Lancrop Laboratories

Technical Note:
Soil Analysis Interpretation

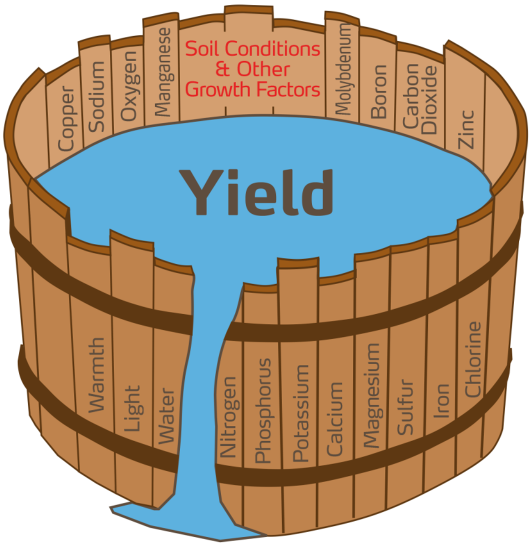
Soil analysis interpretation

Why take a soil sample?

In Justus von Liebig's **Law of Minimum** he stated that plant growth is not controlled by the total amount of resources available, but by the scarcest resource or **the limiting factor**.

Limiting factors could be the climate/weather, the soil, water, variety/seed, nutrient availability, weeds and pests, and many others, but to manage these factors it is important to measure them and understand those that are limiting.

Soil analysis gives the background knowledge on the chemical, physical and biological status of the soil that we need in order to mange our soils and our crops.



JUSTUS VON LIEBIG 1803 - 1873

What to analyse?

Most of the work, and cost, of analysis is in the sampling and transporting the sample to the laboratory.
Once the sample has arrived there are a wide range of tests that can be conducted that give a lot of information about that soil and start to identify those limiting factors.

Nutrient analysis
Soil analysis provides an inventory of the available nutrients and provides the background to build a nutrient management plan. Basic soil analysis in the UK includes P, K, Mg and pH, but this analysis only provides a part of the information needed as other nutrients can be limit crop growth. In order to get the most from a soil sample it is important to analyse for all nutrients using a full broad spectrum analysis.

Chemical and physical analysis
The physical and chemical characteristics of the soil need to be considered before making any soil management decisions or planning a nutrient application strategy. Soil pH, Cation Exchange Capacity, organic matter and soil texture all have an impact on how we manage our soils and crops.

Biological analysis
An active population of soil organisms is essential to a healthy soil; they contribute to the re-cycling of nutrients from the humus, organic matter and soil particles, making them available for plant uptake. Together with organic matter, a biological analysis provides a rounded picture of the soil's overall health and its potential for producing high yielding, quality crops.

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Physical characteristics

Test	Optimum level	Comments
Texture	Reference soil triangle (See Technical Note: Soil Texture)	Soil texture is a measure of the relative proportions of the basic particle size constituents of the soil: sand, silt and clay. It has a significant effect on the soil air, water holding capacity and drainage properties of the soil. Little can be done to alter texture; farmers must understand soil texture across the farm and work with the texture to ensure the soil is as productive and stable as possible. Crop nutrition also needs to be managed based on the soil texture to provide the best productivity.
Organic Matter	> 3% generally indicates a fertile soil (See Technical Note: Organic Matter)	Organic Matter plays a major role in determining soil physical characteristics; soils with medium to high OM levels would generally be expected to have good structure, moisture retention and water infiltration. Intensive tillage increases the loss of organic matter by speeding up the decomposition process. This can be reversed overtime by reducing tillage, using cover crops and increasing external organic inputs such as manures, greenwaste composts.

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Chemical characteristics

Test	Optimum level	Comments
pH	6.5 – 7.5 arable 6.0 – 7.0 grassland	Soil pH is a measure of the acidity or alkalinity of the soil, it has a direct effect on nutrient availability, microbe activity and overall plant health. A knowledge of the soil pH is fundamental to soil and crop management. Liming is the standard way to neutralise the acidity in the soil. Lime requirement depends on soil texture, crop type and the existing soil pH. There is little that can be practically done to reduce pH in alkaline soils; fertiliser applications must be adjusted to ensure adequate supply of nutrients to the growing plants.
CEC	> 3% generally indicates a fertile soil (See Technical Note: Organic Matter)	CEC is a basic measurement of the soils ability to bind or hold nutrients. The CEC of a soil is not easily adjusted, so farmers have to work with the varying CEC's they farm and tailor nutritional management to suit.

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Nutrient status

Test	Optimum level	Comments
Phosphorus (P)	16 – 46 ppm Index 2 to 3 varies with crop	Phosphorus promotes rapid leaf growth, leaf size and plant tillering. It is important for root development and brings forward maturity and stimulates flower, seed and fruit production. Soil analysis measures the available phosphorus in the soil and in the UK this is reported using the ADAS Index system. Soil pH has a major effect on phosphorus availability, once soil pH drops below 6.0 or rises above 7.5 the availability of phosphorus is greatly reduced. Cold soil temperatures will also reduce the uptake of phosphorus so that even when soil phosphorus is adequate in the soil a deficiency can still be induced.
Potassium (K)	121 – 240 ppm Index 2- to 2+ varies with crop	Potassium regulates water balance within the cells and water loss through transpiration. It stimulates growth of strong stems and can provide the frost and drought tolerance of plants as well as improving colour, flavour and storage quality of fruits and vegetables. Most of the soil potassium is in unavailable forms and only becomes available when the soil bedrock weathers. Potassium can leach once available, particularly in higher rain-fall areas with light textured soils, it should be applied regularly throughout the growing season in lighter soils.

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Calcium (Ca)	1600 – 5000 ppm varies with crop	Calcium is needed at the growing point of new tissues. It is one of the important constituents of the cell wall and provides strength and stability. Calcium is prevalent in many soils as it occurs in many Minerals. Calcium in the soil solution readily leaches and tends to be deficient in higher rainfall areas, or where irrigation is poorly managed. Even calcium rich soils may not have sufficient plant available calcium for rapidly growing crops. Calcium should be applied little and often to ensure accumulation within new tissues and fruits.
Magnesium (Mg)	50 – 400 ppm varies with crop	Magnesium is a vital constituent of chlorophyll. Magnesium is readily leached when present in soluble forms, although generally only 6% of the total soil magnesium is in the soil solution at any one time. Higher rainfall areas, irrigated crops and soils with a low CEC are the areas most at risk of poor magnesium supply. The availability of magnesium can be suppressed by high levels of potassium and calcium in the soil or excessive potassium applications.
Sulphur (S)	10 – 80 ppm varies with crop	Sulphur is essential for the formation of plant proteins, amino acids, and enzymes. It is involved in the reduction of nitrate to amino acids. In the past large amounts of sulphur were released into the atmosphere and deposited on the land from industrial processes, this has declined greatly in recent years. On medium to heavy soils, the timing of sulphur application is not critical, but on light soils sulphur should be applied, little and often to avoid leaching.

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Boron (B)	0.5 – 6.0 ppm varies with crop	Boron is essential to maintain structural integrity of plant membranes and is important for pollen viability, flower and fruit development. Soils typically hold 2 – 200 ppm of boron, but less than 5% is available, this available boron is held in organic matter. Under high pH (> 7.5) boron becomes unavailable and excessive use of lime can make this problem worse. Boron readily leaches from light soils or soils with a low CEC. Boron uptake by the plant mainly depends on mass flow and is therefore reduced at low temperatures and in dry conditions.
Copper (Cu)	2.1 – 14 ppm varies with crop	Copper is important for pollen formation and influences fruit set and grain formation. It also is used in the lignification of cell walls. Most copper in the soil is bound up in complexes and unavailable. Peat soils, with a high organic content, have low copper availability and need frequent applications. Copper is unavailable in acid soils (<pH 4) and in alkaline soils (>pH 8).
Iron (Fe)	50 – 500 ppm varies with crop	Iron is essential for chlorophyll formation and function. Iron is present in most soils in adequate quantities as oxides. However, availability declines as pH increases from 4 upwards; this is the overriding factor in iron nutrition and iron deficiency is a worldwide problem on calcareous soils. Soils with high OM content have enhanced iron solubility and therefore availability.

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Manganese (Mn)	45 – 220 ppm varies with crop	Manganese is involved in chlorophyll synthesis and photosynthesis and lignin synthesis. Manganese is plentiful in most soils, but deficiencies are commonplace when soil conditions combine to create a shortage. As soil pH increases, insoluble manganese oxides are formed, soil pH readings higher than 6 cause supply problems, especially on lighter soils. Over-liming and the occurrence of loose, highly aerated soils commonly reduce manganese availability and under cold, wet soil conditions manganese also becomes unavailable.
Molybdenum (Mo)	0.1 – 0.6 ppm varies with crop	Molybdenum is needed for plants to utilize nitrogen. Molybdenum is the only micronutrient that has increased availability as the pH increases, i.e. is more available in alkaline soils, but will be less available in acid soils.
Zinc (Zn)	2 – 7 ppm varies with crop	Zinc is a catalyst in the enzyme systems used for protein and carbohydrate metabolism. It is also responsible for the metabolism of auxins and is important for regulating key growth processes. Zinc is present in a wide range of soils, but there are many areas of the world where zinc is not present in the parent material or has been leached and is therefore deficient. In acid, sandy soils with high rain-fall, zinc can be leached. Zinc is also less available in soils with low organic matter.