



NORTHERN BACKYARD FARMING

SOIL HEALTH

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SOIL HEALTH

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Soil

The skin of the earth

Soil forms the outermost layer of our planet. Without it, we would not be able to sustain life.

Soil is one of nature's most complex and diverse ecosystems, home to over one quarter of the earth's biodiversity.

Four main components make up soil:

- Minerals and rocks
- Water
- Air
- Organic matter (living and dead)

Climate, organisms, geological parent materials, topography, and time all contribute to the formation of soil.

Healthy Soils

It's more than just dirt!



2015 was the International Year of the Soils.

It is not easy to see, and we may not appreciate it as much as we should, but creating and maintaining healthy soil is critical – both for us, and the planet. See the website above for more information.

Experienced gardeners know that the quality of soil can change the outcome of the harvest. This is particularly important in the Northwest Territories (NWT) where fruits and vegetables often travel far to make it to our plates.

Soil also supports animal biodiversity, both below and above ground, and helps to catch, filter and distribute water.



Soils of the NWT

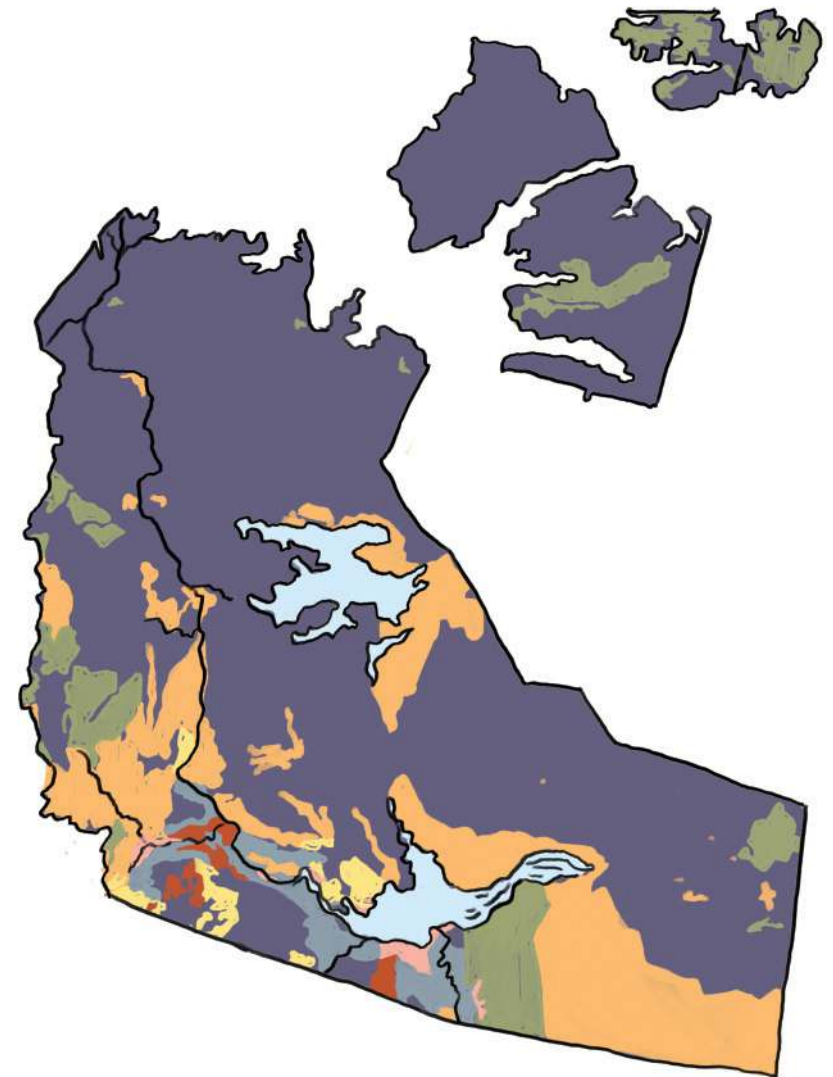
Northern soils are diverse!

Soil types vary across the NWT due to various factors, including climate, organisms, topography, geological parent materials and time. For example, soils formed from boggy peatlands will likely be acidic, whereas soils formed from bedrock made of limestone or calcareous geology will likely be alkaline.

Although we generally have thin, acidic and nutrient poor soils in the NWT, some areas have deep and rich soils.

Soils with the greatest capability for growing and sustaining food production in the NWT are found in river valleys, such as the Mackenzie or Hay River, and in flat sedimentary areas such as those in the South Slave.

This map demonstrates the variation of soil types in the NWT, which have formed under different conditions. Soils can change dramatically in a short distance. Understanding what makes a good soil will help you identify where to grow and how to improve your soil.



Map adapted from Soil Order Map of Canada



Soil Profile

Soils have different layers!

The soil profile is key to understanding the soil forming processes taking place at a particular location. The depth and other characteristics of these layers can also tell us about soil health.

Humus is the top layer of soil made up of living and decomposed materials such as leaves, bugs and plants. It is often thin and dark in colour.

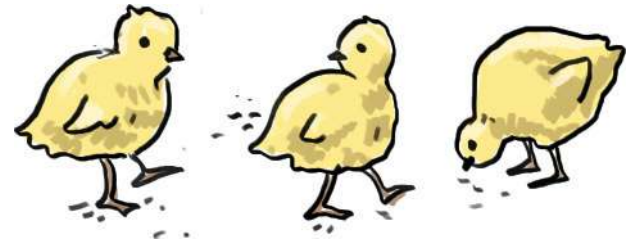
Topsoil is the soft, porous layer rich in humus and nutrients. It is a shelter for living organisms and is where roots grow.

Subsoil is the hard and compact layer made up of many minerals. Roots of bigger plants extend to this layer.

Weathered rock fragments are the layer made up of slightly broken rock and some organic material. Plant roots don't reach this layer.

Bedrock is a hard layer that consists of unweathered parent rocks.

Is Your Soil Healthy?

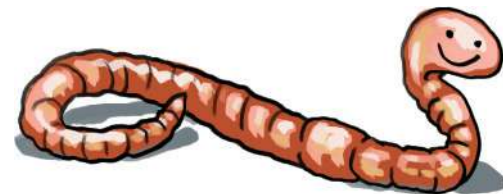


Properties of healthy soil

Soil health is the capacity of a soil to perform functions that are essential for ecosystem productivity and plant and animal health. There are six main components that influence soil health:



- Soil texture
- Soil structure
- Moisture
- Organic matter
- Nutrients
- Soil pH



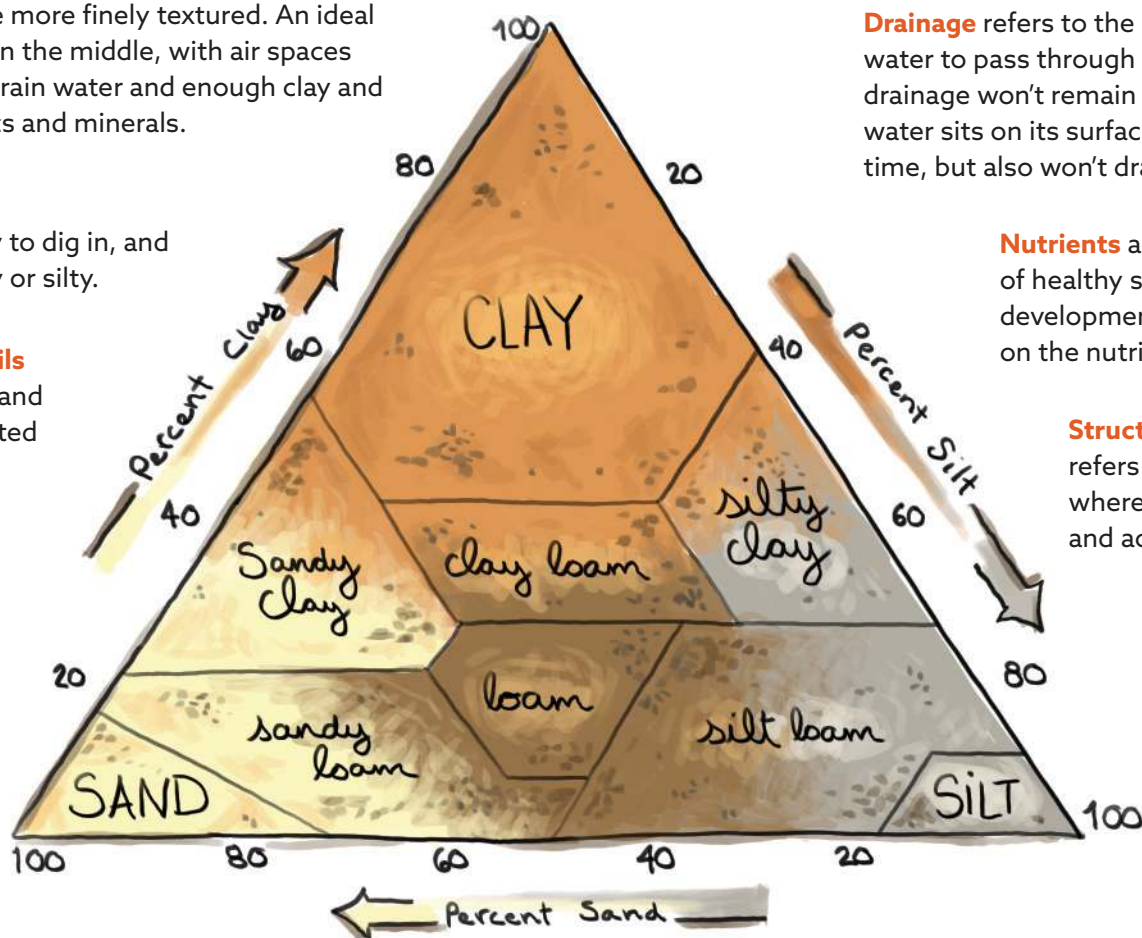
Soil texture

The relative size of soil particles places the soil into one of three texture classes: sand, silt, or clay. Sand being the largest, silt smaller, and clay the smallest of the three texture types.

You may hear soil texture described as coarse or fine. Sandy soils are coarse because they are dominated by relatively large particles of sand, whereas silty and clay-based soils are more finely textured. An ideal soil is somewhere in the middle, with air spaces allowing water to drain and enough clay and silt to hold nutrients and minerals.

Light soils are easy to dig in, and are generally sandy or silty.

Heavy (clumpy) soils are harder to work and are usually dominated by hard clay.



Soil structure

Unlike soil texture, soil structure can be changed by the way we work the soil. Soil structure is the arrangement of soil particles into groupings called aggregates. Soil aggregation is an important indicator of the workability of soil and overall soil health. Drainage, nutrients and air movement are all important characteristics for good soil health.

Drainage refers to the soil's ability to allow water to pass through it. Soil with good drainage won't remain waterlogged where water sits on its surface for long periods of time, but also won't drain instantly.

Nutrients are a key component of healthy soil. Plant growth and development is largely dependent on the nutrients available in the soil.

Structure and air movement refers to the spaces in the soil where roots can easily grow and access air and nitrogen.

Moisture

Soil moisture refers to the water that is in the spaces between soil particles. It is a key component of healthy soil for several reasons, including its ability to carry nutrients necessary for plant growth, regulate soil temperature and help with photosynthesis.

Most of the NWT is very dry during the growing season, so gardens need to be watered thoroughly, especially during the germination and early growth of seedlings.

Soils that are mostly clay or silty will hold more moisture for longer, and thus can go longer between waterings. Sandy soils drain more quickly and may require more watering. Use a moisture meter to check your soil moisture, or dig a small hole after watering to ensure water has penetrated deeply.

Watering in the morning or evening will help to avoid evaporation from the sun. After germination, generally avoid shallow watering, as it will discourage deep root growth.

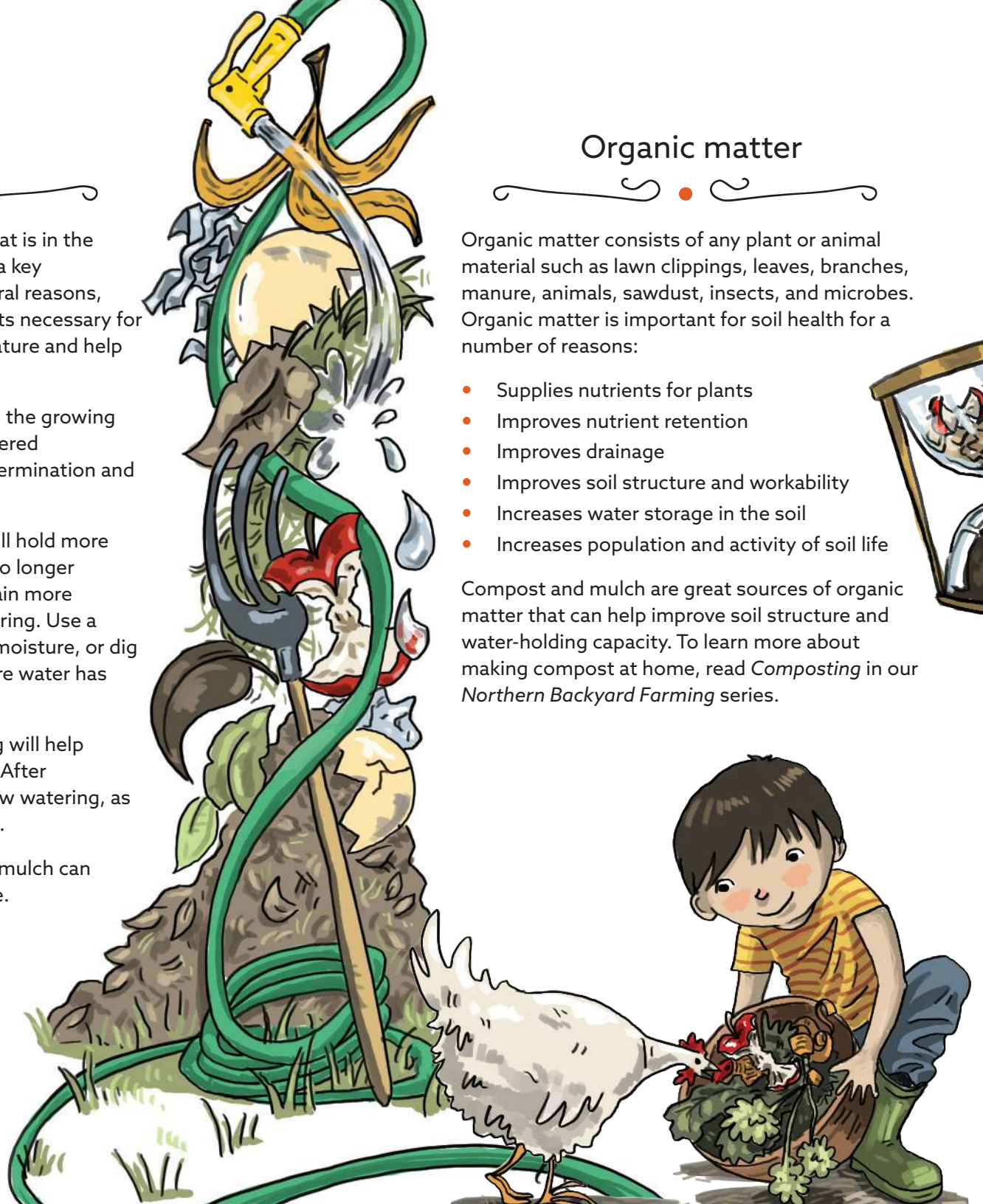
Covering soil with wood chips and mulch can increase its ability to hold moisture.

Organic matter

Organic matter consists of any plant or animal material such as lawn clippings, leaves, branches, manure, animals, sawdust, insects, and microbes. Organic matter is important for soil health for a number of reasons:

- Supplies nutrients for plants
- Improves nutrient retention
- Improves drainage
- Improves soil structure and workability
- Increases water storage in the soil
- Increases population and activity of soil life

Compost and mulch are great sources of organic matter that can help improve soil structure and water-holding capacity. To learn more about making compost at home, read *Composting* in our *Northern Backyard Farming* series.



Nutrients

Of the six macronutrients, nitrogen (N), phosphorus (P), and potassium (K) are so critical for the growth of agricultural and food crops that these are the three that you will see listed on fertilizer labels.

Nitrogen (N) is important for cell formation and photosynthesis. Manufactured N might be from urea or different forms of ammonia, and organic N sources range from blood, fish, and feather meal to alfalfa pellets. Plants with lots of N will appear brilliantly green, while yellowing leaves can be a sign of N deficiency.

Phosphorus (P) promotes root, and fruit growth, and helps growing plants resist disease. Stunted plants with a purple tinge on the underside of leaves can indicate a deficiency of phosphorus. Unlike N or potassium (K), phosphorus does not readily move in the soil, so it is important to place P fertilizers or soil amendments in or near the rooting zone. Bone meal and poultry manure are good sources of phosphorus.

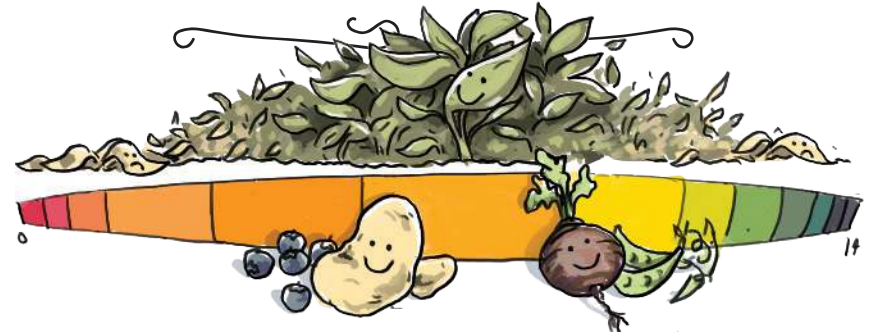
Potassium (K) encourages strong growth and disease resistance. Potassium deficiency is indicated by slow growth, poor yields, mottled leaves and drying on leaf tips and margins. Wood ash and kelp are good sources of potassium.

N

P

K

Balanced pH



pH, meaning 'power of hydrogen' is a scale from 0 (most acidic) to 14 (most alkaline). Knowing your soil pH is important because it influences the availability of nutrients to growing plants.

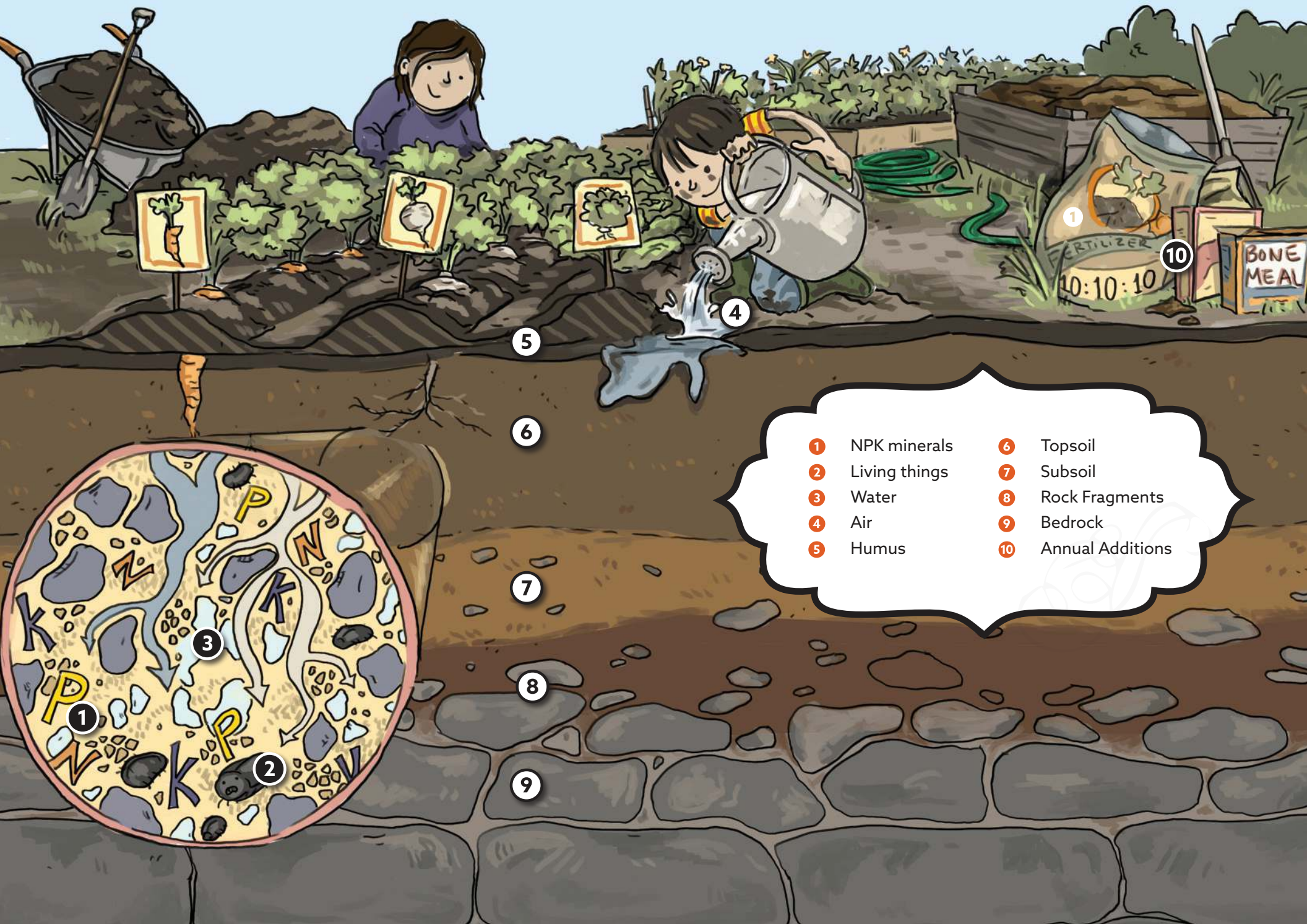
Many NWT soils are on the acidic side, but there are pockets of alkaline soils with calcareous (such as limestone) geological parent materials.

Most vegetable crops grow well with a pH between six and seven and a half. Below six, some nutrients, such as phosphorus, calcium and magnesium are less available. When pH exceeds seven and a half, iron, manganese, and phosphorus become less available.

However, some plants like more acidic soils (blueberries, potatoes) while others do better in more alkaline soils (beans, beets).

Signs that your pH is a problem are stunted vegetables, yellowed leaves, little new growth and unhealthy plants.

If your soil is too alkaline you can add sulphur, and if it's too acidic you can add agricultural lime. If you have a wood or pellet stove – wood ash will also raise the pH.



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|---|---------------|----|------------------|
| 1 | NPK minerals | 6 | Topsoil |
| 2 | Living things | 7 | Subsoil |
| 3 | Water | 8 | Rock Fragments |
| 4 | Air | 9 | Bedrock |
| 5 | Humus | 10 | Annual Additions |



Test Your Soil

How healthy is my soil?

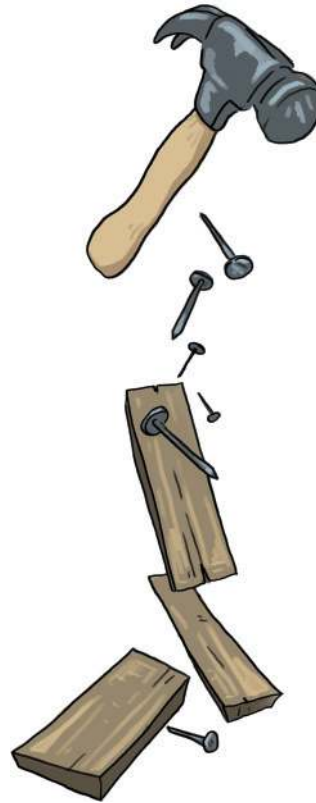
Soil testing can help to determine the types of inputs and adjustments that can be made to optimize soil health. Testing can be done using a home test kit or through laboratory analysis. There are pros and cons to both.

Home test kit:

- Simple and inexpensive
- Tests for nitrogen, potassium, phosphorous and pH
- Not as accurate
- Can be ordered from garden catalogues

Laboratory analysis:

- More expensive
- More comprehensive testing that provides an exact number value
- Allows you to make more accurate applications of soil amendments or fertilizers to your food crops



Build a Garden Bed

Starting from scratch?

Due to climate and other soil forming factors, many locations in the NWT have little to no topsoil for gardening. You may live in an apartment, your lot may be covered with fill, you may live on permafrost, or you may have poor soil. Whatever the reason is, you may need to build your soil from scratch.

To maximize your growing season choose a permafrost-free area with plenty of sun exposure, shelter from the wind, good drainage, and a water source nearby. Garden beds beside a south facing building are usually preferable in the NWT.

In many parts of the NWT the ground is underlain by permafrost, which creates drainage issues and cold slow growing roots. In this case, we recommend building a raised bed! Height from the top of the ground is more important than length of the bed. A deep, raised bed gives ample opportunity for roots to spread out.



Making the mix

In larger communities where there is access to bagged topsoil, gardeners can simply purchase and add premixed bags of soil to garden beds. Compost and manures, which can help with soil structure and moisture retention, are also available for purchase in bags. A typical ratio of one third compost to two thirds topsoil is a good mix for raised garden beds.



The City of Yellowknife sells inexpensive bulk compost every year.

If you have existing soil and want to build a garden bed, dig it up and turn it over to see what you have. Few areas in the NWT have ideal soil, so you will likely want to add bags of topsoil in addition to compost or manure to make more optimal growing conditions. Digging organics into your garden bed is another option to improve soil health. Fall is the ideal time to do this, but some can be added as a top mulch throughout the growing season as well. Organic additions include: leaves, grass clippings, forest floor litter (harvest responsibly), seaweed, household organics, fish carcasses (bury to reduce pests), and animal fur.

Annual additions

Every year it is important to build the soil and replace the nutrients that were removed with the previous year's harvest and weathering. Although soil tests can tell you what the soil needs, there are other signs that your soil may need additives.

Stunted plants and low productivity may indicate nutrient deficiency, whereas soil that dries too quickly suggests the need for additional organics. Various types of soil amendments are available, including synthetic mineral fertilizers, organic fertilizers, liming agents, manure and compost.

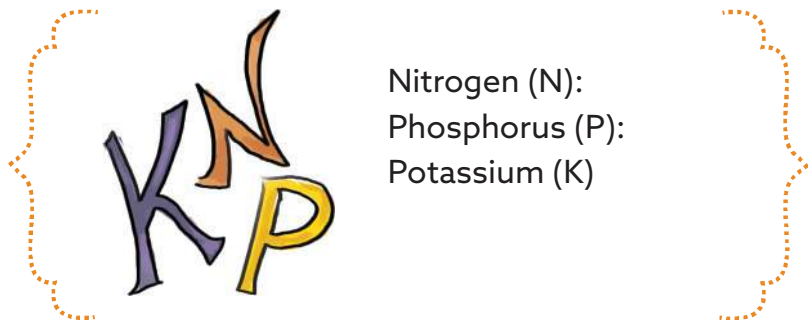
Keep in mind that certain plants need additional nutrients at different growth stages during their life cycle. For example, tomatoes enjoy bone meal, fish emulsion, or other sources of P at planting, and again at the flowering and fruiting stages.

However, be aware that over application of nutrients may harm plant growth and ultimately leach into the soil and groundwater.





In the NWT soils are generally low in P and K. So it's recommended to use fertilizers with higher P and K.



Have you ever wondered about the numbers on your fertilizer bag? They represent the ratio between Nitrogen, Phosphorus and Potassium. For example if you see 10:10:10 on a 15kg bag, then there is 1.5kg of each nutrient.

Most fertilizers you buy in the store are very energy intensive to make.

Most additives you buy will have three numbers on the package:

- 5:5:5 (Nitrogen-Phosphorous-Potassium)
- On a 10kg bag this means 0.5 kilogram each of N-P-K
- In the NWT fertilizers with high phosphorus and potassium are recommended. An even ratio such as 10:10:10 is a good generic choice for the NWT

Organic gardening

The healthiest and recommended method of growing is organic gardening. Using organic fertilizers such as animal manures, mulches, compost, bone, fish, or blood meal will provide all the nutrients your plants need. Organic growing techniques nurture the living microbes and life in your soil. Organic growers strive to:

- Replenish and maintain soil fertility
- Eliminate chemical pesticides and fertilizers
- Enhance ecological harmony

There are too many ways to garden organically to describe here, but practices such as crop rotation, companion planting, cover crops, mulching and composting will all slowly build the soil into a healthy living ecosystem. There are many off the shelf organic fertilizers that will help to build up soil fertility as well.



Manure & compost

Manures don't generally provide a lot of nutrients in the first year of application, but they build structure within the soil and promote a living soil with good moisture retention.

Chicken manure is an excellent soil amendment for our area because it is high in P and other important nutrients.

Raw manure can contain salts that harm young seedlings or transplants. Take care to time the application of raw manures for later growth stages or to carefully water in manures and work them into the garden beds with cultivation or tillage.

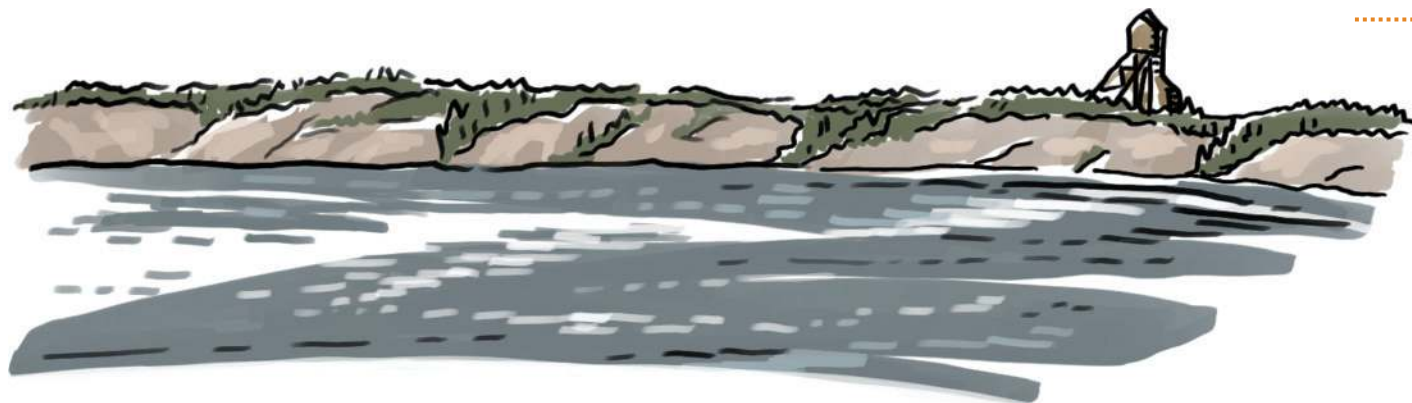
Compost is a highly recommended yearly additive! You can compost in your backyard and reap the rewards of your organic wastes.

Manure, Compost & Meal comes in three common forms, the nutrient ratios vary by product. Generally, bone meal is a good source of P, blood meal is a good source of N and fish meal is a good source of N, P, and K, plus you get a bonus elements like calcium

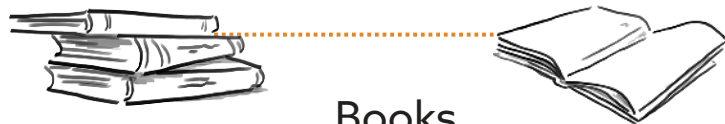
Arsenic in Yellowknife

Is my soil clean?

A long history of gold mining in the Yellowknife area resulted in the generation of large amounts of arsenic waste. Some of this waste was released to the air by the roaster stacks and distributed across the local landscape, while other types of arsenic bearing waste were deposited as tailings at local mine sites. It is difficult to determine which areas around Yellowknife have been impacted (beyond the mine sites themselves) by historic mining activities. Therefore it is important to understand where your soils came from. You may want to consider testing your soil for contaminants such as arsenic if you're going to be growing food. Using raised beds and building your own soil is another popular alternative.



Resources



Books

The Nature and Properties of Soils

Nyle Brady, 2002

Soil Quality for Crop Production and Ecosystem Health

Edward Gregorich & Martin Carter, 1997

How to Grow More Vegetables

John Jeavons, 2006

Building Soils Naturally: Innovative Methods for Organic Growing

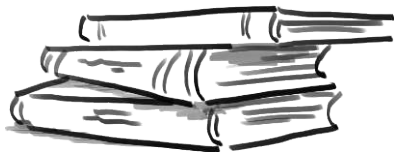
Phil Nauta, 2012

The Canadian System of Soil Classification

Soil Classification Working Group, 1998

Yukon Gardener's Manual

Yukon Energy, Mines & Resources Agriculture Branch, 2005



Web resources

History of Giant Mine

www.aadnc-aandc.gc.ca/eng/1100100027388/1100100027390

History of mining and arsenic in Yellowknife.

Agricultural Soil and Nutrients

www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/soil-nutrients

Soil management for home gardens!

Soils

www.fao.org/biodiversity/components/soils/en/

An overview of soil life.

The Importance of Soil Testing

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex1341](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1341)

When, where, and how to test your soil.

Steps in Fertilizing Garden Soil:

Vegetables and Annual Flowers

<http://extension.missouri.edu/p/g6950>

An overview of how to test soil and amend it with fertilizer.

Soil Map, Soils of Canada

<http://soilsofcanada.ca>

The first stop for information about Canadian soils



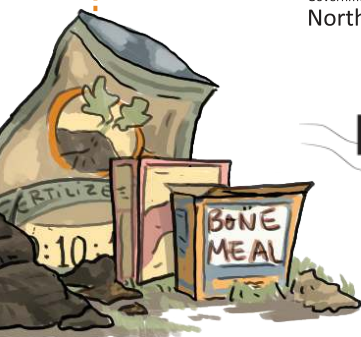
About this book

Growing food starts with healthy soil. There are a number of factors that can influence soil health including pH, moisture, structure, texture and nutrients. This guide is intended to provide basic information about building up and maintaining healthy soil. Understanding your soil's health is an essential part of growing food. This guide is the fourth in a series of booklets that Ecology North has developed about food in the NWT. Pick it up and give it a read; maybe enhancing your soil's health is your next step to growing your own food in the NWT.

For additional books in the series or for more information, please contact Ecology North.
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