control. Biological control of rat populations can be done by introducing barn owls (*Tyto alba*) (see **Figure 3**) or by conserving other predators, such as snakes. Such predators should not be killed unless they are a serious danger to workers or their families.

When using barn owls to control rats, the following points should be kept in mind:

- Discuss the best approach with an extension worker or with local plantation companies before introducing barn owls.
- Barn owls can usually be purchased on the market (if not, ask a nearby plantation where they bought their owls).
- Install nest boxes every five to ten hectares to get a good population of owls.
- Work together with other farmers to buy and keep the barn owls, especially if the plantations are small. You can also share costs.

Figure 3: Barn owl

Barn owls and other predators can help keep a rat population under control, but from time to time that the number of rats may still grow fast (an

'outbreak'). If an outbreak occurs and the farmer decides to take action, it must be kept in mind that **the poisons used to kill the rats can also harm the barn owls and other predators when they eat the poisoned rats.** Farmers should think carefully before using poison, and make sure that they have all the information they need.

Chemical control of rats

If rats are starting to cause much damage despite the presence of owls, poisonous 'baits' can be used to kill the rats. Baits are, in fact, poisoned pieces of rat food, which can be bought in local shops.
Note: These baits are poisonous also for humans, farm animals, and predators that eat the poisoned rats. They should therefore be used with care, and only if it is really necessary.

Baiting rats is only useful if the neighbours join in as well. Otherwise, rats from adjacent plantations will just move into the baited area after the baiting is done.

When using rat baits, the following should be kept in mind:

- Start with the mildest poison, the so-called 'first generation anticoagulants' such as *racumin*, *warfarin* and *chlorophacinone* [3]. Such first generation anticoagulants are less damaging to the barn owls and other predators, but it may happen that rats become resistant to them.
- If rats show signs of being resistant (see below) and the infestation is really severe, the farmer can try 'second generation anticoagulants'. Common brands of such anticoagulants include *brodifacoum*, *bromadioline* and *flocoumafen*.
  Note: Second generation anticoagulants are damaging to barn owls and other predators and therefore should only be used as a last option.
- Baits, once unpackaged, should be handled with care while wearing gloves, because they are poisonous to humans also.
- If goats or cows are grazing freely in the plantation, they may eat the baits and get poisoned. In this case, the baits should be placed in the palms, out of reach of the animals.

Rat baiting can be carried out as follows:

Step 1. If placing the bait on the ground:
- Weed and rake the palm circle to ensure the bait will be easily visible;
- In an area where rat infestation occurs, place one bait next to every palm, about 1 m from the base.

	If placing the bait on the palm: • Place the bait behind a frond butt on the palm trunk; • Mark the frond butt (e.g. with paint) so that it can easily be checked if the bait has been eaten or not.
Step 2.	Note exactly how many baits have been placed, and check every 4–5 days to see how many baits have been eaten.
Step 3.	Replace any eaten baits with new ones until more than 80 percent of the baits remain un-eaten, or until rat damage has declined to less than 10 percent of the bunches [1].
Step 4.	If many baits remain uneaten from the beginning, but rat damage to the fruit bunches continues, then the rats don't like the baits and are not eating them. If this happens it might help to try another type of bait, or to buy fresh baits (if they have been stored for more than 6 months).
Step 5.	If many baits are eaten but rat damage to the fruit bunches continues, rats are likely to be resistant to the poison. Then, it may be necessary to switch to second generation anticoagulants.

Note: It is best to place baits directly after harvesting, so that the rats don't have anything else to eat. Also, it is less likely that baits will be accidentally 'collected' with the loose fruits during harvesting. It is important to always tell the harvesters when rat baits have been placed in a plantation.

Data recording

Every rat baiting activity should be recorded in a log book as shown in the example below.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Rat baiting	Warfarin	10 packs	80000	1	2	20000

5. RHINOCEROS BEETLE (ORYCTES)

Background

Rhinoceros beetle (*Oryctes rhinoceros*) is a pest which mostly infects immature oil palms (see **Figure 4**). While several options are available for chemical treatments to reduce rhinoceros beetle infestation, none of these is currently 'standard practice' in plantations. Rhinoceros beetles breed in rotting wood on the plantation floor, so good maintenance of the plantation is essential because it can help to prevent outbreaks.

Figure 4: Rhinoceros beetle

The damage caused by rhinoceros beetle to immature palms can be recognised as follows:

- Holes are present in the base of the frond (see **Figure 5**);
- Fronds bend or 'break' where they are damaged;
- New fronds are deformed;
- Death of the young palm may occur, if the growing point is eaten by the beetle.

In mature palms infected with *oryctes*, the leaves have a typical shape with chunks missing. Leaf tips may also appear triangular (see **Figure 6**).

Rhinoceros beetle is a common pest in coconut palms, so if there is a coconut plantation nearby, attacks on oil palm plantations are more likely to occur. Severe infestation by *oryctes* can kill large numbers of young palms, so good plantation monitoring and maintenance are important.

Figure 5: Rhinoceros beetle damage in base of immature palm

Figure 6: Rhinoceros beetle damage in leaf of mature palm

Goal

- Keep damage of rhinoceros beetle at a minimum;
- Control the population by removing breeding sites.

Standard

- All dead and rotting wood is removed from the plantation as soon as possible;
- A good legume cover crop is established in immature plantations.

Timing and frequency

- Removal or shredding of dead wood and establishment of a good cover crop should be done during plantation establishment;
- Maintenance is necessary at all times.

Labour time required

Depends on the amount of dead wood and the overall maintenance of the plantation.

Equipment and materials

- Normal maintenance tools
- Wood chipper/shredder (during plantation establishment)

Who

Farmers and their families or hired labourers.

How

To control rhinoceros beetle follow these steps:

Step 1. If dead wood is present, remove it or cut it into small pieces and

	spread throughout the plantation to increase the speed of decomposition.
Step 2.	Keep weeds in the inter-row at a 50 cm height, with a dense canopy (see **Module 3**).
Step 3.	After clearing a piece of land to plant oil palm, sow a legume cover immediately. The leaves of the cover plant will stop the mature beetles from finding the dead wood on the plantation floor and also stop the young beetles from moving up into the palms.
Step 4.	If signs of rhinoceros beetles are observed, the plantation (as well as surrounding fields) should be checked immediately for the presence of breeding sites, which need to be destroyed wherever possible.

Note: Piles of empty fruit bunches can be perfect breeding sites for rhinoceros beetle. If there are signs of beetle damage, check under empty fruit bunch piles. If larvae (see: **Figure 7**) are seen:

- Kill the larvae;
- Turn the empty fruit bunches over and pull them apart as much as possible (to make decomposition go faster).

See **Module 4** for the correct ways to apply empty fruit bunches.

Figure 7: Larva of the Rhinoceros beetle

Data recording

Every pest control activity should be recorded in a log book as shown in the example below.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Plantation cleaning				3	2 days	480000

6. LEAF-EATING PESTS

Background

There are several leaf-eating pests which sometimes infest oil palm plantations. The most important ones in Southeast Asia are bagworms (*Pteroma pendula, Metisa plana, Mahasena corbetti*), tussock moths (*Dasychira* spp*., Orgyia* spp.), and nettle caterpillars (*Darna trima*, *Setora nitens*, *Setothosea asigna*; see **Figure 8**).

Figure 8: Nettle caterpillar [4]

Each of these insects eats through the oil palm leaf, so their presence is easily recognisable by the holes in the leaves (see **Figure 9**). In severely infested palms, only the midribs of the leaflets are left, so the palm cannot capture much sunlight and the yield will be strongly reduced. Prevention and management of outbreaks is therefore important.

Natural enemies are insects which kill pests, for example by laying their eggs in the pest larvae. The natural enemies of leaf-eating pests live in the weeds in and around the plantation (see **Module 3** for suggestions on how to manage weeds). If all weeds are killed, the natural enemies will die or move

away, and outbreaks of leaf-eating pests will become more likely. But even in well-maintained plantations, outbreaks can still occur.

Managing pests requires careful monitoring and the correct use of hazardous chemicals. **Both the monitoring and the application of chemicals should be carried out by trained workers**. If farmer groups want to establish monitoring and spraying teams, it is necessary to ask for help from extension workers or nearby plantation companies. In this handbook, we discuss only preventive measures, because monitoring and spraying need to be taught in the field by specialised professionals.

Goal

Keep leaf-eating insect damage to oil palms to a minimum.

Standard

Maintenance of the plantation is up to standard and promotes the biological control of leaf-eating insect populations.

Equipment and materials

Seeds of beneficial plants (see **Table 1**).

Timing

- Planting beneficial weeds: at the start of plantation rehabilitation;
- Doing correct weed maintenance: continuously.

Labour time requirement

Depending on the number of beneficial weeds planted.

Who

Farmers and their family or hired labourers.

TABLE 1: BENEFICIAL PLANTS

Scientific name	English name
Turnera subulata (white flower)	White buttercup
Turnera ulmifolia (yellow flower)	Yellow alder
Cassia tora, Cassia cobanensis	Senna
Spermacoce alata	Winged false buttonweed
Elephantopus tomentosus	Common elephant's foot
Antigonon leptopus	Mexican creeper
Euphorbia heterophylla	Lechosa

How

- Maintain a dense ground cover canopy (see **Module 3**);
- Plant weeds that are specifically attractive for natural enemies of pests (e.g. *Cassia cobanensis, Euphorbia heterophylla, Antigonon leptopus*, *Turnera subulata*) (see **Figure 10**).
  Note: These weeds are usually not shade tolerant and should therefore be planted at roadsides or in open spots where palms have died.

Figure 9: Damage caused by leaf-eating insects

Figure 10: Bunga pukul delapan

Data recording

Every pest prevention activity should be recorded in a log book as shown in the example below.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Planting *Euphorbia heterophylla*	*Euphorbia heterophylla* seed			3	8	240000

7. GANODERMA

Background

Ganoderma, also known as basal or upper stem rot, is a fungal infection of the oil palm. In severe cases of a *Ganoderma* infection, the oil palm dies. Older plantations may have over 50 percent death rates in the event of a severe infestation. While there is no cure for a *Ganoderma* infection, the spreading of the infection can sometimes be limited through good management.

Ganoderma is spread in two ways:

1. Through soil by threads of fungus;
2. Through air by spores which come from a mushroom (bracket) that grows on the trunk of infected palms [5].

Not all infected palms have brackets on their trunk. When a palm is infected with *Ganoderma*, different symptoms may be seen, such as a yellowing of the young leaves, an accumulation of several young unopened leaves (spear leaves) in the middle of the canopy, or a ring of dead fronds hanging down along the trunk (see: **Figure 11**).
Sometimes palms will stay productive even though they show signs of *Ganoderma*, but often they die within a year.

Goal

To minimise the spread of *Ganoderma* through a plantation

Standard

- Brackets (see: **Figure 12**) are taken from the infected palms and destroyed;
- Soil is mounted around the base of infected palms;
- Dead palms are removed from the plantation and burned;
- Remediation: Field is left without palms for at least 12 months after felling of old palms.

Figure 11: Ganoderma infection

Equipment and materials

- Bush knife (to cut off the brackets)
- Chain saw
- Spade or digging machine

Timing

- Removing brackets: As soon as they are observed;
- Soil mounting: As soon as signs of *Ganoderma* infection are observed;
- Remediation: After felling, before replanting.

Frequency

Depends on the frequency and speed of new infections.

Labour time required

- Removal of brackets: A few minutes per palm;
- Soil piling: 30 minutes per palm;
- Cutting and removing palms: Several hours per palm, depending on the available equipment.

Who

Farmers and their families or hired labourers.

How

To control *Ganoderma* follow these steps:

Step 1.	During harvesting or other field activities look at the palms carefully and note any yellowing or dying of leaves, or the appearance of brackets on the trunks. In particular, look for the following: • Several unopened new leaves (spear leaves) in the top of the crown; • A ring of dead or dying leaves hanging around the trunk; • General yellowing of the leaves; • Small-looking canopy; • Brackets forming on the trunk [1, 6].
Step 2.	If there are signs which might indicate *Ganoderma*, then check the trunk carefully at every harvesting round for signs of brackets. If brackets do not appear within a few weeks, then it is likely that they will not appear later on. If the palm has brackets, then these should be cut off, taken out of the plantation, and destroyed (burned).
Step 3.	To slow the progress of the disease in the palm, it can help to mount soil around the base of palms which show early signs of infection. To do this make a heap of soil up to 75 cm high and 50 cm wide around the trunk. The disease progress should slow down. **Note:** this option is labour-intensive and will probably not stop the disease in the end.

Step 4. To prevent spreading of the disease from root to root, plantations often remove sick palms entirely. For smallholders without chain saws or heavy machines, removing the palms can be very labour-intensive, so it is up to each farmer to decide if he wants to do this or not.
If the decision has been made to remove infected palms then follow these steps:

- Fell all the palms that are dead or have brackets;
- Cut the trunk into pieces;
- Remove all pieces that show disease symptoms (blackening in the inside of the trunk) from the plantation and burn them;
- Shred or cut the remaining pieces into smaller chips and leave those in the plantation to decompose. **Note:** If they are not cut into smaller pieces, they will become breeding sites for rhinoceros beetles!
- Dig out the palm bole (i.e. the part of the roots directly under the base) by making a hole at least 50 cm deep. Spread the soil equally around the hole.
- Remove the bole from the plantation and burn it.
- Leave the hole open or fill it with clean soil from the inter-row.

Note: When *Ganoderma* symptoms are observed, the palm has already been infected for quite some time. Therefore, even when taking the measures described above, the disease can still spread.
There is still much that is unclear about the best way to deal with *Ganoderma*, even though it is a very common and destructive disease. The best time to prevent *Ganoderma* is at the replanting stage. Currently, it is recommended to remove all diseased palms and also the roots and the soil from a two-by-two meter hole of one meter deep, and to wait at least one year before planting any new oil palms. The new palms should be planted where previously the frond piles and harvesting paths were located, as far from the previous planting holes as possible.

Figure 12: Ganoderma bracket

Data recording

Every disease control activity should be recorded in a log book as shown in the example below.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Removing *Ganoderma* brackets				1	4	40000

8. SPEAR ROT, CROWN DISEASE, BUD ROT

Spear rot

Spear rot is a fungus infection of the spear leaf or the palm growing point [1, 5]. Spear rot usually occurs when the palm is already damaged, for example by insects. Preventing insect attacks by doing good maintenance in the plantation is the best way to prevent spear rot.

The symptoms of spear rot are a dead or rotting spear leaf (see: **Figure 13** and **Figure 14**). There is currently no cure for spear rot. If the whole growing point is killed by the fungus then the palm will eventually die. In less severe cases, the growing point can recover.

Figure 13: Spear rot, the spear has turned brown and collapsed

Figure 14: Spear rot, detail

Crown disease

Crown disease mainly attacks young palms (1-4 years after planting) but has been known to persist for up to 10 years. It is still unclear what the cause of crown disease is, but it is clear that some planting materials are more susceptible than others. Buying good planting material and providing sufficient potassium (K), magnesium (Mg) and boron (B) are the best ways to prevent crown disease [5].

Crown disease can be recognised by a typical bending of the leaves, somewhere in the middle. At the point of bending, leaflets are absent or very small. The palm looks very dense, like a pile of leaves. In very severe cases, all the new leaves become affected and the palm growth and yield in the first years is seriously reduced.

Bud rot (Pudrición de Cogollo)

Bud rot (Pudrición de Cogollo or PC in Spanish) is a devastating disease which is found mostly in South and Central America, and sometimes in Africa. The disease starts with the yellowing of the youngest fronds, and a rotting of the spear leaf. In extreme cases, the rot moves down into the growing point of the palm (the ‘heart’, hence the Spanish name which means

‘heart rot’) and the palm may die. If the palm survives, recovery can take months or even years.

Bud rot can be extremely devastating. The disease has wiped out entire plantations, with tens of thousands of hectares being lost within a few years. Despite intensive research, the cause of bud rot remains unknown. Several fungi as well as abiotic factors have been pointed at.

As a management option, it has been common practice to cut away diseased tissue in the early stage of the disease, and to destroy palms that are more severely affected [7]. However, these measures have not prevented the destruction of entire plantations, and overly fast removal of palms might in some cases even have contributed to the severity of the destruction.

Bud rot has not (yet) been found in Southeast Asia.

References and further reading

[1] I.R. Rankine, T.H. Fairhurst, Field Handbook: Oil Palm Series, Volume 3 – Mature, second ed., Potash & Phosphate Institute (PPI), Singapore, 1999.
[2] IRRI photos, 2002, Field rats infesting rice plants, Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Field_rats_infesting_rice_plants_%28110589178 15%29.jpg, Accessed 20 July 2015.
[3] K.H. Lim, S.S. Lim, F. Parish, R. Suharto, RSPO Manual on Best Management Practices (BMPs) for Existing Oil Palm Cultivation on Peat., RSPO, Kuala Lumpur, Malaysia, 2012.
[4] L.P. Koh, 2006, Oil palm: pest, Nettle caterpillar, Flickr, https://www.flickr.com/photos/drlianpinkoh/5391807353, Accessed 20 July 2015.
[5] R.H.V. Corley, P.B. Tinker, The Oil Palm, fourth ed., Blackwell Science, Oxford, UK, 2003.
[6] G.F. Chung, Management of *Ganoderma* diseases in oil palm plantations, The Planter, 87 (2011) 325-339.
[7] G.A. Torres, G.A. Sarria, S. Salcedo, F. Varón, H.A. Aya, J.G. Ariza, L. Morales, G. Martínez, Opciones de manejo de la Pudrición del cogollo (PC) de la Palma de aceite en áreas de baja incidencia de la enfermedad PALMAS, 29 (2008) 63-72.