CLAY, SANDY AND PEAT SOILS, AND SOIL ORGANIC MATTER

Background

Most normal soils ('mineral soils') consist of tiny particles of rock that have been broken into small pieces by such things as wind, water, plant roots, and ice (in colder regions).

- If the particles of rock are quite large, they are called 'sand';
- If the particles of rock are very small, they are called 'clay';
- If the particle size is somewhere in between, it is called 'silt'.

The soil structure in a field is determined by the amount of sand, silt and clay particles, with:

- Sandy soils having mostly large sand particles;
- Clay soils having many small clay particles;
- Silt soils having mostly intermediate sized silt particles;
- Loamy soils having a mixture of sand, silt and clay particles.

In almost all mineral soils there is some organic material, called 'soil organic matter'. Soil organic matter is the remains of dead plants, animals and microbes. It is usually dark brown or black in colour. Normal (mineral) soils contain between 1 and 6% organic matter, but peat soils contain >60% organic matter.

Because of all the organic matter, peat soils need to be managed in a special way.

Peat soil in Riau

How to recognise different types of soils

Sandy soils can be recognised as follows:

- You feel sand particles (pieces) grinding around if you roll a bit of soil between your fingers;
- It falls apart if you try to roll moist sandy soil into a ball or a sausage.

Clay soils can be recognised as follows:

- The particles are so small that if you roll the soil between your fingers, you don't feel the particles, but you feel a 'paste';
- You can take a handful of moist soil and roll it into a ball or sausage that doesn't fall apart easily;
- Moist clay feels sticky if you touch it.

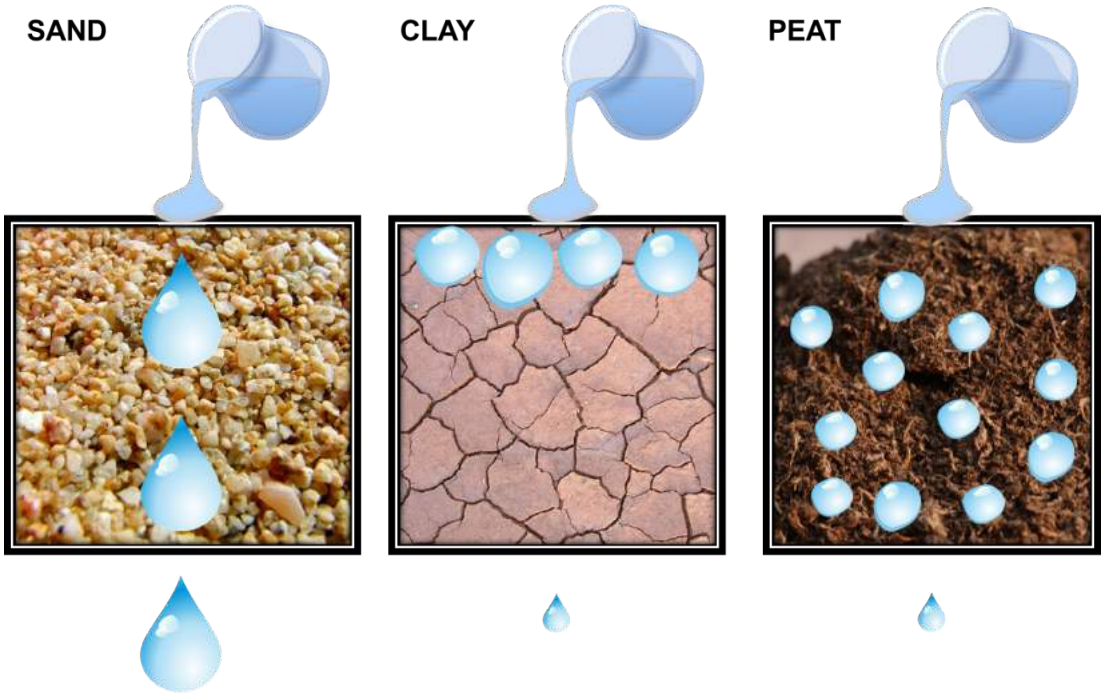
Silt soils can be recognised as follows:

- You cannot feel the particles easily when rolling the soil between your fingers;
- When moist, the soil has a soapy feeling;
- Moist silt soil leaves dirt on the fingers after you've held it.

Loam soils are difficult to recognise because they are a mix of the soils above. If a soil has some characteristics of each of the above types of soil, it is probably loam.

A peat soil can be recognised as follows:

- It is usually dark brown or black in colour;
- It is very spongy: you can feel your feet sink away if you step on it;
- Water drizzles out if you take a handful of wet peat and squeeze it;
- There are pieces of sticks, leaves and other organic materials in the peat;
- It is impossible to roll the peat into a ball or a sausage.



The flow of water through three different soil types. In the sandy soil, the water flows straight through. In the clay soil, the water stays on top. In the peat soil, the water flows in and is kept there like in a sponge.

Important properties of different soil types

Sandy soils

- Poor water holding capacity:
  - Because the particles are so big, the water quickly moves away from between them.
  - After rain, the water will quickly move down the soil.
  - Palms are **more likely to suffer from drought** because all the water has moved down.
  - Soluble nutrients (N, K, Mg) can easily be moved down by water, so these **nutrients are quickly lost from the palm roots (leaching).**
  - However, **nutrients are less likely to be washed away from the soil surface** because they move down into the soil more quickly.
- Small surface area of soil particles:
  - A few big particles have less surface area than a lot of small particles.
  - Nutrients stick to the surface of soil particles. In sandy soils, nutrients will not strongly stick to the soil particles which means the **nutrients are easy for the palm to take up.**
  - However, because the particles are big, the holes between the particles are also bigger and there are less of them, so the **palm can make less fine roots.**
  - Because of the above points, **oil palms on sandy soils need relatively large amounts of fertiliser.**
- Light structure:
  - Because of the big soil particles, the soil doesn't stick together;
  - Digging holes or other soil management activities are therefore relatively easy;
  - There is also **not much risk of soil compaction;**
  - However, there is **large risk of soil erosion from wind.**

Clay soil sample

Clay soils

- Very good water holding capacity:
  - Because the particles are so small, the water is trapped between them.
  - After rain, the water moves into the soil slowly.
  - Palms are **less likely to suffer from drought** because the rain water is held in the soil.
  - However, **flooding after heavy rains is more likely.**
  - Nutrient leaching is **not** likely because the water moves down very slowly.
  - Nutrients can be **washed away** from the soil surface easily because the water stays on top of the soil and doesn't move inside.
- Large surface of soil particles:
  - Small clay particles have a large surface area compared to sand particles.
  - Nutrients stick to clay soils more strongly.
  - Most clay soils are quite fertile and **oil palms need relatively small amounts of fertiliser.**
- Heavy structure:
  - Because of the tiny particles, the soil sticks together very easily
  - Digging holes or other **soil management activities are difficult** and should be carried out only on dry soils.
  - **Soil compaction happens easily**, especially when the soil is wet. Once compacted, the soil becomes very hard and the oil palm roots cannot grow well. Therefore, it is important to be careful with cattle grazing and with allowing machines such as trucks and excavators into the plantation, especially after rain.

Loam and silt soils

Loam and silt soils have a structure somewhere in between sand and clay soil and are usually the best soils for agriculture.

Peat soils

- High water table:
  - Peat soils form when the ground water table is very high and can only be cultivated when they are drained first.
  - Unless drainage is done well, **peat soils often flood.**
  - If peat soils are drained too much, the **soil can dry out rapidly.**
  - Dried-out peat soils have a **large risk of burning** which can destroy a plantation.
  - **Water management is difficult on peat soils** and requires a lot of attention.
  - Peat soils have a **good water holding capacity**, especially when compacted.
- Small surface of soil particles, strong acidity, binding of nutrients:
  - The soil particles in peat form less than 40 percent of the soil; the rest is organic material.
  - Often peat soil has a very low pH (<3.5-4.0).

    - Peat soils do not contain many nutrients apart from N which is in the organic matter.
    - Potassium (K) is not held by peat soil and so is easily leached and lost.
    - Because of acids in the peat soil, copper (Cu) and Zinc (Zn) are bound in the soil and are not available for uptake by the plant.
- Very light structure:
    - Because there are not many soil particles in peat soil the structure is very light, almost fluffy.
    - Palm roots don't have anything to hold on to, so **palms tend to fall over.**
    - **Before planting, peat soils should be compacted (by riding over it a few times with big machines) to make the soil denser.**

Due to the above issues, palms growing in peat soils require large amounts of K and the application of additional Cu and Zn fertilisers.

TABLE 1: REMOVAL AND IMMOBILISATION OF NUTRIENTS ON PEAT SOILS

Nutrient name	Compound	Nutrient requirements (kg/ha/year) at two yield levels	
		18–24 t/year FFB	>24 t/year FFB
Nitrogen	N	80–110 [6]	>110
Phosphorus	P_2O_5 (43.7% P)	30–37	>37
Potassium	K_2O (83% K)	215–260 [7]	> 260
Magnesium	MgO (60% Mg)	0–20 [8]	0–20
Boron	B	Trace	Trace
Copper	Cu	Trace	Trace

Figure 1: Water management on a peat soil in Riau

The importance of soil organic matter in mineral soils

Soil organic matter is important because it improves the soil. Soil organic matter:

- Holds on to fertiliser nutrients;
- Holds water;
- Makes clay soils less dense and heavy;
- Makes sandy soils more sticky;
- Slowly releases nutrients while it is further broken down in the soil.

Soil organic matter content can be increased by:

- Recycling dead plant parts in the plantation (e.g. fronds, frond butts, male flowers etc., see **Module 3**);
- Adding organic waste materials from the mill (e.g. empty fruit bunches, palm oil mill effluent);
- Maintaining a good weed cover at around 50 cm height (see **Module 3**).

Soil acidity

It is useful to check the soil pH (level of acidity) before choosing which fertilisers to apply.

- The pH should be checked both within and outside the weeded circle, because acidification can be local and occurs mostly in the weeded circle.
- Checking the pH can be done very easily using a piece of pH paper and some moist soil.
- The moisture from the soil will cause the paper to change colour, depending on how acidic the soil is.
- If the acidity is below 5, then the soil is somewhat acid and the uptake of fertilisers can be slightly reduced.
- If the acidity is below 4, then the soil is very acid. Making the soil less acid will help to make fertilisers better available.
- Correct severely acidic soil by applying:
    - Rock phosphate (a phosphate fertiliser)
    - Dolomite (a magnesium fertiliser)
    - Lime (calcium carbonate)
    - Empty fruit bunches
    - Bunch ash (burned empty fruit bunches)

Figure 2: Rock phosphate application helps to reduce soil acidity