GUIDE OF SOIL ANALYSIS FOR MEDITERRANEAN AGROSILVOPASTORAL SYSTEMS

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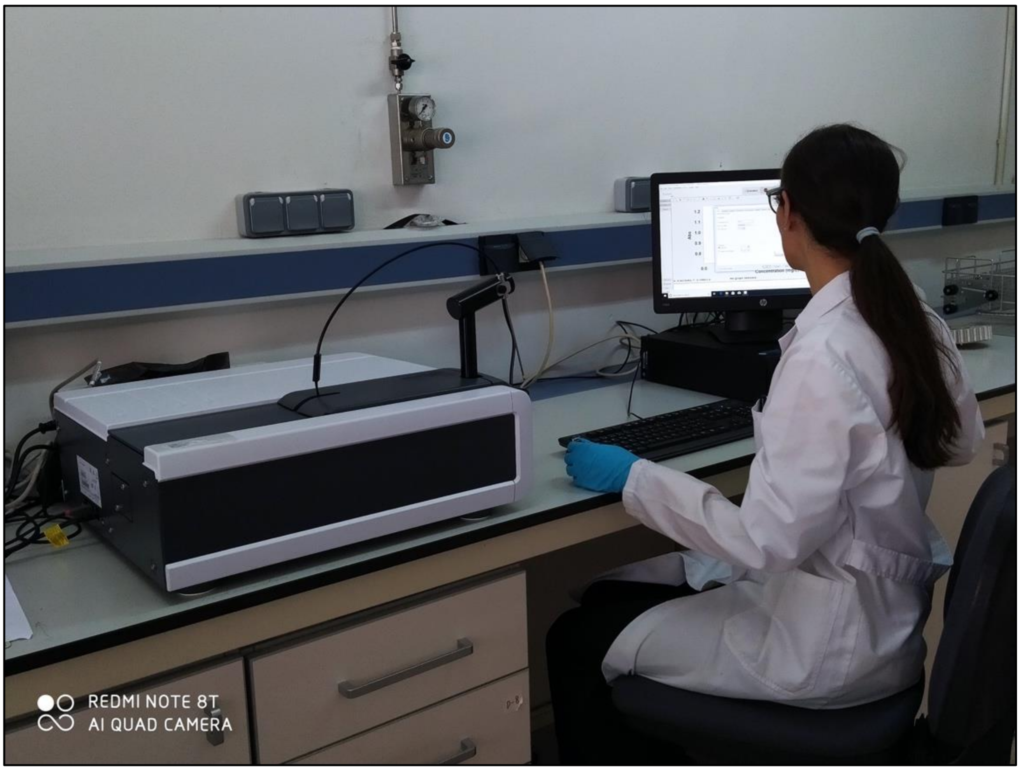
What is soil analysis?

Soil is a surface component of the Earth that developed from geological materials (parent materials: rocks of the surface of the Earth) and dead biomass. Soils are made up of four basic components:

- Mineral components (including primary and secondary minerals, amorphous components and water-soluble salts)
- Organic components (dead biomass and the products of their decomposition)
- Water
- Air

Soil is considered as the growth medium for plants providing them with air, water and nutrients; therefore, a main function of soil is the production of biomass to sustain animal and human life by providing food, feed and renewable raw materials. Soil analysis encompasses several chemical procedures that determine the availability of plant nutrients in the soil, as well as other chemical, biological and physical soil properties important for plant nutrition, or "soil health". Some examples of these analyses are: pH, organic matter, nitrogen, phosphorus and potassium contents, cation exchange capacity (CEC), soil texture, etc.



Which are the benefits?

Main reasons to test soil are:

1. Gain knowledge about the level of availability of nutrients. This information allows to define what type and quantity of fertiliser needs to be applied to improve soil fertility.

2. Diminishing the farmer's expenditures. Soil testing allows the farmer to avoid unnecessary fertilisation, saving on fertiliser costs.

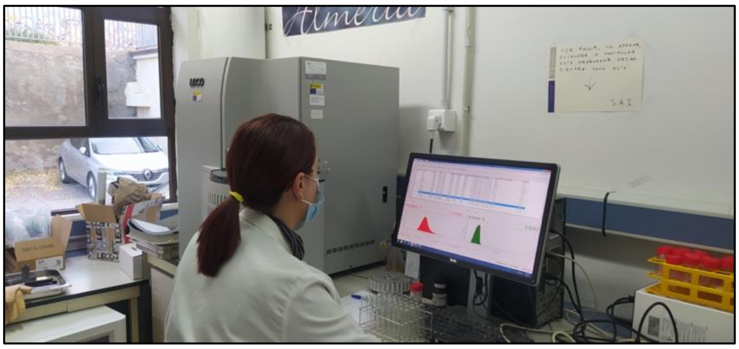
3. Knowing the potential fertility of soil. Improving our understanding of soil characteristics will also allow a better allocation of resources (fertilization alone may not always produce better results because of possible limiting factors).

4. Getting a healthier environment. The overuse and misuse of soils may adversely affect environmental quality. Over-fertilization is harmful to the environment because it results in ground and surface water pollution, nutrient leaching, and irreversible harm to the aquatic life. Testing soil prevents farmer from applying excessive amounts of fertilisers and minimising the related environmental damages.

What are the most important soil analyses for farmers?

Soil testing is the only means for assessing nutrient deficiencies, imbalances, and/or toxicities in soils and crops, and for formulating lime and fertilizer recommendations. Soil analysis comprises qualitative and quantitative analysis. The aim of qualitative analysis is the detection and identification of soil constituents or soil properties, whereas the purpose of quantitative analysis is the determination of the amounts or concentrations of soil constituents. There are many different types of soil analysis, but the key analyses would be:

- Soil pH: pH is a measure of the hydrogen ion concentration in the soil solution. Based on their pH, soils can be roughly divided into three groups: acidic (pH lower than 6.8), neutral (pH between 6.8 and 7.3) and basic or alkaline (pH higher than 7.3). The pH of a soil exerts influence on all biological, physical and chemical properties of and processes in the soil. The growth of plants and other organisms is strongly influenced by soil pH because it controls the availability of nutrients. Most favourable pH values for plant growth are between 5.0 and 7.5.
- Soil organic matter (SOM). It comprises those organic molecules in the soil, which are not part of living organisms. SOM is the most important source of plant nutrients (especially N, S and P). It also influences other physicochemical properties of the soil such as water content, ion exchange capacity and soil structure.



- Nitrogen. Plants need for growth and reproduction Carbon, Hydrogen and Oxygen, which they take up as CO_2, H_2O and O_2 from the atmosphere and the soil. But they also need other elements, called nutrients, which they absorb by roots in ionic form, such as Nitrogen, Phosphorus and Potassium. Nitrogen is the most important nutrient for plant growth; it may be absorbed absorbed from the soil solution through the roots in two ionic forms, nitrate (NO_3^-) and ammnonium (NH_4^+). Additionally, legumes can use atmospheric nitrogen (N_2) directly since it is fixed into organic nitrogen by the nitrogen-fixing bacteria living in their root nodules.
- Phosphorus and Potassium. Phosphorus and potassium are essential plant nutrients that are taken up by plants in the form of inorganic ions ($H_2PO_4^-$, HPO_4^{2-}, K^+). Phosphorus is needed for root development, for seed formation and it is essential for all metabolic processes as forming part of the ATP molecule. Potassium is the most abundant cation in plants (3% dry mass). It is needed in carbohydrate formation and translocation of sugars, and it is believed to increase resistance of plants to various diseases.
- Cation Exchange Capacity (CEC). It is a quantitative measure of all the cations adsorbed on the surface of the soil colloids; in other words, it is the capacity of soils to hold (adsorb) and exchange cations (nutrients). By holding cations on soil colloids, they are prevented from leaching. Because of this the adsorbed cations can be made available for uptake by plants roots.
- Soil texture. The mineral matter of soils is composed of inorganic particles varying in size: Sand particles range from 0.05 to 2.0 mm, silt particles are between 0.002 and 0.05 mm in diameter while clay particles are less than 0.002 mm in size. The relative proportions of the soil particles determine the soil texture; accordingly, soils are classified in four major textural classes: (1) sands; (2) loams; (3) clay loams; and (4) clays. Soil texture determines the rate at which water drains through the soil and consequently how much water is available to the plant. Soils with a higher clay content can store more nutrients and water because soil with small clay particles has a large surface area per unit volume. On the other hand, sand particles in a soil facilitate drainage and aeration of the soil; so that organic matter breaks down faster in sandy soils than in fine-textured soils because of a higher amount of oxygen available for decomposition. Therefore, intermediate textured loamy soils are considered the best soils for most crops.

How to properly perform soil sampling for analysis?

Because of soil variability, differences in soil composition and properties are present not only from region to region but also from a one part of a given farm to another, and frequently within very short distances of a same field plot. Before any soil analysis can be performed, it is necessary to procure a test sample that will represent the soil under investigation. The extent to which the result of an analysis identifies a real characteristic of the whole soil depends upon the accuracy of sampling.

Samples are collected with a till spade or a shovel by cutting a V-shaped slice to the proper depth: 0-30 cm for field crops, 0-30 cm and 30-60 cm for permanent crops (orchards and vineyards). Before digging, aerial plant material and litter shall be removed by scraping with a hoe, so that only soil (and fine roots, if any) is included in the sample. If the field plot under analysis is homogeneous in soil and topography, individual samples from 5-6 places evenly distributed over a hectare are taken. If strongly sloped or having different soil types, a composite sample from each of the different zones should be analyzed. A composite sample is obtained by thoroughly mixing all individual samples from the same homogeneous zone in a clean plastic bucket until a completely homogeneous mixture is attained. A small portion adequate for analysis (approximately 1 kg of soil, free of stones and coarse roots) is then transferred to a clean plastic bag, which should be clearly labelled with the owner's name, address and designation of the sample for transfer to the laboratory.

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