

Indicators of soil health

A series of qualitative indicators, which do not require laboratory analysis, make it possible to quickly assess, on the ground, the state of soil health. These indicators can be grouped into three types: **a)** from the **visual analysis of a section of the soil** (identifying organic material, roots, soil organic matter, macro-fauna, aggregates and pores); **b) indicators by physical tests** (penetrability, infiltration, aggregate stability); and **c)** through the **smell of the soil**.

■ Indicators to monitor soil quality

There are a large number of indicators to monitor the quality of soils and the changes that occur in them. These include **indicators of the physical properties of the soil**, such as depth, texture, infiltration potential or water retention capacity. Others are **chemical indicators**, such as organic matter or carbon content, pH, or electrical conductivity. Finally, there are also **biological indicators**, such as microbial biomass, respiration or, more recently, soil biodiversity. However, **all of them require complex sample collection and laboratory analysis**. The way to interpret them and the methodology to measure them are widely described in any soil science manual.

However, **there are other indicators that do not require laboratory analysis** and that allow a quick assessment of soil health in the field. Although they are mostly **qualitative indicators** that do not allow making certain comparisons, they do allow us to quickly identify possible problems in the soil, and to have a reference for monitoring the change over time of the soil. We can group these indicators into three groups: indicators from a visual analysis of a section of the soil, indicators through physical tests, and indicators of soil odour.

■ Visual analysis of a soil section

Some indicators can be obtained directly from the visual analysis of a **soil section (Figure 1)**. To do this, a hole is dug in the ground or, more quickly, a **soil sample of the first 10-15 cm** is removed with a knife or shovel. The elements that can be observed visually are the following:

- **Cover of dry organic material.** Look at the soil surface for dry organic matter cover. A balance between good cover and a certain degree of decomposition of organic matter is an indicator of healthy soil.
- **Abundance of roots.** Roots grow in all directions and root density is a sign of healthy soil. At the same time, in plants with taproot roots, the fact that the main roots grow vertically downwards is a sign that there is no horizontal impermeable layer as a result of tillage.
- **Dark colour of soil organic matter.** In well-structured soil, a gradient is usually appreciated that begins with a darker



Figure 1. Section of healthy soil. Photo: Marc Gràcia.

colour on the surface that gradually lightens with depth. Depending on the type of soil, in well-structured soils the top may have a darker layer of humus.

- **Macro-organisms in the soil.** The aim is to identify macro-organisms in the soil, which can be arthropods or other groups (with adequate soil moisture and if the sample is large enough, worms should be found). They are easier to see under the cover of organic material, and a good number of them indicate healthy soil.
- **Aggregates and pores.** Looking closely at a sample in your hand, you can observe aggregates of different sizes. A soil without aggregates and with an amorphous structure is a soil without pores and with very little aeration, which prevents the movement and life of the components of the food web.



Figure 2. Elements for the infiltration test. Photo: Marc Gràcia.



Figure 3. Dry soil samples from a regeneratively cultivated agricultural field (left) and a conventional agricultural field (right) submerged in water. Photo: MJ Broncano.

■ Soil physical tests

There are simple physical tests that give us good indications about the health of the soil. With these tests we can observe how the soil changes as measures are taken to improve it.

- **Penetrability.** In this test, **a knife or machete is stuck to check the resistance offered by the soil.** It should be done in conditions of minimal humidity. The machete marks the limit beyond which it is difficult to nail. In a healthy soil it should be easy to drive the knife deeper than 15 cm.
- **Infiltration.** To carry out this test, a tall metal ring (it can be a can open at both ends) is driven into the soil at a depth of 3-5 cm. The ring is filled with a fixed amount of water and the time it takes to infiltrate is observed, so that if it is a short time it is considered that the soil has a good infiltration (**Figure 2**).
- **Stability of the aggregates.** A sample is taken from the top layer of the soil. It is left in the air to dry. Once dry, it is immersed in a glass jar filled with water and the time it takes for the aggregates to dissolve is observed. When the aggregates break up the soil sample becomes a homogeneous layer at the bottom of the jar. If the aggregates are not very stable, they will be broken up in less than 5

minutes. If the aggregates are stable and, therefore, the soil is healthy, they can be kept for several days before falling apart (**Figure 3**).

■ Soil odour

The smell gives us valuable information about the state of the soil. In order to appreciate the smell, the soil must have a minimum humidity. If the soil is very dry, before smelling it, take a sample, moisten it with water and wait a while for it to homogenise.

- **Sweet scent with distinctive earthy geosmin scent.** Geosmin is a chemical produced by some bacteria and fungi found in the soil. This substance is perceptible when the soil is moistened and is an indicator of a healthy soil. It is the characteristic smell of forest humus.
- **Smell of rotten eggs.** This odour denotes a soil dominated by anaerobic organisms. A healthy soil must be aerobic.
- **Metallic smell.** This odour indicates an unbalanced soil dominated by bacteria.
- **Odourless.** When a soil has no odour, it is that it is a very dry soil or with very little activity of organisms.

The regenerative production model recovers contact with the soil

Healthy soil allows plants to grow at their maximum productivity, without diseases or pests and without the need for external supplements. The most important thing to know how a soil works is **to regain contact with it**. Many farmers work from the top of the tractor, they have lost contact with the soil. This sheet highlights the importance of the soil and is intended to be a guide to which indicators allow us to find out the status of and changes to soil health.