

Smallholder Oil Palm Handbook

Module 1: Planting Material



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Module 1: Planting Material

GOAL

To evaluate the planting material in the plantation, and to ensure that farmers are able to select the best seeds.

After this section, farmers should:

- Be aware of the differences between the *dura*, *pisifera* and *tenera* genotype, and be able to recognise the different fruits;
- Be able to assess which material they have within their plantation and to identify the *dura*, *pisifera* and otherwise unproductive palms;
- Be aware of the potential problems of inferior planting material, and strategies to overcome these.

Contents

1. *TENERA, DURA, AND PISIFERA*
 2. BUYING GOOD PLANTING MATERIALS
 3. EVALUATING PLANTING MATERIAL IN THE FIELD
 4. WHAT TO DO WITH *DURA* PLANTING MATERIAL
- APPENDIX 1. DEALING WITH *DURA* PALMS

List of figures

- Figure 1: Production of *tenera* seeds in a breeding company
Figure 2: Shells of *dura*, *pisifera*, and *tenera* fruits
Figure 3: Components of *tenera* and *dura* fruits
Figure 4: *Tenera*, *dura*, and *pisifera*
Figure 5: Production of a *tenera* palm
Figure 6: What happens when planting seeds taken from the plantation?
Figure 7: Genuine seed from PPKS
Figure 8: Genuine seed certificate from PPKS
Figure 9: Position of the seed in a polybag
Figure 10: Mixed planting material with both *tenera* and *dura* fruits
Figure 11: Planting new palms in empty spots
Figure 12: Planting banana in empty spots

List of tables

- Table 1: Oil production in plantations with different planting materials

1. *TENERA, DURA, AND PISIFERA*

Why are good seeds important?

- Oil palms can produce good yields for **25–30 years**.
- Good quality, certified seeds will produce good palms that give very large yields.
- Seeds of poor quality, with unreliable certificates or no certificates at all, will give a poor yield for 25 years!

So make sure you only plant hybrid seeds!

Introduction

In oil palm, the best yields are produced by so-called 'hybrids'. A hybrid is a cross between two different types of parents. Hybrids are produced in specialised breeding companies (see [Figure 1](#)). The parents of hybrid oil palms are different because of the thickness of the 'shell' of their fruit (see [Figure 2](#)).

The shell of an oil palm fruit is the brown/black woody ring between the yellow flesh and the white kernel (see [Figure 3](#)). There is no oil in the shell.

Normal palm oil (called crude palm oil or 'CPO') is extracted from the yellow flesh, which is also called 'mesocarp' (see [Figure 3](#)). Oil can also be extracted from the white kernel, and this oil is called 'palm kernel oil' or 'PKO'. However, this is a special oil and normal palm oil factories are not interested in it.

The mother palm of a hybrid is called *dura*. *Dura* fruits have a thick shell (see [Figure 2](#)). The father palm of a hybrid is called *pisifera*. *Pisifera* fruits have no shell at all (see [Figure 2](#)).

The cross between *dura* and *pisifera* palms is a hybrid called *tenera* (see [Figure 2](#)). Hybrid *tenera* fruits have a thin shell and the palms produce up to 30 percent more oil than their parents!



Figure 1: In a breeding company, open female inflorescences are pollinated by hand and then packed in a plastic bag.

Example: Oil production from plantations with *tenera*, *dura* and *pisifera*

In the table below, an example is given for a plantation with good quality hybrid planting materials (Plantation 1) and two plantations with non-hybrid materials (Plantations 2 and 3). This example clearly shows why mills prefer *tenera* bunches.

TABLE 1: OIL PRODUCTION IN PLANTATIONS WITH THREE TYPES OF PLANTING MATERIALS

	Plantation 1	Plantation 2	Plantation 3
Planting material:	100% <i>tenera</i>	50% <i>tenera</i> 25% <i>dura</i> 25% <i>pisifera</i>	100% <i>dura</i>
Situation:	Good quality certified seeds	Seeds taken and planted from the plantation	Only <i>dura</i> seeds planted
FFB yield (t/ha)	24.0	18.0	24.0
Oil from <i>tenera</i> (23%)	5.5	2.8	0.0
Oil from <i>dura</i> (16%)	0.0	1.0	3.8
Oil from <i>pisifera</i> (sterile)	0.0	0.0	0.0
TOTAL oil yield (t/ha)	5.5	3.8	3.8
Selling price for farmers ¹	3600 US\$/ha	2700 US\$/ha	3600 US\$/ha
Selling price for mill ²	4290 US\$/ha	2964 US\$/ha	2964 US\$/ha
Profit for mill	690 US\$/ha	264 US\$/ha	-636 US\$/ha

1) FFB price = 150 US\$/tonne; 2) CPO price = 780 US\$/tonne

Remarks:

- *Tenera* fruits contain about 30 percent more oil than *dura* fruits (see Plantation 1 and Plantation 3).

- *Pisifera* palms usually don't produce any fruit at all (they are sterile), so the FFB yield is generally zero. That explains why Plantation 2 has less FFB yield.
- All plantations require a similar amount of fertiliser and labour, so these costs remain the same across all plantations.
- Plantation 1, with 100 percent *tenera* palms, clearly produces significantly more oil than the other two plantations!

How to recognise *tenera*, *dura* and *pisifera* palms

The only type of oil palm that can produce large amounts of oil is the hybrid *tenera* type. All seeds from good companies are of this type.

Tenera palms are considered the best palms because:

- Each fruit produces a large quantities of oil (which is in the mesocarp, the yellow 'flesh');
- The palms produce a large amount of fruit bunches.

Tenera fruits can be recognised by:

- A thin shell (see [Figure 3](#));
- Brown/black fibres in the mesocarp around the shell (see [Figure 3](#)).

Dura palms are not considered the best palms because:

- They produce large fruit bunches, but
- The fruit contains about 30 percent less oil than *tenera* fruit!

Dura fruits can be recognised by:

- A very thick shell (see [Figure 3](#));
- No fibres in the mesocarp around the shell.

Pisifera palms can be recognised by:

- Leaves growing in an upward direction instead of to the side which makes the crown of the palm appear very 'narrow';
- No fruit bunches (the palm is sterile);
- Some palms may grow very tall.

Pisifera fruits are difficult to find because the palms are sterile. *Pisifera* fruits can be recognised by:

- No shell around the kernel (see [Figure 4](#));
- The fruit consisting of only yellow mesocarp (flesh) and some white kernel.

If there is a mixture of *dura* and *pisifera* palms in a plantation then usually their numbers will be more or less constant, for example 30 *dura* palms, 30 *pisifera* palms, and 60 *tenera* palms.

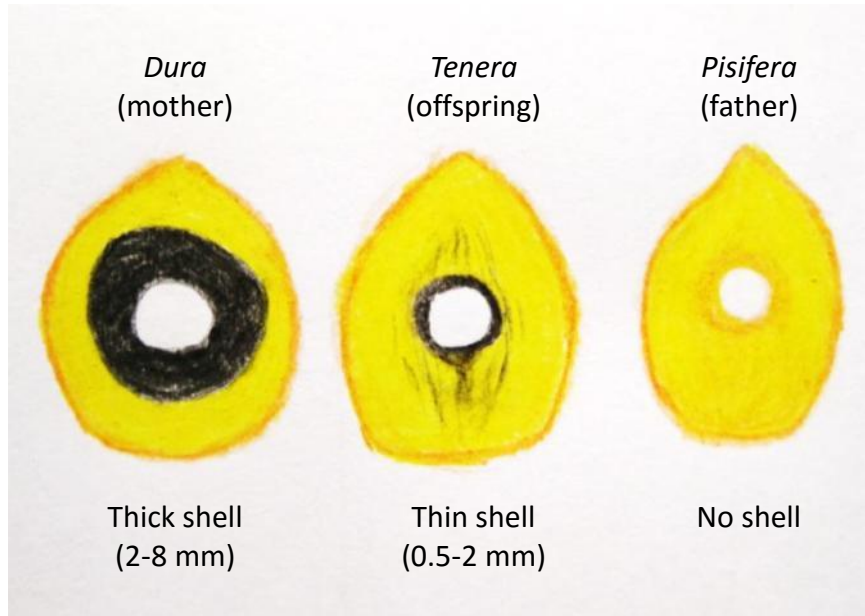


Figure 2: Shells of dura, pisifera, and tenera fruits.

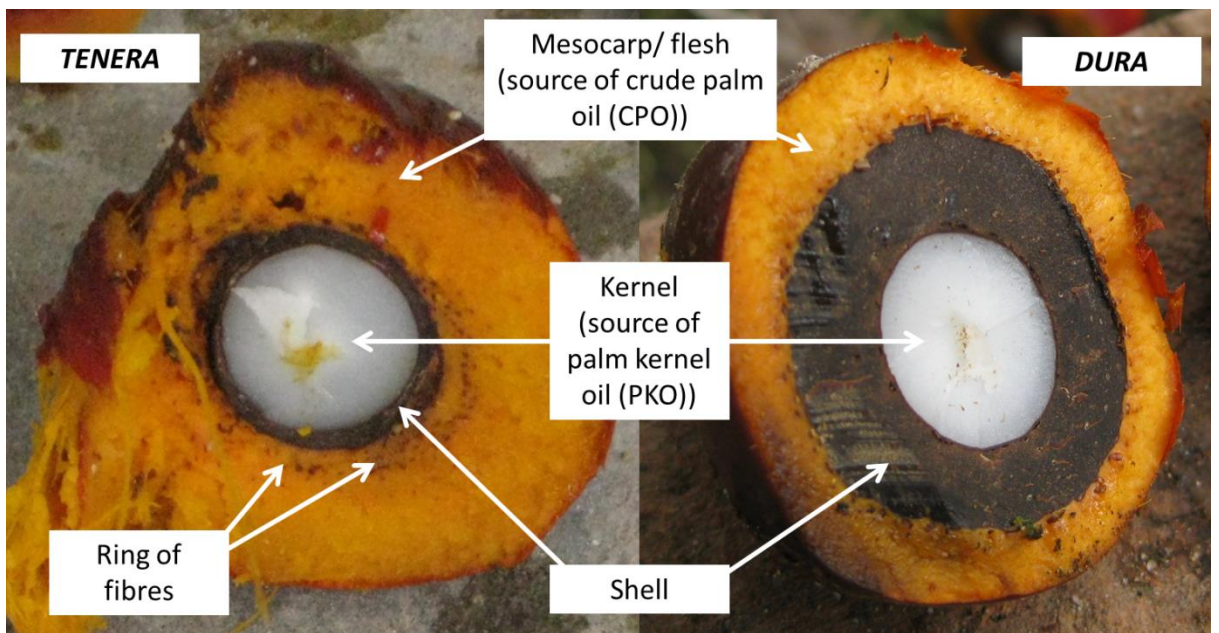


Figure 3: Components of tenera and dura fruits.



Figure 4: *Tenera, dura and pisifera*

How to make *tenera* palms

The fathers and mothers of all living creatures (people, cats, oil palms, ants etc.) give traits to their children in the form of genes. Genes are located inside every cell of the body. In humans, for example, there are genes for colour of the hair, or talent for singing or mathematics. In cats, for example, there are genes for colour of the fur.

In oil palms there is one gene that determines the thickness of the shell (the 'shell thickness gene'). The shell thickness gene has only two forms: 'thick shell' or 'no shell'. The mother and the father palm each give one 'shell thickness gene' to their children (so, to their seeds), which can be either the 'thick shell gene' or the 'no shell gene'. Seeds with two 'thick shell genes' will become palms that produce fruits with a thick shell (*dura*). Seeds with two 'no shell genes' will become palms that produce fruits with no shell (*pisifera*).

When you cross a *dura* with a *pisifera* (like they do in the seed producing companies) you get a *tenera*:

- The *dura* mother gives a 'thick shell gene';
- The *pisifera* father give a 'no shell gene';
- The seeds get one 'thick shell gene' and one 'no shell gene' and will become palms that produce only fruits with a thin shell (*tenera*).

Below is the process for producing a *tenera* palm:

Mother: *dura*
Gene 1: THICK shell
Gene 2: THICK shell



Father: *pisifera*
Gene 1: NO shell
Gene 2: NO shell



X



Offspring: *tenera*
Gene 1: THICK shell
Gene 2: NO shell



Figure 5: Production of a *tenera* palm

Why we cannot plant seeds from a plantation

If you cross only *dura* mothers with *pisifera* fathers, you can be certain that:

- The gene from the mother can only be thick shell;
- The gene from the father can only be no shell;
- The seeds will always become palms that only produce thin shell fruits.

If you plant the seeds that you took from a plantation, this is what happens:

- The mother is **not** *dura* but *tenera*;
- The father is **not** *pisifera* but *tenera*;
- You will **not** get only good hybrid *tenera* palms but a mix of *tenera*, *dura* and *pisifera*.

Here is what happens when you take seeds from the plantation (see [Figure 6](#)):

- The gene from the mother can be either thick shell or no shell;
- The gene from the father can be either thick shell or no shell;
- The palms that grow from the seeds of these parents can be thick shell, thin shell, or no shell.



Figure 6: What happens when you plant seeds taken from the plantation?

Conclusion

Independent plantations with bad planting material usually have around 50 percent *tenera* palms, 25 percent *dura* palms and 25 percent *pisifera* palms. In commercial plantations, only *tenera* palms are found. Smallholder plantations that were planted by a company will also contain only *tenera* palms.

Never plant seeds from your plantations or buy seeds that are not certified!!

2. BUYING GOOD PLANTING MATERIALS

Goal

- Get optimal yields for 25 years;
- Produce fruit bunches that contain a lot of oil;
- Get a maximum price for the fruit bunches and a good 'return' on fertiliser and labour.

Standard

- Planting material is 100 percent *tenera*;
- All planting material is certified and comes from a good breeding company.

Remarks

It is illegal for smallholders in Indonesia to buy non-certified seeds!

But:

- It is difficult for individual farmers to buy certified seeds. A land certificate is always required.
- The easiest way for farmers to buy certified seeds is by buying them as a group or cooperative.
- In Indonesia, PPKS give a discount for smallholder cooperatives buying seeds.

Timing

When buying the seeds or seedlings.

How

Buying the right seeds

Farmers who plant independently can make sure they buy the right seeds by following these key points:

- Buy seeds from a certified, reliable breeding company that can deliver the seeds directly to the farmer. **Never** use a 'middleman' or trader.
- Work together in cooperatives or farmers' groups when buying seeds.
- **Never** buy seeds or seedlings from anyone other than reputable companies. Bad palms will give bad yields for 25 years!

- Look for a company logo. Good companies such as PPKS now put their logo on each seed (see **Figure 7**). If the logo is not there, the seed is fake! However, beware that there can also be fake seeds with fake logos - so the logo alone is still not enough.
- Ask to see a certificate. Reliable companies will always provide a certificate of authentication (see **Figure 8**).

In Indonesia, PPKS in Medan produces good quality oil palm seeds that can be trusted [1]. They also have local offices in Kalimantan and Sumatra. For information, contact:

Pusat Penelitian Kelapa Sawit (PPKS)
JL. Brigjen Katamso, No. 51
Medan, North Sumatera, 20158
Phone: +62 61 7862477
Website: www.iopri.org



Figure 7: A genuine seed from PPKS, pre-germinated and stamped with the name of the company.



Figure 8: Genuine certificate from PPKS.

Testing the quality of seeds and seedlings

It is impossible to know for certain from a seed or a seedling if the plant is *tenera*, *dura*, or *pisifera*, but we know that certified *tenera* hybrid seeds always come from a *dura* mother, so they are all of the *dura* type with a thick shell. The type of seed or seedling can be identified through the following steps:

- Step 1.** Select 20 seeds at random, or collect 20 seeds from seedlings by carefully digging into the polybag to find the seed and then removing the seed without damaging the roots (see **Figure 9**).
- Step 2.** Open all the seeds with a hammer and check if the shells are thick (*dura*) or thin (*tenera*):
 - If some of the shells are clearly thin, the seeds are fake and all the seeds and seedlings should be thrown away!
 - If all shells are thick, the seedlings are all from *dura* mothers. This can mean two things: (i) the seeds are from a breeding company and will all become good *tenera* palms, or (ii) the seeds are from a seed trader who bought *dura* bunches that the mill did not want.

Note: This kind of check is not a good replacement for buying certified seeds. Some seed traders will buy *dura* bunches only, so planting seeds without a good certificate is always a big risk, even after testing them.

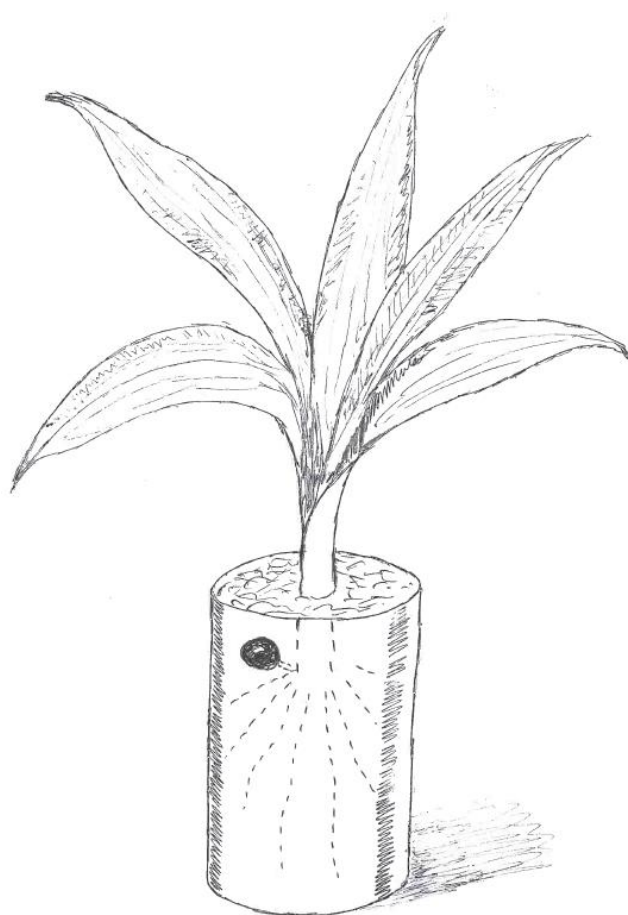


Figure 9: Schematic drawing of the position of the seed in a polybag.

Data recording

It is important to record all activities carried out in the plantation. The table below gives an example.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Buying seeds	PPKS seeds	150	1.5 million Rp			

3. EVALUATING PLANTING MATERIAL IN THE FIELD

Goal

- Be able to establish if the productive palms in the plantation are of good *tenera* type or mixed with *dura*;
- Be able to identify how many *dura* palms there are, if any;
- Be aware of the possibility to increase productivity by finding all unproductive palms and cutting them down;
- Be able to identify if problems with the mill or large price deductions can be expected in the future.

Standard

- Farmers know exactly what their planting material is;
- If there are *dura* palms, they are marked;
- If there are *pisifera* palms, they are removed.

Note: if the plantation was planted by a company (plasma), it is not necessary to check the planting material because plantation companies usually buy and plant good quality seeds only.

Timing

- As soon as possible after the plantation becomes productive; or
- At the start of the plantation rehabilitation.

Frequency

Once in the plantation lifetime, at every harvesting round until all the palms have been tested.

Labour time required

- Testing 20 palms: 1 hour;
- Marking 20 palms: 0.5 hour;
- Testing all palms: 1 hour per harvest until all palms are done.

Equipment and materials

- Blue and red spray paint
- Bush knife
- Notebook

Who

- Farmers and their family or hired labourers.

How

If the planting material is of good quality, then less than 1 in 100 palms should be *dura*, and all other palms should be *tenera*. The planting material can be tested by following these steps:

- Step 1.** At the time of harvest, select a palm that has just had a bunch of fruit harvested.
- Step 2.** Collect four (loose) fruits from the bunch.
- Step 3.** Cut the ripe fruits with a machete. Make sure to cut neatly in the middle, otherwise it will be difficult to see the shell thickness correctly (see [Figure 10](#)).
- Step 4.** Examine the shells of the fruits and determine for each fruit if it is *dura* or *tenera*. Use [Figure 3](#), [Figure 4](#) and [Figure 10](#) as a guide. *Tenera* fruit, apart from having a thin shell, usually also has some brown-black fibres around the kernel (see [Figure 3](#)).
- Step 5.** If all fruits in the bunch are *tenera*: mark the palm (for example with blue paint) and then move on to the next palm.
- Step 6.** If a fruit could be a *dura*: look carefully at all four fruits of the bunch to be sure they are *dura*. The fruits can look a bit different in shape and size. If the fruits are definitely *dura*, mark the palm (for example with red paint). **Note:** all fruits in one bunch are always of the same type (*dura* or *tenera*), and all bunches on one palm also!
- Step 7.** Repeat process until 20 palms have been checked.
- Step 8.** If one or more *dura* palms are found, then all palms in the plantation should be tested by following the procedures described above at every harvesting round, marking each *dura* palm immediately with red paint, and each *tenera* palm with blue paint. Keep good track of which palms have already been tested.
- Step 9.** Some palms may not produce any ripe bunches at all; this is especially likely in a plantation with some *dura* palms. If any empty palms are found, take the following steps:
 - Monitor the palms over a **one year period**;
 - If the palms do not produce any bunches during this time, then they are 'sterile'. These sterile palms may be *pisifera* or they may be sterile for some other reason.
 - Sterile palms should be poisoned or cut down, because they take fertilisers and sunlight but produce nothing!

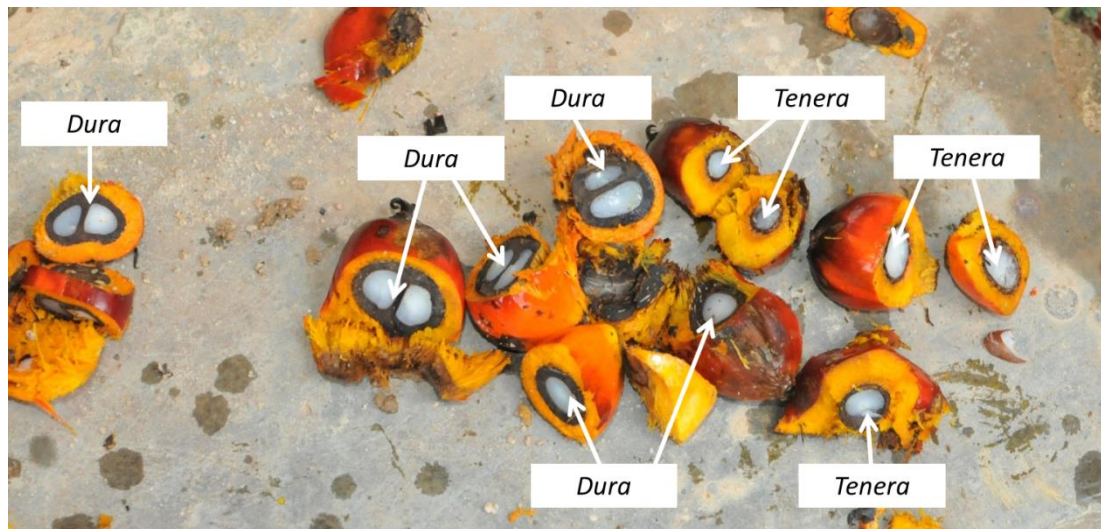


Figure 10: Mixed planting material with several tenera and dura fruits.

Data recording

In your plantation notebook, write down:

- Field size
- Number of palms in the plantation
- Number of *tenera* and *dura* palms
- Number of sterile/unproductive palms

For the activity of checking the palms, the table below can be used as an example.

Date	Time	Location	Activity	Input type	Input amount	Input costs	Labour input		Labour costs
							People	Hours	
16/01/13		Field 3	Evaluating 20 palms for <i>dura</i>	Blue and red spray paint	1 each	40000	2	2	40000

4. WHAT TO DO WITH *DURA* PLANTING MATERIAL

Every farmer needs to know what kind of palms he has in his plantation, so that he can make the right decisions about how to manage his plantations. Farmers that have *dura* and/or *pisifera* palms need to be aware of the problems that they could have in the future and think about possible solutions.

Having *dura* palms in a plantation is not good for the following reasons:

- The price that the mill pays for fresh fruit bunches is determined by the government and is based on the **oil produced from the fruits**.
- *Dura* bunches don't produce enough oil, so the price is actually **too high** and the **mill will make a loss on these bunches**.
- Also, the thick shell of the *dura* is difficult to crack and can damage the machines in the mill.
- If the mill discovers that some bunches are *dura*, they can:
 - **refuse to buy the bunches**, or
 - **give a very large price deduction to compensate for the low oil concentration**.
- **In the future, mills might decide not to accept any bunches from the farmer, or they may ask for proof that there are only *tenera* bunches.**
- So, all farmers should know what kind of palms they have, and must be **prepared to take action**, to ensure they do not get in trouble with the mill.

Currently many mills in Indonesia do not check if the bunches are *dura* or *tenera*, or they give a small deduction only.

If a mill discovers the *dura* bunches and problems arise, there are several things the farmer can decide to do. These are discussed in [Appendix 1](#).

References and further reading

[1] IOPRI, 2012, Purchasing procedures (tata cara pembelian), International Oil Palm Research Institute, Medan, <http://www.iopri.org/cara-pembelian.html>, Accessed April 7 2016.

APPENDIX 1. DEALING WITH *DURA* PALMS

Option 1: Cut down all palms and replant.

If farmers have more than 1 percent *dura* palms in their plantation, it means that their planting material did not come from an official company and is not of excellent quality. The yields will probably not be as good as with excellent planting materials

If farmers want to be sure that they can get maximum yields, they can decide completely to replant the fields that have *dura* palms.

Advantages

- If farmers buy good certified seeds or seedlings, they can be certain that they will have good palms and very likely also good yields in the coming 25 years.
- All the new palms will grow optimally because they are all planted at the same time.
- It is easier to cut down and replant everything in one go than to do it palm by palm.

Disadvantages

- It is expensive to replant everything.
- Productivity is lost for 3 years.
- The good *tenera* palms in the old plantation are also cut down.

Conclusion

In Indonesia, it is illegal to plant unofficial planting material. Therefore, it is recommended to replant all plantations that contain *dura* palms. But considering the costs, it is not always a good option for farmers to cut down all their palms, unless a problem with the mill is expected to occur soon. If there are many *dura* palms and the farmer can afford it and is willing to invest in best management in the new plantation, then cutting down all palms in the entire field (or in part of the field) and re-planting it with excellent material can be a good investment for the future. However, if there are only a few *dura* palms, then cutting down everything is probably too expensive for most farmers.

Cutting down all the palms is called 'early replanting' when the plantation is already old (more than 15–20 years after planting). This may be especially beneficial if the yield is already poor, or if many palms are affected by *Ganoderma*.

Option 2: Only cut down the dura and sterile palms and replace them with certified good-quality *tenera* palms.

Once all the palms in the plantation have been checked, the farmer knows which are good and which are bad. The bad palms can be cut down and/or poisoned, all together or in groups over a longer period of time. The trunks of the dead palms must be cut into small pieces to decompose, otherwise they become a breeding ground for the rhinoceros beetle (*Oryctes rhinoceros*), which will attack the newly planted palms. A legume cover crop, such as *mucuna*, should be sown immediately after cutting, to improve soil fertility and cover the rotting wood. As soon as the legume cover crop has a good canopy (usually after 3 months), a new seedling can be planted in the hole where the previous palm was.

Note: If it is suspected that the palm was suffering from *Ganoderma* (stem rot), then:

- It is best to wait one year between cutting down the palm and replanting.
- **The new seedling should be planted at least 2 m from the old palm planting point.**
- The bole (i.e. the densest part of the roots; directly under and around the trunk) of the old palm should be dug up from the ground and spread in the inter-row.
- See **Module 5** for more information on *Ganoderma*.

Advantages

- After 3–4 years, all palms in the plantation will be *tenera*.
- It is not necessary to cut down all the palms.
- Cutting down and replanting can be done in steps, as fast or slow as suits the farmer.
- The farmer can continue to harvest the standing palms normally.

Disadvantages

- Part of the yield is lost for 3–4 years.
- The newly planted seedlings will get less sunlight and will grow slower, so their yield will not be optimum in the first 10 years (see **Figure 11**).
- There is a risk for infection with *Ganoderma* when planting in the same spot, and rhinoceros beetle because of the rotting wood of the old palms lying around in the plantation.
- The *tenera* palms that are left in the field are not from the best origin (otherwise there would not have been any *dura* or *pisifera*)
- It is labour-intensive to replant palm by palm.

Conclusion

For farmers that cannot cut down all the palms or that have only a few 'bad' palms, this approach may be useful. It is especially useful when palms are still young (less than 6 years from planting), because the shading of new seedlings is less.



Figure 11: The palm on the right was planted later, to fill an empty spot.

Option 3. Cut down the *dura* and sterile palms and replace them with another crop.

It may be that certified seedlings are not available or the price of the oil is not good. In this case, it is possible to cut down the *dura* and the sterile palms and plant another crop instead. It must be kept in mind, however, that the other crop **should not grow taller than the oil palm**, because then it will reduce the oil palm yield due to shading.

Advantages

- The remaining oil palms will be *tenera*, and can be harvested normally.
- The yield of the remaining palms will increase, because they are no longer shaded by their neighbours.
- Farmers 'spread risks' by producing several different crops.
- There is no risk for oil palm diseases, like in option 2.

Disadvantages

- If oil palm is the most profitable crop, then some of the profit will be lost.
- The new crop can only be planted in the small patches where the old palms were (see: [Figure 12](#)).
- The new crop will be quite shaded, and should be shade-tolerant.
- New crops will compete with the oil palm for water and nutrients.
- Management becomes more difficult and labour-intensive because there are different crops in the same field.
- Falling oil palm bunches (during harvesting) may cause damage to the new crop.

Conclusion

Whether or not this option is attractive depends on whether there is a shade-tolerant crop available that is (nearly) as profitable as oil palm. Planting another crop can be especially attractive in older plantations (more than 10 years from planting) because the shading will make the planting of young oil palms less profitable. This option can be combined with accelerated replanting five to ten years later.



Figure 12: Banana planted in an empty spot in an oil palm plantation.

Option 4. Leave all the palms, but apply fertilisers to the *tenera* palms only.

If cutting down palms is not possible or desirable, it can also be decided to leave all the palms, but to apply fertilisers only to the good *tenera* palms. There are two options: to harvest and sell the *dura* bunches separately (for a lower price), or mixed with the *tenera* bunches. If the mill discovers the *dura* bunches, then the price for all the bunches may drop, or it may become necessary to harvest and sell separately.

Advantages:

- No palms need to be cut down.
- The *dura* palms keep producing, and as long as the mill does not check, the bunches can be sold (though farmers should keep in mind that this is illegal, disadvantageous for the mill, and it may also cause serious problems for the farmer in the future).
- Less fertilisers are used because they are applied only to the *tenera* palms.

Disadvantages:

- It is not legal to keep the *dura* palms.
- The problem of the *dura* and sterile palms is not solved.
- The farmer may get problems with the mill in the future, if the *dura* bunches are discovered.
- The *dura* and sterile palms compete with the *tenera* palms for sunlight, reducing their productivity.
- The *dura* and sterile palms will take up a share of the fertilisers that were meant for the *tenera* palms, because their roots can be up to 6 m long, so there will be fewer nutrients available for the *tenera* palms. This might need to be compensated by adding more fertilisers, so then the benefit of a reduction in fertiliser use is limited.

Conclusion:

This option is simple, but it also has several serious disadvantages. It makes most sense in old plantations (more than 15 years after planting) where other options are not attractive. It can be combined with accelerated replanting after saving for a few years. This option may also be useful to prepare for other options, so that fertilisers are not wasted. **Note:** for long-term management of young plantations, this option is not a good one.

Option 5. Leave all the palms and continue to manage them as if they were all good palms.

If the management is already not very intensive, and cutting down palms is not possible or desirable, it can be decided to leave all the palms and just manage them as if they were all the same. There are two options: to harvest and sell the *dura* bunches separately (for a lower price), or mixed with the *tenera* bunches. If the mill discovers the *dura* bunches, then the price for all the bunches may drop, or it may become necessary to harvest and sell separately.

Advantages:

- It is easy, management can just continue 'as usual'.
- On the short term, the *dura* palms will keep providing bunches and income, as long as the mill does not check.

Disadvantages:

- It is illegal to keep the *dura* palms.
- The problem with the *dura* and sterile palms is not solved.
- The farmer may get problems with the mill in the future, if the *dura* bunches are discovered.
- Fertilisers may be wasted on sterile palms that do not give any fresh fruit bunches.
- The *dura* and sterile palms compete with the *tenera* palms for sunlight.
- If the *dura* bunches are sold separately, they will get a lower price, and investments in fertilisers may not be earned back

Conclusion:

This option is not really a solution, and is only financially attractive if the mill does not separate *dura* and *tenera* bunches. This option may be useful in old plantations (more than 15 years after planting) that can be replanted soon. In practice, as long as the *dura* bunches can be sold to the mill as if they are *tenera* or with a small deduction only, most farmers are likely to select this option for their management.