2. PLANNING AND MAKING A SOIL SURVEY

2.0 The purpose of the soil survey

The purpose of making a soil survey is to obtain a representative image of the various types of soils and of the soil horizons present on the site where you plan to build fish-ponds. To save time, effort and money, a soil survey of the site should be done as early as possible. It should be done before the purchase of a site which may prove to have soils unsuitable for pond construction and before designing the fish-farm.

2.1 Soil samples

*Which kind of soil sample do you need?*

Soil samples may be taken in two ways, according to the kind of tests to be performed. They are:

- **Disturbed samples** which do not represent exactly how the soil was in its natural state before sampling;
- **Undisturbed samples** which represent exactly how the soil was in its natural state before sampling.

Disturbed samples are used for the more simple tests that will be performed and particularly for those tests which you will perform yourself in the field. Undisturbed samples are necessary for the more sophisticated tests which must be performed in the laboratory for more detailed physical and chemical analyses. Undisturbed samples must be collected with greater care for they should represent exactly the nature of the soil. For a complete study of the soils on your site, you will need both disturbed and undisturbed samples.

*How deep should you take soil samples?*

Soil samples for aquaculture are normally taken to a depth of 2 metres, so you should examine each soil horizon to that depth. If the water table is found at a depth of less than 2 metres, soil samples should always be taken as deep as possible.

*Which precautions should you observe when collecting soil samples?*

- Sample all soil horizons over 10 cm in thickness; all
Soil samples for chemical analysis

- Each sample taken for chemical analysis should weigh about 1 kilogram except in gravel soils when the sample should be large enough to contain at least 100 grams of fine earth (particles smaller than 2 mm in diameter);
- Remove stones and large pieces of organic material such as leaves and roots in surface samples;
- Avoid mixing samples from different horizons;
- To obtain samples from a soil profile in an open pit, proceed as described in Section 2.2.

What to do with your soil samples

- You may perform simple tests in the field yourself. This is done at the sampling site, as described later in this manual;
- You may collect the soil samples and bring them to a specialized soil laboratory for more detailed physical and chemical analyses; such laboratory facilities exist in some universities (for example, Faculties of Agricultural Science or Departments of Civil Engineering) and in public administrations responsible for Agriculture, Forestry or Public Works.

Remember ...

- If you have to examine and compare the soil samples when you take them, carefully collect them in separate piles to avoid mixing different samples and place the piles on sheets of plastic or newspapers so that they do not become mixed with other materials such as leaves, manure or gravel which may be on the ground;
- If you do not plan to examine and compare the soil samples when you take them, place them immediately in strong plastic bags or in canvas bags with plastic liners; tie all bags tightly;
- Label all sample bags carefully and completely; write clearly on the label the identification number of the sampling location, the upper and lower depths of the horizon sampled, and the date.
For chemical analyses, the soil sample may be disturbed; for physical analyses, the soil sample may be disturbed in some cases but has to be undisturbed in others, as described in the note at the end of Section 3.1.

2.2 Soil sampling methods

Soil samples may be taken by three methods which involve either digging, drilling or boring holes at the place on your site where you have chosen to collect samples from different depths. They are:

- **The open pit method;**
- **The auger boring method;**
- **The thin-walled tube method.**

**The open pit method**

Open test pits are the only means available actually to see and be able to examine a soil profile in its natural state. They may be dug by hand or by special excavating equipment such as a trench digger. If necessary, you may obtain undisturbed samples from selected horizons of an open pit.

**The basic steps to follow when digging an open pit are:**

- Dig a pit with very straight sides 0.80 x 1.50 m and 2 m deep or, if less, until you reach the parent rock; the upper part of the pit should be wide enough for you to see the bottom easily (the drawing shows you how);
- If you have selected a site with alluvial soil, you may find ground water before you reach 2 metres. If you find water, further digging is impossible but sample the soil at the bottom of the pit as far down as possible;
- When you have finished digging, examine one of the well-exposed sides of the pit carefully to determine the different soil horizons: this is called a soil profile; it should be examined when freshly dug. Make a drawing of this soil profile for each pit you dig and measure and write the depths of each soil horizon. Carefully write on your drawing the location of the site where each sample was taken.
Now you are ready to begin taking the disturbed or undisturbed soil samples that you need, either for field testing or for laboratory testing. To obtain samples for chemical analysis, proceed as follows:

- Carefully clean the whole vertical profile;
- Sample each horizon from bottom to top, starting with the lowest horizon and proceeding upward. You will be shown how to take samples later in this chapter;
- To sample the uppermost horizons, which may have been disturbed when digging the pit, move to an undisturbed area as close as possible to the actual pit, dig a shallow hole and take the sample there.

**The auger boring method**

The auger boring method is a way to obtain soil samples from different depths by drilling, without having to dig a pit. This way, a continuous series of soil samples is taken which makes it possible to assemble a core* showing the soil horizons. The auger boring method is cheap and fast, you can quickly check the soil at several places on your site, but it provides only disturbed samples. An auger may be used in most soils above the water table and in cohesive soils below the water table. If you do not have an auger, you may be able to borrow one from a neighbouring agricultural station or experimental farm.

**Two common soil augers**

There are many kinds of soil augers but the most
The basic steps to follow when sampling with an auger are:

- **common kinds** are the **bucket auger** and the **screw auger**.

A standard **bucket auger** is a metal cylinder about 16 cm long and 8-10 cm in diameter. It has a cutting edge on the bottom surface which enables it to cut through most soils easily. Generally, bucket augers are equipped with an extension shaft and handle which allow you to take samples at greater depths, usually down to 1.1 m. A sample taken with a bucket auger is slightly disturbed but it is acceptable for most sampling purposes and it provides a sample large enough for further laboratory analysis. A bucket auger with a diameter of 10 cm is especially good for local permeability tests (see Section 9.6).

Some limitations when using a bucket auger are:

- It is less efficient in soils which contain a lot of sand and gravel;
- It is difficult to use in clay soils;
- The sampling depth is limited to a little more than 1 m at the most.

A **screw auger** is a metal spiral about 30 cm long and 3.5-4 cm in diameter. Screw augers are equipped with several extension rods, usually 30 cm long, which can be attached, one by one, to take samples at greater depths.

Some limitations when using a screw auger are:

- Soil samples are **severely disturbed**;
- It is not efficient in soils which contain a lot of sand and gravel;
- It is difficult to use in hard clay.

*The basic steps to follow when sampling with an auger are:*
- Drill the auger into the soil to a depth of 10-15 cm;
- Pull the auger up carefully to keep the soil in place, just as it was in the ground, and place the soil sample on a sheet of plastic or newspaper;
- Continue drilling 10 to 15 cm at a time; place the successive sections one after the other to assemble a core* showing the soil horizons;

- Make a drawing of the core; measure and write the depths at which you observe the various horizons;

  *Note: The term 'core' may also refer to a cylindrical or conical sample of soil collected using a soil auger, typically used for soil surveying and analysis.
• If you reach water, drill more carefully but try to continue drilling for another 30 to 40 cm.

Note: if the soil below the water contains a lot of sand, the sides of the hole will not stay in place and you will have to stop drilling. If the soil below the water contains enough clay, the sides of the hole will stay in place and you will be able to continue to drill, even below the water level.

The thin-walled tube method

With the thin-walled tube method, you use a light-weight tube or pipe which is open at both ends. It is pushed into the soil to obtain a sample and is then removed from the hole. If it is well done, this method will provide undisturbed samples.

Standard thin-walled tubes are manufactured about 30-60 cm long and 4-7 cm in diameter. You can also make your own sampling tubes from lengths of steel pipes made of No. 16 (1.6-mm) or No. 18 (1.25-mm) gauge steel, 15-30 cm long and 3.5-5 cm in diameter.
Some limitations when using a thin-walled tube are:

- It is not effective in loose soils;
- It is not effective in hard or gravelly soils.

It is important to remember that, if used properly, this method will enable you to obtain practically undisturbed soil samples. The degree of disturbance of the samples will depend on the manner in which the sampling tube is inserted into the soil and on the characteristics of the tube. The greatest disturbance is caused when pushing or driving the sampling tube into the soil, so this should be done with great care. There is also less chance of disturbance if the tube is thin-walled and sharpened to a good cutting edge at one end.

**The basic steps to follow when sampling with a thin-walled tube are:**

- **Dig an open pit;**

  - Carefully oil the inside wall of each sampling tube (you can use old motor-oil);

- **Determine the various soil horizons on the soil profile; prepare a sketch of the soil profile and write in the depths of the layers;**

  - At the spot where you wish to obtain a soil sample, insert one sampling tube horizontally into the soil; try to **push the tube into the soil at a high and constant speed**; only if necessary, use a hammer and a piece of wood;
2.3 How to make a soil survey for a freshwater fish-farm

The survey procedures described here are simple and suitable for the study of potential sites for fish-pond construction. For other areas of agriculture, there are more elaborate procedures such as those described in "Soil survey investigations for irrigation", FAO Soils Bulletin, 42 (1979).

A soil survey is conducted in two parts

The first part is a short, quick survey to get a general idea of the soil varieties present and where they are found on the site. This is called a reconnaissance survey. A reconnaissance survey is usually conducted by digging a number of open pits and examining the exposed soil profiles. Selected samples are then taken for field or laboratory testing. The results of this quick survey should enable you to determine which parts of the site may be suitable for pond construction, such as those with good impermeable soil, and which parts of the site are unsuitable, such as those with gravel beds or thick layers of organic soil. You will learn how to make a reconnaissance survey in Section 2.4.

- Dig the sampling tube out of the ground with a knife; be careful to keep it horizontal so that you do not disturb the enclosed soil sample;
- Close the two ends of the tube tightly to keep the soil sample inside; you can use pieces of cloth, plastic sheet, or pieces of tyre inner tube and string to close the ends;
- Place the closed sampling tube in a plastic bag and label it;
- Repeat this procedure along the soil profile as many times as necessary.
The second part is a more complete survey of the parts of the site which you found to be suitable in the reconnaissance survey. This is called a **detailed survey**. A detailed survey is usually conducted by drilling a number of holes using the **auger boring method**. The auger samples you take will allow you to determine in greater detail the existing soil conditions and the suitability of the soils present. If necessary, you can take undisturbed soil samples to a laboratory for additional testing. You will learn [how to make a detailed survey](#) in Section 2.5.

**Note**: the number of samples you will have to take on a site will depend on the variety of soil conditions present. The greater the variety, the greater the number of samples you will have to take and examine to get a clear picture of possible site suitability.

### 2.4 Making a reconnaissance soil survey

The following are some basic steps to help you when making a reconnaissance soil survey:

- **Select a site** for your proposed fish-farm.

**Preparing for the survey**

- Draw a small **sketch map** of the proposed site and locate all of the major topographical features such as streams, rivers, swamps, gravel beds, rock outcroppings, hills and anthills, forest or savannah lands (see example below);
- Review the sketch map you have drawn and **study** all topographical features and any other factors which could affect soil quality such as types of vegetation, human activities and general topography;
- On the basis of this **study**, decide upon a **plan** for your reconnaissance survey, keeping in mind that you should provide at least one sample of each kind of soil from the various parts of your selected site for pond construction. As a rule, you should take soil samples from at least **one location in each hectare of land**;

- **Number the location** of each place you have chosen to take soil samples from on your sketch map. You have already been told that to make a reconnaissance survey you usually dig open test pits. So, number each of your pit sampling locations with P. Number them consecutively P1, P2, P3, P4 ... P12, until all the locations have been numbered (see 12 locations in the example below).

**Note**: when making a soil survey in a valley, plan your survey to **obtain samples across the valley** and along the slope where most of the soil variation occurs.

**Note**: when you have different kinds of vegetation such as cultivated land, pasture, open savannah, forested savannah, and light and thick forest area, plan your reconnaissance survey so that you obtain soil samples from each of the different vegetations. You can eliminate areas from your plan with large surface stones, gravel beds or rock outcroppings which are unsuitable for earth pond construction. Most thickly forested areas can also be considered
outcroppings which are unsuitable for earth-pond construction. Most thickly forested areas can also be considered unsuitable.

Note: each square is 100 x 100 m or 1 ha and the total usable area is about 7.5 ha.

Digging the open pits and examining the soil profiles

- In each of the locations you have numbered on your sketch map, dig an open pit 0.80 x 1.50 m and 2.00 m deep;

  Dig each pit and examine each profile

- Examine the soil profile as soon as it is exposed when it is still fresh so that you can define the horizons more easily. If it becomes dry before you can examine it, cut a vertical slice from the side of the pit and examine the fresh profile, as you were told in section 2.2;
● Make a **drawing** of the profile as soon as you have examined it. Record your findings and any other field **observations** you have made that may be of value later. Number the drawing according to your site map.

**Taking the samples**

● Now you are ready to take the soil samples that you will need from the profile. If you need disturbed samples, they can be taken with a small shovel or garden trowel. If you need undisturbed samples, they can be taken from the various soil horizons using the **thin-walled tube method**.

![Taking a disturbed sample](image1)

![Taking an undisturbed sample](image2)

● Bag and label all of the soil samples that you take and store them in a safe, dry place until you are ready to use them. Remember to note on the label the number of the sample location, the upper and lower depths of the soil horizon samples and the date.

**Note:** when you have completed the reconnaissance survey and have roughly determined which different soil types are present and where they are found on the site, note this information on your site map. If the results of
2.5 Making a detailed soil survey

The following are some basic steps to help you when making a detailed soil survey.

**Preparing for the survey**

- Carefully study your site map and the notes of your findings and other field observations from your reconnaissance survey. Decide upon a plan for your detailed survey to complete this information. In particular, you will need to locate more accurately the various types of soil present on the parts of the site which may be suitable for pond construction;
- Select the locations where you need to take additional soil samples. As a rule, this will mean choosing two or more sampling locations in each hectare of land;
- **Number** on your site map each new location from which you have chosen to take additional soil samples. You have already been told that to make a detailed survey you usually drill a number of holes using the auger boring method. So, number each of your auger sampling locations with A. Number them consecutively, being careful not to use numbers already used, as follows: A13, A14, A15, A16 ... A29, until all the locations have been numbered (see 17 new locations on site map below).

*Note*: each square is 100 x 100 m or 1 ha
Taking auger samples and examining the soil profiles

- In each of the new locations, take a series of samples using the auger boring method;

- Examine these samples as soon as possible, while they are still fresh. Make a drawing of each core* and record your findings and any other field observations you have made that may be of value later. Number each drawing according to your site map.

Draw sample core and write depths

Taking subsamples

- Take subsamples from the core*, if necessary, for later laboratory analysis. You can do this by first defining the various horizons present and then, using your hand or a small trowel, taking a soil sample from selected horizons to complete the information available from the reconnaissance survey open pits.

- Bag and label all of the soil samples that you take and store them in a safe, dry place until you are ready to use them. Remember to note on the label the number of the sample location, the upper and lower depths of the soil horizon sampled and the date.
Note: when you have completed the detailed survey, compare the results with the results of your reconnaissance survey. Draw a final map showing the distribution of the different soil types. If there are any doubts, take additional auger samples in specific locations to complete your information. The soil samples you have already taken may also be examined again and additional samples (for example, undisturbed samples from the open pits) may be taken to check further on particular soil properties.