CORE COMPONENTS OF SOIL HEALTH

Soils are never "one size fits all," but all healthy soils do have these three essential components in common.

1 Plentiful nutrient content and availability

Healthy soils have a plentiful supply of minerals and other essential nutrients, as well as a balanced pH, making them readily available for uptake by the plant. Depletion is offset by the minerals that return to the soil through fertilization or decomposition.

Factors such as temperature and pH can greatly reduce nutrient availability. The availability of phosphorus and calcium is poor in highly acidic soils, while iron, copper and zinc are less available in highly alkaline soils.

2 Biodiversity and a strong microbiome

High-performing soils have a vibrant population of insects, worms and microbes. A strong microbiome is a miniature environment that harbors little to no pathogens and is rich in the beneficial organisms that promote root and plant growth.

Certain crop practices can have a harmful effect on soil biodiversity, resulting in a loss of these organisms and the myriad benefits they provide, and allowing pathogens to gain a foothold.

3 Balanced soil profile

Balanced, silty soils with high organic content combine good aeration with excellent nutrient and water retention, requiring fewer costly inputs. Highly productive soils often contain as much as 20% water and 20% air.

Sandy soils are well-aerated but hold little water or nutrients, while clay soils may store more water and nutrients but are poorly aerated. Generally, low organic content means poorer overall fertility.

Key definitions:

Soil health: Healthy soils have a balanced structure with high organic content, good biodiversity and high nutrient availability.

Plant health: True plant health goes beyond "no visible disease symptoms." Healthy plants have robust nutrient uptake and utilization and are well-equipped to withstand the effects of disease and environmental stresses.

How do healthy soils benefit growers?

Reduced impacts of stress

During the season, crop stress events, such as heat, frost, drought and disease, strain plant resources and greatly reduce potential end-of-season harvest yields.

Healthy, productive soils can offset the worst of these stresses, helping maintain optimal harvest yields and business profitability.

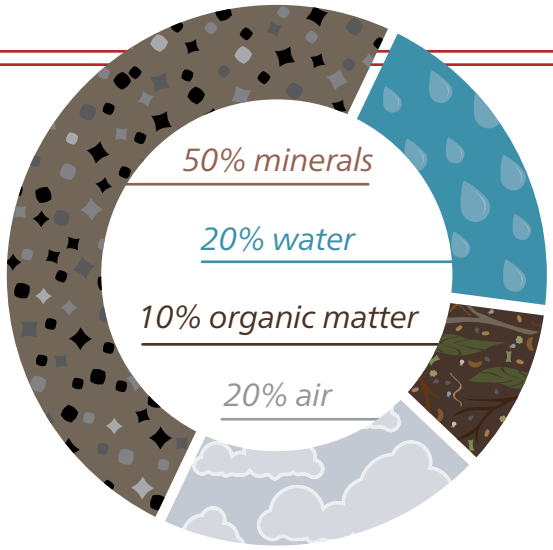
Increased production with fewer inputs

Well-balanced soils that are rich in organic matter naturally supply much of the nutritional and water requirements that would otherwise need to be supplemented by the grower.

Reducing the amount of inputs required means money saved.

Sustainability and profitability

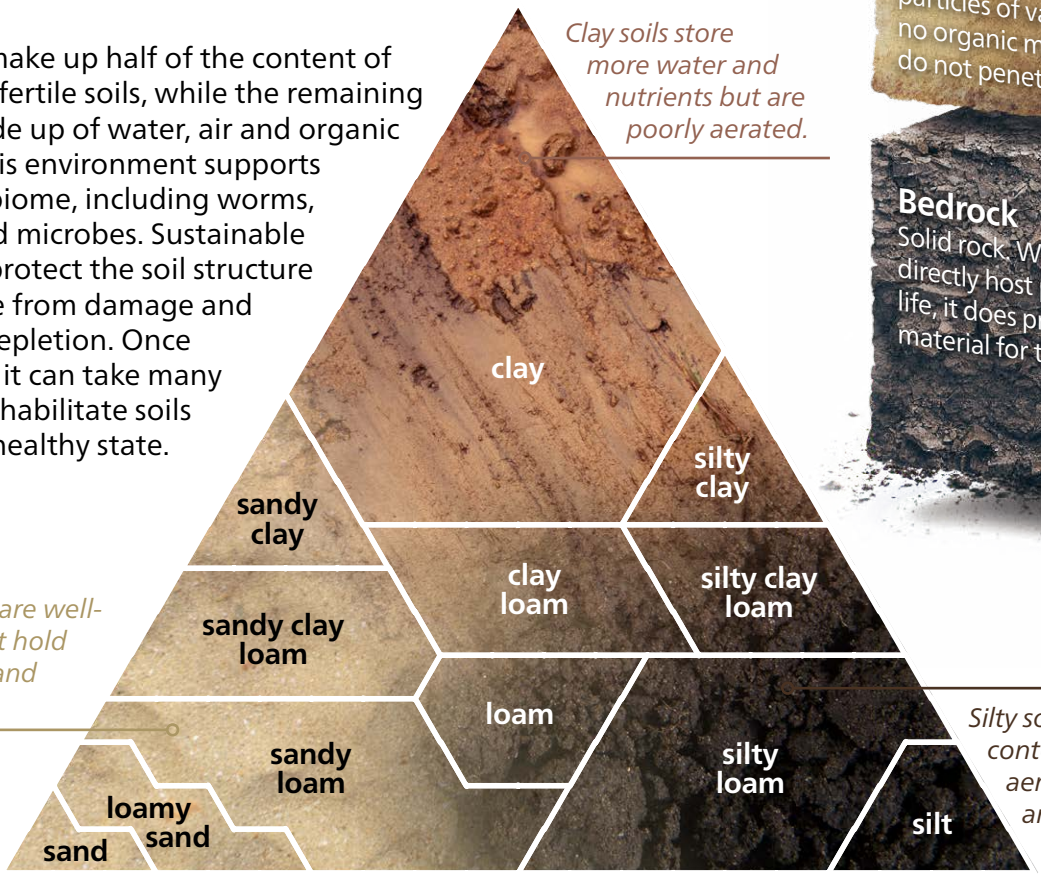
Healthy soils are not only more environmentally sustainable, but they also represent a valuable, revenue-generating asset for growers, their businesses and their families for years to come.



"We know more about the movement of celestial bodies than about the soil underfoot."

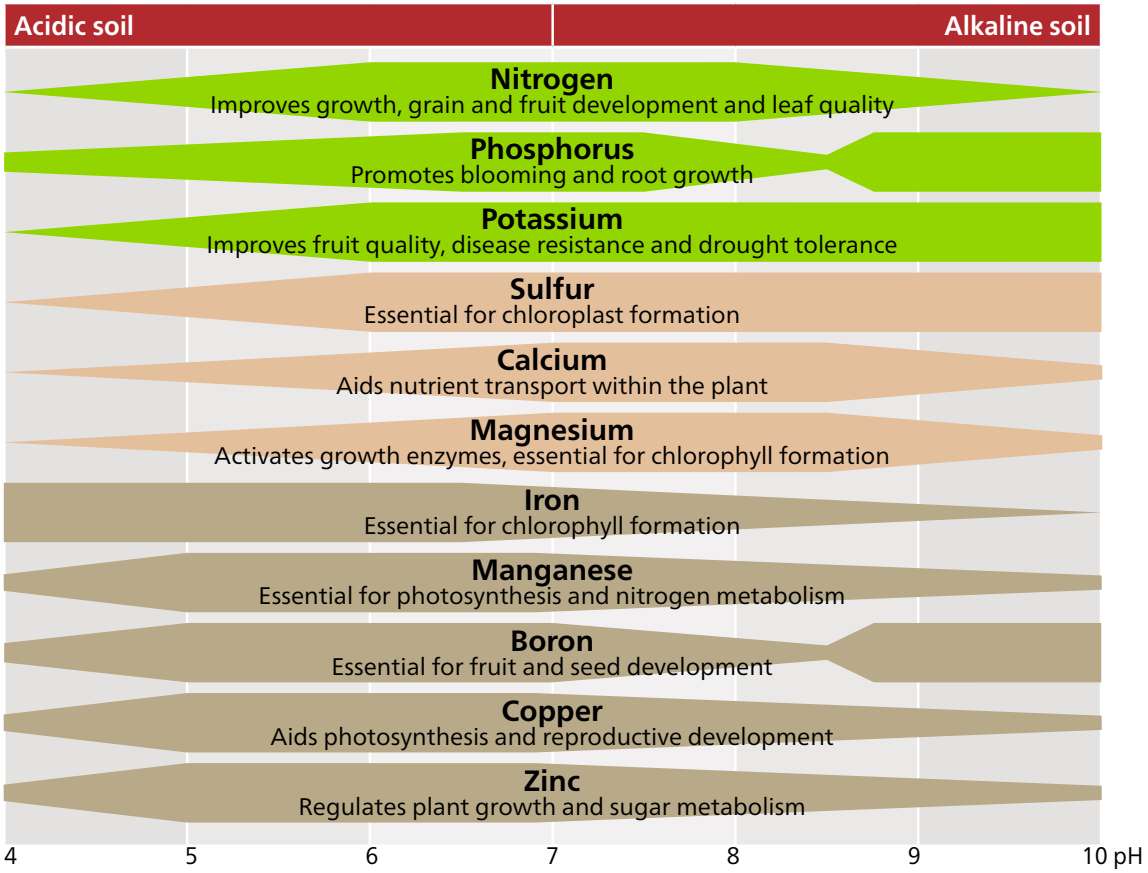
—Leonardo da Vinci

Minerals make up half of the content of balanced, fertile soils, while the remaining half is made up of water, air and organic matter. This environment supports a diverse biome, including worms, insects and microbes. Sustainable practices protect the soil structure and biome from damage and nutrient depletion. Once damaged, it can take many years to rehabilitate soils back to a healthy state.



Balanced soils and nutrient availability

Nutrient availability is affected by soil pH. A moderate pH allows for optimal availability of most nutrients, which means fewer corrective inputs are required from the producer.



Key soil microbes

Since microbes are the most populous living component of the soil, evaluating their presence and activity can serve as an excellent proxy for measuring overall soil health.

***Bacillus* spp., *Lactobacillus* spp.**
Acts as an antagonist against a wide variety of pathogens, including *Fusarium*, *Pythium*, *Rhizoctonia*, *Sclerotinia* and even nematodes.

***Trichoderma* spp.**
Fungus that creates a symbiotic relationship with plant roots. Acts antagonistically toward pathogenic fungi such as *Botrytis* and *Fusarium*.

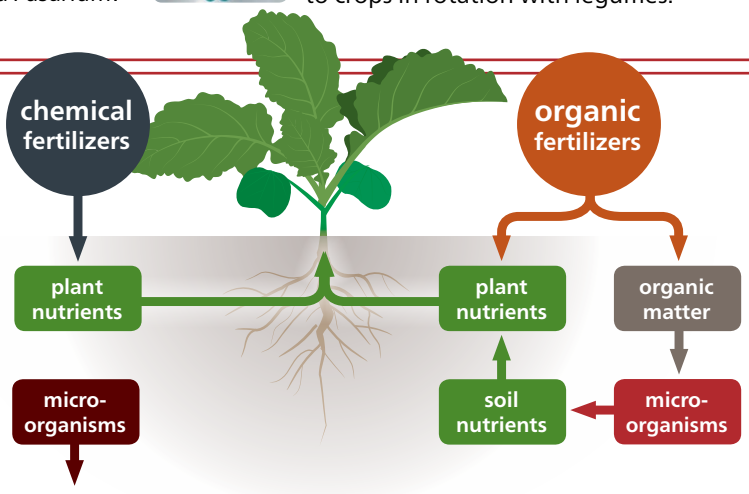
***Pseudomonas* spp.**
Plays a major role in plant growth promotion, induced resistance and biological control of pathogens, including nematodes.

***Rhizobium* spp., *Bradyrhizobium* spp.**
Forms symbiotic relationships with roots in legumes, making nitrogen available to the plant. Benefits pass on to crops in rotation with legumes.

The cost of missing microbes

Conventional fertilizers are highly reliable and efficient, but they can unintentionally starve or even kill beneficial soil microbes.

In practical terms, this missing population creates an ever-increasing need for additional fertilizer applications. By comparison, organic fertilizers can feed both plant and soil, leading to reduced input requirements over time.



Best practices for maintaining healthy soils

Unfortunately, it is much easier to damage the health of our soils than to restore it. While it takes many consecutive seasons of sound practices to develop and maintain healthy soils, those benefits can be lost in just a few seasons of poor soil management.

> *"The nation that destroys its soil destroys itself."*
>
> —*Franklin Delano Roosevelt*

Some best practices for maintaining healthy soils include:

Soil testing

Testing quantifies the current state of your soil, providing a baseline to measure improvement while helping avoid unnecessary treatments. For the clearest picture of a soil's true health, modern tests include measurements of microbial content and activity.

Increasing organic matter

Organic matter supports soil fertility, improves nutrient- and water-holding capacity, and provides a food source for beneficial microbes. In addition to the other practices listed here, incorporating amino acids into your program can also increase soil carbon and nitrogen.

Minimizing disturbances

Excessive disturbance (e.g., plowing, discing, tillage) entails more work for the grower and interrupts the soil's natural cycles, leading to increased erosion, weeds, soil compaction and loss of organic matter. Consequently, no-till systems are becoming more popular.

Keeping soil covered

Keeping living roots in the soil benefits the microbiome. Cover crops also prevent erosion, suppress weeds, increase soil organic matter and nutrient cycling, and reduce compaction. Some cover crops may be mulched into the soil the following season, adding additional organic matter.

Crop rotation and intercropping

Biodiversity aboveground contributes to biodiversity below-ground. Rotating or intercropping grains and legumes is an increasingly common practice that restores soil fertility, reduces disease recurrance and lowers the need for additional nitrogen.

Using soil inoculants, activators and enzymes

These types of products support healthy microbial populations, either by adding beneficial microbes directly or by providing the enzymes and other compounds that favor an optimized microbiome. Improved activity can be measured by comparing soil enzyme levels.

FURTHER READING:

1. Albright, M.B. "The Brown Revolution: Why Healthy Soil Means Healthy People." National Geographic, 2015.
2. Crowley, S., *et al.* "Comparative analysis of two antifungal *Lactobacillus plantarum* isolates and their application as bioprotectants in refrigerated foods." Journal of Applied Microbiology, 2012.
3. Delgado-Baquerizo, M., *et al.* "A global atlas of the dominant bacteria found in soil." Science, 19 January 2018.
4. Gaffney, M., *et al.* "Biostimulant mediated improvement of soil microbial activity." Microbiology Society Focused Meeting, October 2018.
5. "Living Soil." Soil Health Institute, 2018. livingsoilfilm.com
6. Natural Resources Conservation Service (NRCS), United States Department of Agriculture, 2014.
7. Perez-Garcia, A. *et al.* "Plant Protection & Growth Stimulation by Microorganisms: Biotechnological Applications of *Bacilli* in Agriculture." Current Opinion in Biotechnology, 2011.
8. Reid, A. and Greene, S. "How Microbes Can Help Feed the World." Report on American Academy of Microbiology Colloquium, 2012.
9. "Soil Atlas 2015." Institute for Advanced Sustainability Studies, 2015
10. Thomas, C. "Managing plant diseases with biofungicides." Virginia Vegetable, Small Fruit, and Specialty Crops, Nov. 2002.

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Alltech has nearly four decades of expertise in microbiology, beginning with research on Saccharomyces cerevisiae *(commonly known as brewer's yeast).*

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