Preface: Healthy Soil, Healthy Vegetables

For over two decades now, I have dedicated myself to biointensive agriculture, where preserving life in the soil is a major factor leading to crop success. I started with small plots of land that I transformed into living labs, and my journey led me to explore the countless mysteries that lie beneath our feet, to study nature's cycles, and to learn what the soil can teach us. It is this very expertise—experience built over time and inspired by nature—that I want to share with you in this guide. As I tended the soil and delved into its inner workings, I learned to take a close look at nature, to understand subtle signs made by plants, insects, and microorganisms. I discovered a complex ecosystem, a remarkable community made up of billions of microorganisms, bacteria, fungi, and earthworms working in harmony to support the plant world. The way I see it, the more life there is in the soil, the healthier and more fertile it is. Respect soil life, feed it with rich organic matter, and cultivate the earth without traumatizing it. As I applied these principles, my soils became darker—a sign of increased organic matter—but, more importantly, they evolved to become more alive and thus more fertile.

Through the pages of this guide, join me and discover the fundamental principles of growing vegetables in living soils. We will take a deep dive into the world of microorganisms that thrive underground and learn how to understand and cultivate the land in a way that is gentler, more measured, and, especially, that respects these ecosystems.

May this journey to the heart of living soils be a source of inspiration and hope for you, just as it once was for me. Going forward, together, let's cultivate soil life and, in so doing, cultivate a better future.

Jean-Martin Fortier, market gardener in Saint-Armand, Quebec

The Living Soil

Our biointensive market gardening system is primarily based on creating and maintaining living soils, which promote plant growth and, ultimately, fruiting—all while increasing fertility and biodiversity.

Soil: One of Three Fundamental Environments for Plants

Plants live at the intersection of three natural environments: the lithosphere (soil, ground), the atmosphere (air), and the local ecosystem (biological world).

The soil, underground, is where plant roots grow. It serves multiple purposes, including acting as a pantry to supply plants with the nutrients they need. It also provides physical support, firmly anchoring plants in the soil, which is especially relevant for fruit-bearing vegetables that tend to grow taller and are generally bigger.

The atmosphere influences the above ground portion of the plant, which is constantly exposed to climatic conditions, which make all plant life possible. It delivers sunlight for photosynthesis, provides atmospheric gases such as carbon dioxide, and drives soil formation and evolution through weathering of rock and the Earth's crust.

The local ecosystem consists of all living organisms, plant and animal that come into contact with the plant. These relationships can be beneficial or detrimental to it.

The three environments work in concert to satisfy the needs of plants, both physiological (water, oxygen, light, and heat) and nutritional (water, CO_2, mineral and organic elements).

To continuously improve soil quality, the Market Gardener Method applies the following principles: minimum tillage, standardized cultivation systems, and an approach that is both organic and intensive. Above all, growers' practices should be based on a deep understanding of their own soil.

Minimum Tillage

The Market Gardener Method relies on shallow tillage, in only the top 2 to 4 inches (5–10 cm) of soil, leaving most soil layers undisturbed. Because vegetable microfarms operate without large mechanized agricultural machinery they can optimize growing space. In other words, if you don't need a turnaround area for tractors, you need less space between beds, and if those beds will not have to accommodate large machinery, then rows can be sown closer together. The benefits here are twofold: growers can optimize their small market-gardening plots, while also limiting the costs associated with the purchase, use, and maintenance of a large fleet of agricultural machinery. Another notable advantage is avoiding soil compaction, which hinders crop development. However, a tractor may be essential to complete specific tasks like moving heavy loads, stirring and turning compost, and carrying equipment or materials around the farm. So, while a profitable microfarm can be successfully run without a tractor, the Market Gardener Method does not strictly prohibit its use.

Biointensive market gardeners should prioritize equipment, such as tilthers, broadforks, and various hand tools to cultivate soil, as well as practices including occultation (tarping) and, especially, permanent beds. These processes only lightly disturb the soil, protecting its organic matter while suppressing weeds, thereby encouraging the development of crops and beneficial soil organisms. Maintaining a ground cover—with either a cover crop or a silage tarp—keeps soil moisture in a healthy range and limits nutrient leaching and soil erosion caused by precipitation and irrigation. For more on appropriate tools and their uses, see *Vegetable Garden Tools* by Jean-Martin Fortier.

Standardized Systems

When operations and garden plots are more standardized, efficiency increases and growers save time. Therefore, it all starts with creating permanent beds and aisles grouped into predefined blocks. Growers can then calibrate all their equipment to fit the dimensions of these garden beds. Crops must also be carefully planned, from crop rotations and successions within a bed, to farm tasks scheduled for certain times of the year. Armed with this detailed calendar, growers can efficiently allocate the operations to be completed from week to week and even from one day to the next.

Cultivating the same beds every season is the simplest way to improve soil quality. It limits compaction in the beds and reduces the need for amendments, as inputs can be used more effectively when they are not spread in the aisles. If you are dealing with cold weather and heavy soils, we recommend raising beds by a few inches to promote natural drainage and to help the soil warm up faster in the spring.

Biointensive Farming

Lastly, to improve yields, plant vegetables quite densely, with rows set as close together as possible. This enhances productivity, facilitates harvesting by hand, and streamlines the use of equipment like irrigation systems, tarps, row covers, and insect netting. Crops grown biointensively also provide ground cover quickly, preventing weeds from germinating and developing.

This results in increased yields as beds can be cultivated multiple times through the use of crop successions. Depending on your regional climate and available equipment, such as greenhouses or tunnels, you can grow one to four—or even five—crop successions per year in a single bed. To apply this principle, you must adjust your planting schedule accordingly. When each crop has an allocated spot in the farm calendar, you optimize the use of every bed. If you carefully stick to the plan, they will never be empty for long, leaving little space and time for weeds to grow. With this approach, the soil is exclusively dedicated to growing vegetables and will deliver maximum yields.

Understanding Your Soil: Foundations for a Good System

The Market Gardener Method is particularly well suited to developing small-scale market gardening systems that deliver high yields. Primarily, it relies on growers having a good understanding of their soils, so they can work them wisely. To succeed, you need to ask yourself the right questions about your soil type and, above all, use common sense to answer them! What is it made up of? How can you track changes in the soil? How can you improve it? How can you maintain fertility and stimulate soil life? These are the main themes addressed in this book.

All organic vegetable growers, whether professionals or home gardeners, must be familiar with their soil, its composition, and the interactions between all organisms within it. Under their feet lies a full-fledged organic waste recycling and recovery facility that runs day and night. With the help of various insects, animals, and microorganisms, such as bacteria, algae, and fungi, organic waste is transformed into nutrients that are essential to plant life. The top few inches of soil, where plant roots grow, are the most biologically active. This layer is called the rhizosphere. Market gardeners who respect their soil and strive to improve it—especially when based on an analysis that identifies amendment needs—can see a significant increase in yields if they are careful not to exhaust the soil. When the soil is supported by interactions between fauna and flora, and given the required attention, it can become a thriving ecosystem in its own right—a living soil. But how can you get to know your soil and thus improve your vegetable garden or farm?

What Is a Living Soil?

What Are Soils Made Up Of?

Soil is constantly evolving. It builds structure and breaks down in response to myriad external events and other factors. It is alive, so changes occurring within it—both positive and negative—depend on factors such as climate and human actions. From the parent rock through to the surface of the earth, soil forms multiple layers that vary depending on its mineral content and location. Soil is shaped by intense plant, animal, and microbial activity and the ecosystem that supports it. It is therefore a living substrate comprised of organic matter needed to sustain plant, animal, and microbial life, as well as minerals, liquids, and gases. After you identify and understand these components, their ratios, and the type of life that thrives in your soil, you will be better equipped to maintain, enrich, and prepare it for future crops.

Soil Layers

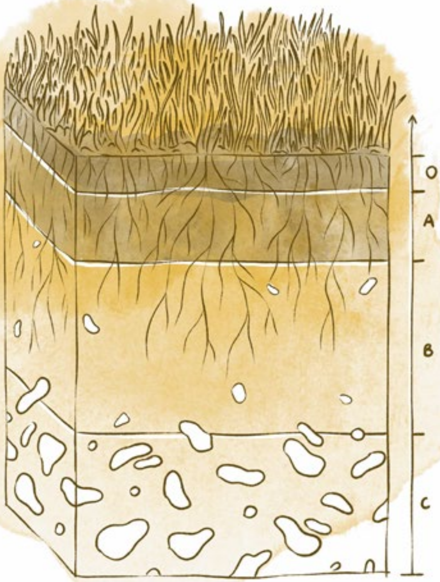
By looking at the layers that make up your soil, you can determine their composition, assess their biological activity, ascertain any mineral loss through leaching, and locate root systems and rocks.

Soil Horizons

In pedology—the science of soil formation and evolution – the word "soil" refers to the ground between the surface and the parent rock, which is the upper mineral layer in the Earth's crust. Soils form as the rock weathers, creating a soil profile made up of distinct layers, called horizons, that are roughly parallel to the surface. Each horizon is symbolized by letters or numbers and has its own visual characteristics and morphological properties:

- O for "organic." This is the top horizon, just below the surface, and is made up of organic matter.
- A for "arable." This horizon contains both minerals and organic matter.
- B. This layer tends to have more color and is where leached minerals accumulate. Market gardeners commonly refer to it as the subsoil.
- C. This is the deepest horizon. It lies just above the parent rock and is made up of partially weathered parent material.

Sometimes you can find a horizon labeled E for "eluvial." This lighter-colored layer, which is not always present in the soil profile, develops as a result of leaching.
In the field, the easiest way to view these layers is to make a deep, vertical cut in the soil, about 20 inches (50 cm) or more depending on your soil depth. This is called a soil profile.



STANDARD SOIL PROFILE AND BRIEF NOMENCLATURE
The layers containing humus are the most fertile and can be recognized by their near-black color. They form under the litter, the uppermost soil layer, which primarily consists of undecomposed plant residues like dead leaves, twigs, and clumps of dried grass.

Note from Jean-Martin Fortier

Although market gardeners and home gardeners may only be concerned with the soil layers they cultivate, to a depth of about 12 inches (30 cm), it's also important to focus on the lower layers, the subsoil, where root systems grow. This area is a precious source of nutrients, a kind of pantry for plants. You can feed it by growing cover crops and leaving the deep roots of some vegetables in the ground where they can gradually decompose.

Soil Evolution

The age of a soil typically correlates to its maturity. Forest soils are considered mature, while cultivated soils are deemed immature as their natural evolution is constantly interrupted by human intervention.

Parent Rock

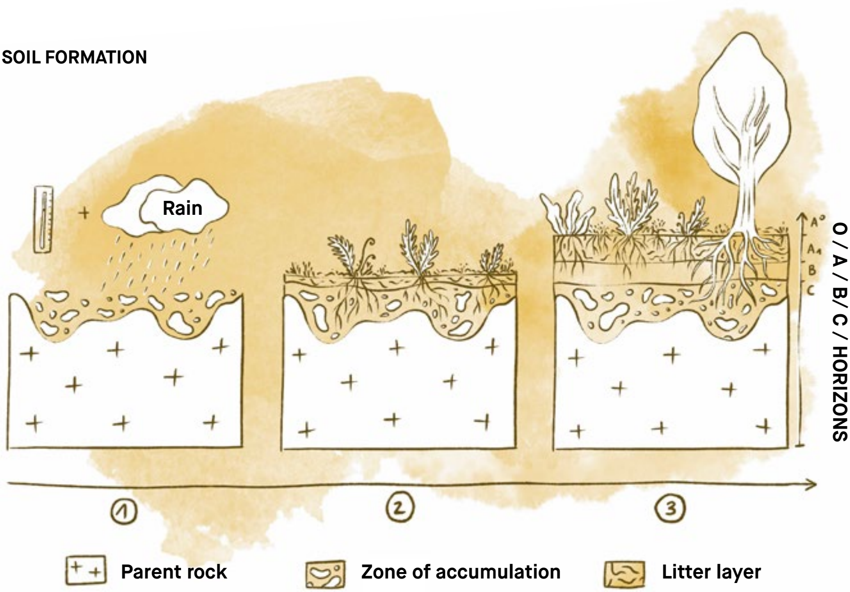
The rock found in the deepest soil layer is the starting point for pedogenesis, or soil formation. In a weathering process shaped by climate and pioneering species (flora), mostly mosses and lichens, the parent rock gradually breaks down. This soil formation can be interrupted by factors related to climate, such as erosion or leaching, as well as geological events and human activity.

Anthroposols

Some soils, called anthroposols, have been profoundly impacted by humans, especially by farming practices. They undergo near-constant alterations that interrupt pedogenesis. When soils are continually tilled at varying depths, their horizons are regularly turned over, stirred, and mixed. Organic matter cannot gradually build up and become stable because the process is perpetually disturbed by external inputs, both organic and inorganic.

In these very young or immature soils, the soil profile is simplified, featuring only two horizons: horizon A contains the organic matter that the market gardener has incorporated into the soil, and horizon C generally consists of a thick layer of silt. Horizon O is practically nonexistent. On many cultivated plots, all plant matter, including unused parts (roots, stems, leaves), are removed in the harvest and tilling process. As a result, the soil is unable to turn decomposing crop residues into humus. Naturally occurring soil colloids (see p. 27) are altered and eventually disappear, and the soil gradually becomes a nonliving environment.

SOIL FORMATION



1. The parent rock breaks down due to the mechanical action of cold temperatures and dissolves by the chemical weathering of water. This process creates a B horizon in which organic and inorganic materials accumulate.

2. Pioneering species accelerate chemical weathering in the parent rock material and generate organic matter, which forms litter and humic substances.

3. Litter and humus develop, in different horizons, and various plants begin to grow.

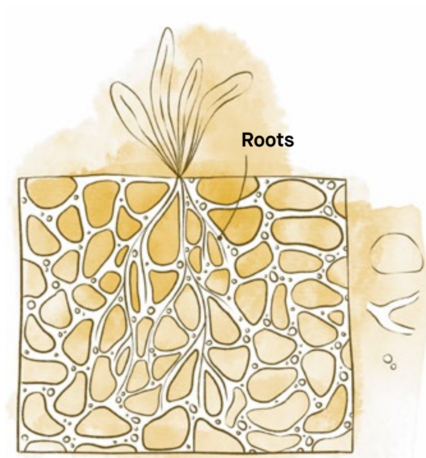
To top it all off, heavy motorized equipment is often driven over these plots, further compacting the soil. Hence the appeal of the Market Gardener Method; it advocates working the soil manually to avoid compaction and retaining the roots of certain crops after harvest to restore organic matter deep in the soil.

This method is inspired by soil in nature that feeds on organic matter that is first deposited onto the litter, the surface layer covering the soil. It is made up of residues from plants (leaves, twigs, etc.), fungi (spores and mycelia), and animals (excrements, invertebrate remains, etc.).

Soil Composition

Soil horizons contain various components, such as gases, liquids, and minerals that contribute to the soil ecosystem.

SOIL COMPOSITION
Soils are composed of solid fractions—aggregates—as well as liquids and gases that fill the gaps (pores) between them. Roots also make their way into these pores.



What Are Soils Made Up Of?

Soils consist of components that exist in different states. The gaseous content includes gases that are identical to those found in the atmosphere, such as carbon dioxide and oxygen, as well as gaseous byproducts of decaying organic matter, such as methane. The liquid component, referred to as the soil solution, contains water and ions that allow it to dissolve soluble material, including soil minerals, organic matter, and amendments. This combination of water and dissolved nutrients is a source of essential nutrients for plants. The solid content (organic and mineral matter), the largest by volume, determines the texture and nature of the soil. These components combine to create soil, which is an ecosystem in itself.