Understanding and Identifying Healthy Soils

OVERVIEW

LEARNING OBJECTIVE

Gardeners will understand the importance of healthy, living soils and learn a series of simple steps to test a soil's health.

DURATION

MATERIALS NEEDED

- Flipcharts and markers
- Spades and hoes
- String or tape measure
- Notebooks and pens for gardeners

KEY CONCEPTS

- A healthy, living soil is key to growing healthy plants. If our soil is not healthy, our plants will be stunted and will not yield well.
- We can easily test our soils to see if they are healthy or not.

TRAINING AGENDA

1	Introduction and warm-up	DISCUSSION	10 mins
2	Why is a healthy soil so important?	DISCUSSION	1 hour
3	How can you tell if a soil is healthy? Simple soil testing techniques	PRACTICAL ACTIVITY	1.5 hour
4	Closing discussion	DISCUSSION	10 mins

10 min

1. Introduction and warm-up

Welcome gardeners to the training. Do a brief introduction to today's topic and review the training agenda. You may want to outline the training agenda on your flipchart or board so gardeners can see it when they arrive.

Conduct a warm-up exercise or ice-breaker to make sure all gardeners feel welcome and are ready to fully participate. Suggested warm-up and ice-breaker activities can be found in the Facilitator's Guide: Encouraging Learning through Participant Engagement.

Participant Engagement Guide

1 hour

2. Why is a healthy soil so important?

INTERACTIVE DISCUSSION

GOAL OF DISCUSSION: Participants will reflect on the importance of healthy soil and relate it to their own experiences with staying healthy.

MATERIALS NEEDED: Flipchart and markers

1. Ask participants to silently reflect on what the words 'soil health' mean to them—abundant crops or lots of earthworms for example.
2. Have participants discuss in pairs why a healthy soil is so important. Ask participants to share their reflections with the larger group and note the answers on a flipchart.
3. Using the pairs that worked together on the last question, put two pairs together so that they are now small groups of four. Ask the group to think about:
   - How healthy people can become sick but can also get better by eating nutritious food. Does the same apply to our soils?
   - If so, what can we give soils that are 'sick' so that they can get better?
   - How can we maintain our soils' health by feeding it nutritious food?
4. Ask participants to share their reflections. Note them on a flipchart.

KEY MESSAGES

- A healthy soil is a living soil. Healthy soil is crawling with earthworms, beetles, ants, and many other organisms. Some organisms, called microbes or microorganisms, are too small for humans to see, but you know they are there if you see decomposing leaves or roots. Many microbes and other forms of soil life live in dark, loamy soils.
- A healthy soil is key to growing healthy plants with lots of nutrients. If our soil lacks nutrients, then our crops will be stunted and will not yield well.
- We can improve degraded soils by ensuring they are always covered by either dead or living mulch and continuously feeding our soil with lots of organic matter, such as well-rotted manure. It takes many seasons of work to improve the health of a degraded soil, but improvements in yield can be seen right away.

1.5 hours

3. How can you tell if a soil is healthy? Simple soil testing techniques*

PRACTICAL ACTIVITY

GOAL OF ACTIVITY: Gardeners will learn simple, no-cost soil testing techniques to help them distinguish healthy and non-healthy soils. They will be able to apply these techniques easily in their home gardens and fields. Through the testing process they will understand the components of a healthy soil and start to understand how to build and maintain healthy soils.

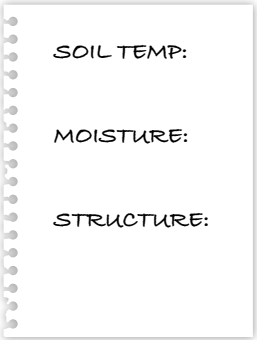
FACILITATOR PREPARATION: Identify a suitable garden site where gardeners can gather. Before the training, identify a site where gardeners can test two patches of soil: one that is covered in organic matter and relatively healthy and one that is exposed to the sun and is degraded. This activity can be done any time of the day, however the soil temperature test is most effective once the sun is up and has warmed the soil.

MATERIALS NEEDED:

- Spades and hoes
- String or tape measure
- Notebooks and pens for gardeners

Exposed Soil

Covered Soil



STEP 1. Gather participants at the designated area. Explain to participants that they are going to go through some simple soil testing steps they can use at home to help them evaluate if a soil is healthy or not.

STEP 2. Mark out two equally sized squares on the ground, one on the exposed soil and one on the covered soil. The squares should be around 50 cm on all sides. Explain to gardeners that you are going to compare the characteristics of the exposed soil to the characteristics of the covered soil.

STEP 3. Before digging, take the soil's temperature in each square. Ask participants first to put their hand or wrist on the exposed soil – what is the temperature? Then ask them to feel the temperature of the covered soil and compare.

STEP 4. Split participants up into two groups and assign them to a square. Have the groups carefully remove the soil from the square until there is a 30 cm deep hole. This is the upper part of the root zone. Try as much as possible to carefully lift the soil out of the hole to preserve its structure. Keep the soil off to one side.

**Adapted from the Permaculture Association UK Soil Test Handbook*

STEP 5. Have the participants gather information about the soil's smell, structure, texture, moisture content, the presence of soil organisms such as earthworms and other animals and depth of topsoil in their square. Each group should assign a notetaker to record the information found by the group.

Soil temperature

Record if the soil surface was cool, warm, or hot.

Smell test

Ask participants to grab a handful of soil and smell it. Record if the soil has no smell, an earthy or sweet smell, or a bad smell.

Structure test

Remove a large clump of soil and examine it to see if it has any air pockets or pores running through it. Break large clumps apart to observe the structure of the soil inside. Note how common it is to find large clumps with lots of easy-to-see pores running through them. Pull out a few examples to compare to the other soil from the other square later.

Texture test

Ask participants to examine the texture of the soil by taking a handful of soil and squeezing it in their hand. Does it fall apart as soon as you open your hand or does it hold its shape? Does it crumble if you poke it lightly or does it still stick together?

Moisture test

Ask participants to take another handful of soil and squeeze it. Does the soil have little moisture, no moisture or a lot of moisture?

Soil life test

Ask participants to sift through the soil they excavated from the hole and record any signs of soil life. It would be best if they count and record the number of different soil organisms, such as earthworms or other animals, they find to compare to the other group.

Depth of topsoil

After participants have sifted through the first 30 cm of soil in their square, ask them to measure the depth of the topsoil using a string or tape measure and record it. The topsoil depth could be very shallow (<1 cm) or very deep (>30 cm). A gardener will recognize when the soil starts to look and feel different. The subsoil will be more compact and probably a different color than the topsoil.

STEP 6. Gather participants together at one square and have that group report their findings. Switch groups so that both groups can see the soil excavated from each square.

STEP 7. Move away from the squares to a place where participants can sit. Discuss each concept with participants:

Soil temperature

- What happens when the soil is too hot? Compare with a child with fever.
- What can we do to ensure the soil does not get too hot?

Soil smell

- What is the smell of a healthy soil?
- What does it mean if there is no smell?
- What can you do if there is no smell?
- What does it mean if the soil smells bad?
- What can we do about it if the soil smells bad?

Soil structure

- What is the structure of a healthy soil?
- How does stepping on wet soil affect a soil's structure?
- What soil structure is best for growing plants? Why?

Soil texture

- What is the texture of a healthy soil?
- What soil texture is best for growing plants? Why?

Soil moisture

- Why is soil moisture important?
- How would soil moisture differ if soil is covered or exposed?

Soil life

- Why is soil life important?
- Why do some soils have a lot of soil life and others have very little?
- What can we do to encourage more soil life?

Depth of topsoil

- Why is the depth of topsoil important?
- Is there anything we can do to build more topsoil?

Soil temperature
The surface of the soil should not feel too hot or too cold. Below the surface, the soil should feel slightly cool to the touch. Soil that exposed to the hot sun often gets too hot, just like someone with a fever. If the soil gets too hot, it is difficult for young plants to grow. Soil organisms, such as earthworms, leave in search of cooler soil. Covering soil with mulch or keeping living plants growing in the soil is a first step towards preventing soils from becoming too hot.

Soil smell
Healthy soil should have an earthy, slightly sweet, smell. If the soil smells earthy, sweet, or fresh this indicates a healthy microbe community living in aerobic (plenty of oxygen) conditions. If the soil is sandy and dry, it will have little or no smell at all. This soil needs lots of organic matter added to it. If the soil has a sour or putrid smell, then it is most likely frequently waterlogged and it may be easier to find another spot instead. If the soil has a strong chemical smell, it is best not to use it for a garden site.

Soil structure
Healthy soil has pores and air pockets running through it. These are created by soil life burrowing through soil. These pores act as water channels, so water can infiltrate into all parts of the soil equally. They also create air pockets so that plant roots can access air, and soils can dry evenly. When soils do not contain enough organic matter, there will be few burrowing soil organisms living in the soil who can create pores and any pores created can easily collapse. Gardeners can also easily destroy pores by applying heavy pressure on the top of soil when walking or driving over soil or by digging in the soil too much.

Soil texture
Healthy soil holds its shape after you squeeze it and crumbles if you poke it lightly. This soil type is called loam. Loamy soil contains just enough clay and silt to make it stick together but not make it too compact. Loamy soils are good for growing plants because they act as a "sponge" that lightly retains moisture so that plants can easily use it. A soil that sticks together when wet has a lot of clay in it. Both loamy and clay soils are rich in nutrients and contain lots of organic matter. Clay soils will not drain easily, so it is important to have good drainage systems when using these soils so plant roots are not waterlogged. A soil that falls apart as soon as you open your hand is a sandy soil. This soil drains water quickly—sometimes too quickly for plants to use it—and is low in nutrients. It also needs a lot of organic matter dug into it to provide nutrients and improve its "sponge-like" texture.

Soil moisture
If there is no moisture when you squeeze the soil, and the soil does not stick together, then it is too dry. This soil needs lots of organic matter to retain some moisture in order for plants to grow well. If there is no water coming out when you squeeze the soil, but you can sense moisture and the soil sticks together, then the soil is moist. This is great for growing plants. If you see water coming out when you squeeze the soil, then the soil is wet. Soil that is too wet will cause plant roots to rot and deprive them of air.

Soil life
A healthy soil should have lots of soil life, not just earthworms but lots of different creepy crawlies, such as termites or ground beetles. These organisms in the soil helps plants decompose so the nutrients in them can be returned to the soil. As insects move through the soil, they move nutrients from the bottom layers of the soil to the top layers, which also replenishes soil nutrient levels. Insects and earthworms also create pores in the soil that facilitate water movement and root growth. It is important not to disturb these pores by walking on freshly dug garden beds!

Even though we cannot see many small organisms when we are gardening, we can be pretty sure that if we see lots of earthworms, our soil will also contain many small organisms. These small organisms (also called microbial organisms or microbes) are enriching our soil with many nutrients and are even helping us fight off many soil diseases. Soil organisms thrive when soil is moist and rich in organic matter.

Topsoil
Topsoil is the uppermost layer of soil. It was formed by the slow decomposition of the plants that have grown on it. It takes a long time to build topsoil, but very little time for it to disappear once exposed to air, wind, and rain. Some topsoils can be very deep (>30 cm or more), while others very shallow (<1 cm). The deeper the topsoil, the better the plant growth. Although it takes many years to increase the depth of a soil's topsoil, continuous additions of organic material and minimum tilling will slowly improve the topsoil and make it easier for gardeners to grow vegetables.

10 min

4. Closing discussion

Invite participants to share what they have learned about soils.

NEXT GUIDE: Healthy Soils

Building Healthy Soils

OVERVIEW

LEARNING OBJECTIVE

Gardeners will understand how to improve and maintain soil health using simple techniques.

DURATION

MATERIALS NEEDED

- Flipchart and markers
- 1 small bucket of finished compost
- Small bag of water-soluble inorganic fertilizer, like urea
- 2 cups or empty water bottles
- Water

KEY CONCEPTS

- Soil health can be maintained or improved by consistently using multiple good soil management practices. Each practice on its own is helpful, but soils will be most protected when multiple practices are used together.
- Even severely degraded soils can be restored to good health by adding compost or well-rotted manure and keeping soils moist and covered at all times.
- Inorganic fertilizer contains nutrients that plants need but must be applied carefully in order not to harm the soil and its living organisms.

TRAINING AGENDA

1	Introduction and warm-up	DISCUSSION	10 mins
2	Gardening practices that improve and maintain soil health	DISCUSSION	1 hour
3	How to restore degraded soils back to health	DISCUSSION	15 mins
4	Understanding inorganic fertilizers	DISCUSSION	45 mins
5	Closing discussion	DISCUSSION	10 mins

10 min

1. Introduction and warm-up

Welcome gardeners to the training. Do a brief introduction to today's topic and review the training agenda. You may want to outline the training agenda on your flipchart or board so gardeners can see it when they arrive.

Conduct a warm-up exercise or ice-breaker to make sure all gardeners feel welcome and are ready to fully participate. Suggested warm-up and ice-breaker activities can be found in the Facilitator's Guide: Encouraging Learning through Participant Engagement.

Participant Engagement Guide

1 hour

2. Gardening practices that help improve and maintain soil health

INTERACTIVE DISCUSSION

GOAL OF DISCUSSION: Gardeners will discuss practices that help improve and maintain soil health using locally available resources.

MATERIALS NEEDED: Flipchart and markers

1. On your flipchart, draw a grid like the one below. Going up the left side of the paper, write "What We Can Do" and then list various soil management practices. Across the top of the paper, write "The Result We Can Get" and list desirable soil characteristics. You may wish to do this before gardeners arrive.

What can we do?	**The result we can get**					
	Not-too-hot temperature	Earthy, sweet smell	Lots of pores and air pockets	Moist, but not wet	Abundant soil life	Deep topsoil
Apply mulch	X			X		X
Add compost and other organic matter		X	X	X	X	X
Use cover crops	X	X	X	X	X	X
Reduce compaction	X	X	X	X	X	
Plant a diversity of crops					X	X

2. Ask gardeners to break into pairs or small groups to think about how each soil management practice will affect the soil. What outcomes can they expect from consistently using each practice?

3. Starting with "applying mulch," have each small group report their thinking about one soil management practice to the larger group. Fill in the grid on your flipchart with an "X" when the larger group agrees that the practice will help build the desired soil characteristic.

4. Have the small groups take turns presenting until each soil management practice has been covered.

5. Ask gardeners to describe any other soil management practices they have used that they find beneficial. List these practices below the other soil management practices and discuss with the group how they could contribute to healthier soils.

KEY MESSAGES

Soil health can be maintained or improved by consistently using multiple good soil management practices. Each practice on its own is helpful, but soils will be most protected when multiple practices are used together.

What can we do?	The result we can get					
	Not-too-hot temperature	Earthy, sweet smell	Lots of pores and air pockets	Moist, but not wet	Abundant soil life	Deep topsoil
Apply mulch 	X			X		X
Add compost and other organic matter 		X	X	X	X	X
Use cover crops 	X	X	X	X	X	X
Reduce compaction 	X	X	X	X	X	
Plant a diversity of crops 					X	X

Why do we mulch?

Mulch can be dried leaf litter, dried grasses, dried crop residues, or paper spread on the soil in between crops. Mulch forms a protective covering over the soil that reduces evaporation, so soils remain moist for longer, and regulate soil temperature. Mulches help control soil erosion by cushioning the impact of raindrops and slowing runoff. They suppress weeds by shading them out and will enrich soils as they decompose.

Why do we apply compost and other organic matter?

Compost and other forms of organic matter will return nutrients to the soil that otherwise will be lost. Organic matter is any plant material, such as crop residues, kitchen waste, leaf litter, or dried grasses. Manure and urine from plant-eating animals are also organic matter. Enriching the soil with organic matter will improve the soil's structure and its ability to hold water. Soils that contain a lot of organic matter will have an earthy, sweet smell. Organic matter also provides food and habitat for many forms of soil life. Thus, adding organic matter can improve soil life. Over time, topsoil that is enriched with organic matter will get deeper. Soils have an amazing ability to absorb organic matter; it is nearly impossible for a gardener to add too much organic matter to their soil!

Why do we use cover crops?

Cover crops are often leguminous plants that pull nitrogen, an important plant nutrient, out of the air. When parts of these plants die, this nitrogen is added to the soil. Cover crops keep beds "covered" because they are planted in between cropping seasons when garden beds are normally bare. This reduces erosion and regulates soil temperature. The roots of cover crops will slowly add nutrients to soil, create pores for water infiltration, and provide food for soil life as they die. This can create a more porous soil texture and a deeper topsoil over time.

Why do we reduce soil compaction?

Soils can become compacted when animals and humans walk on them. When soils are compacted, it becomes harder for plant roots to grow and for water to penetrate the soil surface. A sign of soil compaction is when water is pooling on top of the soil instead of infiltrating. A compacted soil is hard to dig and can be either very wet or dry. When we reduce compaction by not walking on our beds, we preserve the soil pores created by roots and insects. These pores allow plants to easily access water and air. It also reduces stress on plant roots so that they can easily grow.

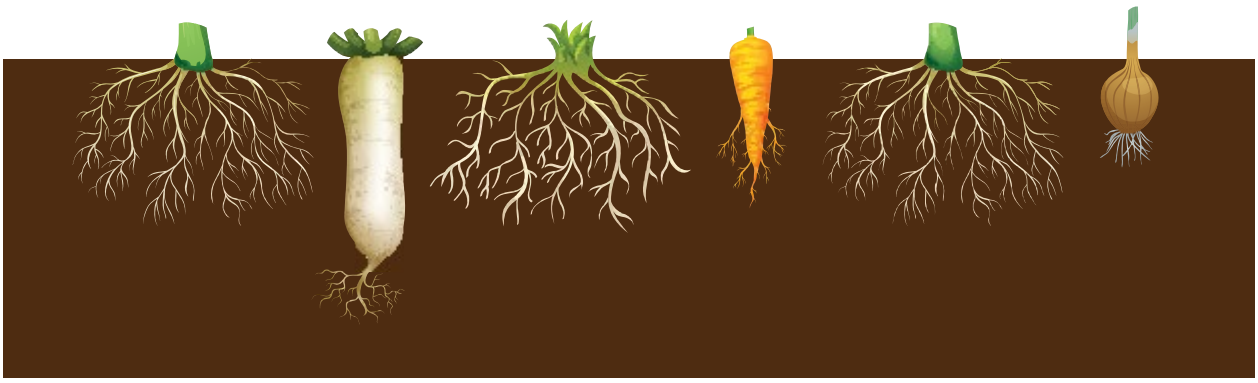
Why do we plant a diversity of crops?

Each vegetable crop uses soil nutrients and soil space differently. Some plants use more of one particular nutrient than others and are considered "heavy feeders," while others are "light feeders." The rooting system of each crop is also different. Some vegetable crops have fibrous root systems that form a web of small roots that use nutrients from the upper portion of the soil, while others have a taproot system that pulls nutrients from deep within the soil profile.

When gardeners grow a diverse set of plants, they can use more of the nutrients already within soil and reduce competition for soil space between their crops. This leads to more productivity, but it can also enrich the soil. When plant roots grow, they create pores of different sizes and at different depths. When plant roots die, they add organic matter to the soil and encourage a diversity of soil life to multiply within the soil. This can create a more porous soil texture and a deeper topsoil over time.

INTERSPERSING ROOT TYPES

Alternating a row of fibrous roots followed by a row of taproots or bulbs (repeated across the bed) can use different zones within the soil.



15 min

3. How to restore degraded soils back to health

INTERACTIVE DISCUSSION

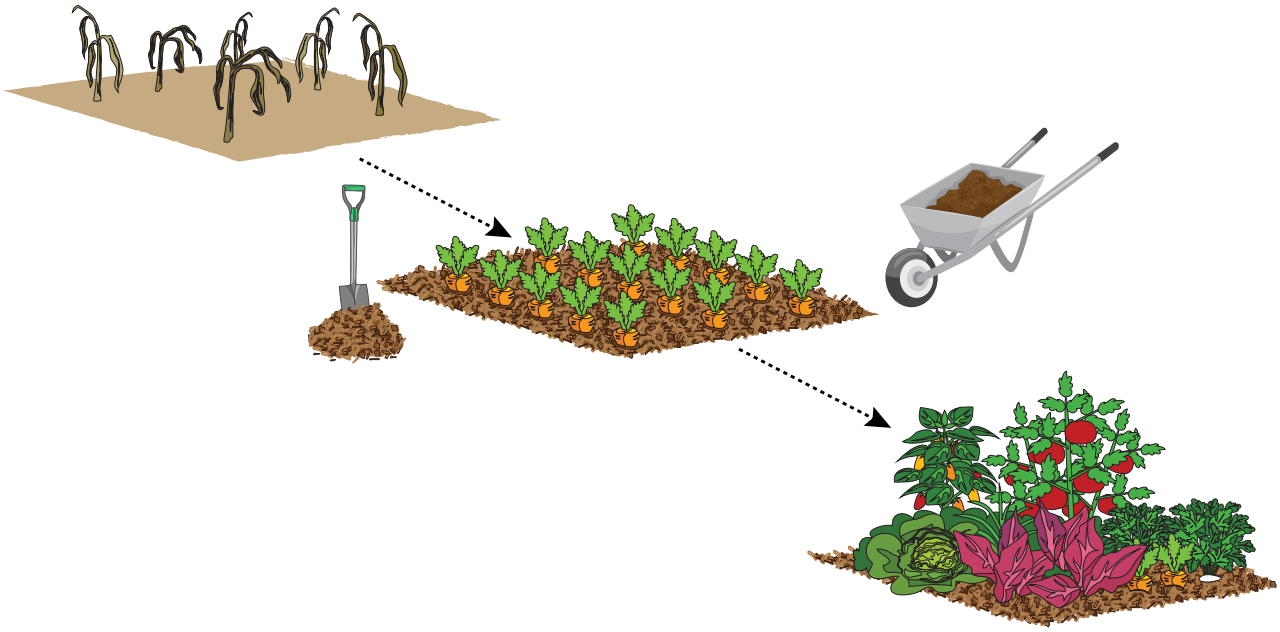
GOAL OF DISCUSSION: Gardeners will discuss how these soil improvement methods can be used over the long term on degraded soils if needed.

MATERIALS NEEDED: Flipchart and markers

1. Ask gardeners to share their opinions: have they ever seen soil health improve over time or have they only seen it get worse? Ask gardeners to raise their hands to show how many think that poor soils only become worse over time. How many think that poor soils can improve over time? Why?
2. Tell gardeners that even poor soils can improve if they are taken care of. A household that lives on a plot of land that has very poor soil might want to invest time and energy into improving the health of the soil in a spot where they intend to garden long term.
3. Discuss the steps of "nurturing" poor soils back to good health. Why is it important to carefully pick a small plot of land to improve?

KEY MESSAGES

Even severely degraded soils can be restored to good health by adding lots of organic matter in the form of compost or well-rotted manure and keeping soils covered and moist. It will take many years of consistent effort to rebuild the health of degraded soils, but it might be very beneficial for gardeners who do not have easy access to good soil. Gardeners should start by picking a small plot of land that will be their garden bed for many years to come. Starting small is important! Multiple wheelbarrows of compost or manure can be used in a 1m x 1m plot each year. The more compost or well-rotted manure they can apply to the same plot of land, the better. They may wish to apply compost several times a year. The soil surface should be covered all year with either crops, mulch, or cover crops and extra water applied periodically to help decomposers. Gardeners will see yield benefits during the first season. After several years of effort, they will be able to see a clear difference in the soil's color and structure. This can be a very productive place to have a continuous supply of vegetables for household consumption.



45 min

4. Understanding inorganic fertilizer

INTERACTIVE DISCUSSION

GOAL OF DISCUSSION: Gardeners will have a better understanding of inorganic fertilizers and how to apply them correctly in combination with organic methods.

MATERIALS NEEDED:

- Flipchart and markers
- 1 small bucket of finished compost
- Small bag of water-soluble inorganic fertilizer, like urea
- 2 cups or empty water bottles
- Water

1. Ask participants to share any experiences they have using inorganic fertilizer for vegetable or other crops. Have participants explain what steps they took in as much detail as possible. Gardeners may have a mix of positive and negative stories to share.
2. Explain to gardeners that inorganic fertilizers can be beneficial for their gardens, but only if they are used properly. Gardeners should decide for themselves if they want to use them or not. They may choose to first buy a very small amount of fertilizer so they can experiment with applying what they learned in this lesson. It is possible that participants will want to join together to purchase fertilizer and share the cost between them. If it is their first time using inorganic fertilizer, recommend that they start small so they can learn as they go.
3. Give gardeners a definition for inorganic fertilizers and ask gardeners to name some locally available inorganic fertilizer products. Write these names down on your flipchart. If gardeners name other products, such as pesticides or herbicides, write these down in another list so gardeners can see the difference.
4. Draw two columns on your flipchart. At the top of one column, write "Organic fertilizers" and at the top of the other write "Inorganic fertilizers." Discuss with gardeners how organic and inorganic fertilizers are different.
5. As you discuss the characteristics of organic and inorganic fertilizers, do some demonstrations to further gardeners' understanding of the differences between fertilizers.
6. Ask gardeners to discuss why they think using organic and inorganic fertilizers together can achieve good results.
7. Write the six steps to properly apply inorganic fertilizer on your flipchart and discuss with gardeners.
8. Revisit some of the negative stories that gardeners shared in the beginning of the session. Do gardeners have any ideas for why they might have seen negative results when using inorganic fertilizer in the past?

KEY MESSAGES

Inorganic fertilizers are concentrated sources of nutrients that plants need to grow. The macronutrients provided by inorganic fertilizer are nitrogen, phosphorus, and potassium and are often abbreviated as N (nitrogen), P (phosphorus), and K (potassium). Inorganic fertilizers can also contain micronutrients, which are essential to plant growth but only used in small amounts. Some micronutrients that can be found in inorganic fertilizers include calcium (Ca), magnesium (Mg), sulphur (S), boron (B), zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), chloride (Cl), and molybdenum (Mo). These nutrients are also found naturally in soils, compost, and manure. Inorganic fertilizers provide these nutrients in high doses and in forms that are easily taken up by plants. When used appropriately, inorganic fertilizers can help make sure that plants stay healthy by ensuring they receive enough of these important nutrients. Like people, plants also require a diverse diet to make sure they get all the nutrients their bodies need. Inorganic fertilizers can provide some of these nutrients, but a gardener will need to provide other sources of nutrients to make sure plants are getting everything they need.

MACRO

N	P	K
NITROGEN	PHOSPHORUS	POTASSIUM

MICRO

Ca	Mg	S	B	Zn	Cu	Mn	Fe	Cl	Mo
CALCIUM	PHOSPHORUS	POTASSIUM	BORON	ZINC	COPPER	MANGANESE	IRON	CHLORIDE	MOLYBDENUM

Common Inorganic Fertilizers

Fertilizer Name	Nutrients
Urea	Nitrogen (46%)
Diammonium phosphate (DAP)	Nitrogen (18%) and Phosphorus (46%)
Rock phosphate	Phosphorus (34%)
Single Superphosphate (SSP)	Phosphorus (7–9%), Calcium (18–21%), Sulphur (11–12%)
NPK	Look at the bag to see the percentages of NPK for that fertilizer blend. The three numbers are listed in the order of N–P–K, so if you see 45–16–16, then that bag contains 45% N, 16% P, and 16% K.
Agricultural lime (often called gypsum)	Calcium (30%), Sulphur (24%). Agricultural lime also can improve acidic soils, which can make many nutrients more available to plants.

What are some differences between organic and inorganic fertilizer?

	Organic fertilizers	Inorganic fertilizers	Demonstration
What nutrients are provided?	A mixture of nutrients, but the amount of each individual nutrient can vary dramatically depending on the quality of the compost. This is why it is important to include nutrient-rich material in your compost, such as kitchen waste and animal waste, so that the nutrient content of your compost is as high as possible.	Contain a specific blend of macro-nutrients (nitrogen, phosphorus, and potassium) and/or micro-nutrients (calcium, sulphur, magnesium, zinc, and so on). If a plant is deficient in one or more of these nutrients, it will benefit from the application of an inorganic fertilizer.	Show gardeners the illustration of fertilizer labels and discuss how to tell which nutrients are contained in each fertilizer type.
How are nutrients released?	Nutrients are released slowly and consistently.	The nutrients in inorganic fertilizers can easily dissolve in water. This makes them very accessible to plant roots right after they are applied, but rain or irrigation water will keep leaching, or pushing, them further down in the soil until eventually they are beyond the root zone.	Take two cups or water bottles. In one, insert some compost and, in the other, insert some water-soluble inorganic fertilizer like urea. Add water to each cup or water bottle and show gardeners how the inorganic fertilizer will dissolve very quickly in the water, but the compost will not. Talk about what might happen to inorganic fertilizer when it rains or gardeners irrigate their fields.
Do they help soils develop good structure?	Organic fertilizers are essential to improving soil structure and water holding capacity. As organic material decomposes, it adds a "stickiness" to the soil that traps water and nutrients.	Adding inorganic fertilizer to the soil can help plants and their roots grow better. If this material is returned to the soil, it can help build soil structure. But adding inorganic fertilizer without reincorporating plants into soil will not build soil structure. In fact, if inorganic fertilizer is used in sandy or degraded soils, it will easily wash away.	Have gardeners each squeeze a sample of compost in their hands and discuss how this "stickiness" might benefit soils over time.
Does it matter how I apply the fertilizer?	Organic material should be fully decomposed so that the nutrients are available to plants. Applying raw manure to soils can injure plant roots and kill plants.	Over-applying inorganic fertilizer can injure plants and kill microorganisms in the soil. Avoid direct contact between inorganic fertilizers and seeds. Inorganic fertilizers can be harmful to human health, so avoid touching fertilizer with uncovered skin and keep them away from children.	Show gardeners in the palm of your hand the amount of inorganic fertilizer that should be used per plant (half a bottle cap) and discuss how inorganic fertilizer needs to be applied so that nutrients can reach plant roots when dissolved. Contrast this with how it is common to find young plants growing right in finished compost piles.

Why do organic and inorganic fertilizers work best when used in combination?

Plants need a combination of the right environment to grow in and nutrients that help them build healthy tissue. Organic materials help soils develop good structure and maintain water so that nutrients can be slowly released to plants, but they may not contain enough nutrients for continuously high yields. Inorganic fertilizers can supply these nutrients, but do not build soil structure in the same way that organic fertilizers do. When used together, plants can really flourish because they have everything they need in abundance. Inorganic fertilizer can also compensate for removal of harvested produce from the farm. When gardeners are harvesting and then eating large amounts of produce, many of the nutrients from the soil leave with the harvest. These nutrients need to be returned to the soil through compost and inorganic fertilizers.

How do we properly apply inorganic fertilizer to our home gardens?

1. It is challenging for home gardeners to know what nutrients their soil needs most. For this reason, it is recommended that gardeners choose NPK if it is available because it supplies all three major nutrients. If NPK is not available, they should choose a fertilizer that contains nitrogen. They should confirm that the label says "nitrogen" or "N" in the nutrient ratio before buying.

2. Prepare your garden bed with organic material as recommended. Organic materials can be used without inorganic fertilizer, but inorganic fertilizers should preferably be used in combination with organic fertilizer.

3. If direct seeding, draw two lines 7–10 cm away from the planting line on either side. Sprinkle inorganic fertilizer in the lines at the same rate as you would apply seeds. Pinch the line to cover the fertilizer with soil.

4. If transplanting seedlings, draw a ring that is 7–10 cm away from the transplant. Sprinkle half a bottle cap (around 3–4 grams) of fertilizer in the ring and pinch the ring closed with your fingers to cover the fertilizer.

5. It is very easy to apply too much fertilizer, so do not 'top-up' your application. If you are concerned about soil fertility, apply more organic fertilizer instead.

6. It is very important that the seeds or young roots not directly touch inorganic fertilizer to avoid being "burned."

10 min

5. Closing discussion

1. Ask gardeners to discuss in pairs the key points about how to build and maintain long term soil health.

2. Ask each pair to share with the group.

NEXT MODULE: 03–Production Planning