



## STAGE 4: SOIL IN THE ENVIRONMENT

Students will learn about the importance of healthy soil to healthy plants. They will explore soil composition, including the biodiversity of this complex ecosystem, to understand that there are different types of soil. Often soil dictates what can be grown—or not—in a particular area. Students will explore human impact on soil and farmers' role in soil health and the technology they use to mitigate environmental harm. Designing a new farming machine is an optional bonus activity.

Lesson 1: What is Soil?

Lesson 2: Soil Types in Ontario (and Regions)

Lesson 3: Compaction and Erosion

Lesson 4: Soil Nutrients

Lesson 5: STEM and Technology on Farms

Lesson 6: Designing an Innovative Farm Machine

## LESSON 3 - Compaction and Erosion

### Overview:

Soil is affected by many things, natural and human-caused. Soil compaction is caused by something pressing on soil, pushing the particles together. Compaction can be caused by natural or human action, such as erosion by wind or water or driving heavy vehicles on farm fields. In both cases, compacted soil will be less- or non-productive.

Students will learn how soil is compacted and about the effects of erosion. They will begin to learn what farmers are doing to prevent or mitigate soil compaction and erosion.



## Learning Goals

- Understand how soil is compacted and why it matters
- Consider the effects of erosion
- Assess these things:
  - How humans affect soils
  - Ways we can improve soils
  - How farmers protect soil

## Materials Needed

- Lesson Slides

### **ACTION: Compaction materials needed:**

- trays of soils (different types of soil, if possible)
- variety of balls or other things to roll in soil (one class tried toy tractors with tires and tracks)
- spray bottle (optional)

## Time Frame: 40 min

## Curriculum Expectations

### **Ontario Science & Technology Curriculum Strand E Soils in the Environment**

- E1.1 Assess the importance of soils for society and the environment
- E1.2 Assess the impact of human activity on soils, and describe ways in which humans can improve the quality of soils and/or lessen or prevent harmful effects on soils
- E2.4 Explain the process of erosion, including its causes and its impact on soils
- E2.5 Identify various strategies used to maintain and improve soil health in Ontario
- E2.6 Describe the process of composting, and explain some benefits of composting



### Agriculture/Agri-Food Themes

- By using sustainable farming practices, such as driving on fields less and planting cover crops, farmers support soil health. More and more, agriculture is applying technology to create a sustainable farming future.

### Media Links (embedded in the slides)

Preventing Soil Erosion <https://www.youtube.com/watch?v=im4HVXMG168>

Innovative Technology <https://www.youtube.com/watch?v=K-FvYZv785U>

Cover Crops <https://goodineverygrain.ca/2018/10/04/cover-crops-101/>

Drones Help farmers Spray Less <https://canadianfoodfocus.org/on-the-farm/gps-helps-farmers-use-less-pesticides/>

Dino Robot <https://www.naio-technologies.com/en/news/large-scale-vegetable-weeding-in-canada-with-dino/>





## Teaching Notes

<p><b>Slide 6: Minds ON!</b></p>	<p><b>What do you notice?</b></p> <p>Ask students - What do you notice about this picture? Likely answers are cracks, dead bits of grass, very little green grass. Encourage students to take their observations further; do they think they could poke a finger into the soil? Or plant a seed?</p>
<p><b>Slide 7: What is Compacted Soil?</b></p>	<ul style="list-style-type: none"> <li>• Soil is compacted when something presses down on it and soil particles are pushed together</li> <li>• This makes it more difficult for water to drain through the soil, roots to grow through the soil, and even seedlings to emerge from the soil.</li> </ul>
<p><b>Slide 8: What Causes It?</b></p>	<ul style="list-style-type: none"> <li>• Different types of soil can be affected differently in the same conditions.</li> <li>• Soil can be compacted by heavy rainfall. Each drop is like a tiny hammer, making a hole in the soil.</li> <li>• Driving on soil, especially with heavy vehicles, can leave deep marks, and compact the soil under the tire treads.</li> <li>• Driving on wet soil can also compact the soil together.</li> <li>• Walking on soil a lot can compact it. If you've seen a path worn in a field or yard, that is compacted soil.</li> </ul>
<p><b>Slide 9: What Happens When Soil is Compacted?</b></p>	<p>Think about farmers. What are some consequences of compacted soil? Can seeds grow through compacted soil? Can water flow through compacted soil? What happens to plants trying to grow in compacted soil?</p>





<p><b>Slide 10: When Soil is Compacted</b></p>	<p>Plants and organisms cannot live in compacted soil. But that's not all; compacted soil can also mean different types of damage could happen.</p>
<p><b>Slide 11: Consequences</b></p>	<p>When there is compaction, this prevents water from flowing into the soil. This can lead to flooding, water erosion of the soil, and unwanted soil movement. Ultimately, crops cannot grow and the health of that soil is impacted.</p>
<p><b>Slide 12: ACTION: Compaction</b></p>	<p><b>TIP!</b> Educators are most often doing this as a whole-class investigation and gather the soil before the lesson.</p> <p>Materials needed:</p> <ul style="list-style-type: none"> <li>• trays of soils (different types of soil, if possible)</li> <li>• variety of balls or other things to roll in soil (one class tried toy tractors with tires and tracks)</li> <li>• spray bottle (optional)</li> </ul> <p>Directions:</p> <ul style="list-style-type: none"> <li>• Place a tennis ball in a tray of sand. Place a small piece of wood or sturdy cardboard on top as a platform and use it to roll the tennis ball across the tray. Examine the depth of the groove it creates.</li> <li>• Students could repeat the process with different-sized balls or weights on the platform. Observe the effect changing the weight has on the depth of the groove.</li> <li>• Students could also investigate the effect of using different sized balls to simulate the effect of changing the size of the tire.</li> <li>• Students could also compare wet soil to dry soil.</li> </ul> <p>Alternative: Check out this great activity from Let's Talk Science!  <a href="https://letstalkscience.ca/educational-resources/hands-on-activities/what-makes-soil-hard-and-compacted">https://letstalkscience.ca/educational-resources/hands-on-activities/what-makes-soil-hard-and-compacted</a></p>



<p><b>Slide 13:</b> <b>What is Erosion?</b></p>	<ul style="list-style-type: none"><li>• Erosion is another way soil is affected; it happens when the top layer of soil is worn down and transported by wind or water.</li><li>• Two main types: wind and water erosion.</li></ul>
<p><b>Slide 14:</b> <b>Erosion</b></p>	<ul style="list-style-type: none"><li>• Wind erosion: When topsoil is loose (there is nothing holding that soil in the field), the wind can pick it up and carry it away. Reminder: roots act as an anchor in soil to hold plants in the ground. They can also act as an anchor to hold soil particles in place.</li><li>• You might see this as dusty fields during planting season, or as dirt covered snowbanks in the winter.</li></ul>
<p><b>Slide 15:</b> <b>Erosion</b></p>	<ul style="list-style-type: none"><li>• Water erosion can wash away nutrients and cause flooding.</li><li>• In addition to washing the nutrients and top soil away from fields, water erosion can also cause flooding as the soil is washed into nearby waterways.</li><li>• This video shows the impact of plants on preventing soil erosion. <a href="https://www.youtube.com/watch?v=im4HVXMG168">https://www.youtube.com/watch?v=im4HVXMG168</a></li></ul>
<p><b>Slide 16:</b> <b>What can farmers do?</b></p>	<ul style="list-style-type: none"><li>• What can farmers do to reduce compaction and/or erosion?</li></ul>



**Slide 17:  
Farmers are  
farming differently**

What can we do about it? How are farmers helping?

- We all need to eat so we can't stop farming. It's impossible to eliminate soil compaction, but we can reduce it by improving how we farm.
- Farmers are making changes to reduce soil compaction and reduce the chances of soil erosion. They are planting cover crops to protect the soil in winter and driving less on their fields, using technology to do some jobs.
- Farmers practice conservation tillage (tilling only where seeds will be planted), which protects the soil, reduces compaction and erosion, and uses much less fuel. All together in Ontario, farmers save more than 170 million litres of fuel per year. That is like taking 122,000 cars off the road!
- Farmers today use drones to check their fields—no driving! And they use satellite images to see what's happening in the fields—poor drainage, insect infestations, plant health. They also use GPS to guide equipment to make sure driving is very precise, with no wide turns or overlapping rows.

**Slide 18:  
Cover Crops**

- A cover crop is a crop (such as radish, clover, winter wheat, oats, turnips, sunflowers etc.) that are planted primarily to benefit the soil. They are planted into bare soil after harvest to provide a "cover" over that soil to protect it from erosion, break up compaction, or boost soil health by adding nutrients.
- Their roots provide a solution to compaction by digging deep into the soil to break up the compacted soil particles.
- They will reduce erosion by "holding" the soil in place from wind or water movement.
- For more information visit: <https://goodineverygrain.ca/2018/10/04/cover-crops-101/>





**Slide 19:  
Innovative  
Technology**

- Work is being done to find solutions to soil compaction. Some of these solutions include changing farming practices but others involve innovative technology.
- Some of it is low tech – changing the type of equipment used on the fields or even changing tire sizes and types.
- Some farm equipment are using tracks (like on a bulldozer!) instead of tires. Tracks can help distribute the weight of the tractor more evenly over a larger surface area
- Old farm equipment has skinny, thin tires that really concentrated the weight of the machine within that small tread space. Now, farm equipment has thick, wide tires that also distributes the weight of the tractor more evenly over a larger surface area which reduces compaction.

**Slide 20:  
Innovative  
Technology**

- Work is being done to find a solution to soil compaction. Some of these solutions include changing farming practices but others are involving innovative technology
- Some of it is high tech – using drone mapping to monitor fields and then using that digital mapping to complete some farming practices! This includes planting seeds from the air and spraying fertilizer or pesticides only where they are needed in the field.
- Let's watch some videos to learn more! (Could be shown at lunch time.)
- This video shows 10 innovative farm machines. Which ones do you think will prevent soil compaction?
- <https://www.youtube.com/watch?v=K-FvYZv785U>



**Slide 21:  
Innovative  
Technology**

- Work is being done to find a solution to soil compaction. Some of these solutions include changing farming practices but others are involving innovative technology
- Along with digital mapping, farmers use GPS and auto-steer (self-steering) in their tractors. This can help farmers drive in straight, even lines; prevents overlapping of the farm machinery and can also help them spray only where necessary, so they are not driving on every bit of their fields. <https://canadianfoodfocus.org/on-the-farm/gps-helps-farmers-use-less-pesticides/>

**Slide 22:  
Innovative  
Technology**

**Innovative Technology**

Work is being done to find a solution to soil compaction. Some of these solutions include changing farming practices but others involve innovative technology.

- Farmers can use drones and satellite technology to create maps of their fields to look at plant health or soil conditions. These maps allow farmers to precisely manage their plants' needs or fix any soil challenges by creating regions within their farm and seeing visually the overall health of the farm.



<b>Slide 23: Innovative Technology</b>	<p>The Dino Robot is a weeding machine that has been tested in Canada: <a href="https://www.naio-technologies.com/en/news/large-scale-vegetable-weeding-in-canada-with-dino/">https://www.naio-technologies.com/en/news/large-scale-vegetable-weeding-in-canada-with-dino/</a></p> <p>(Text is in English and French; videos are in French).</p>
<b>Slide 24: Wrap Up</b>	<p>Discuss - You probably saw compacted soil in your school grounds. If students stopped walking on it, the soil would improve.</p> <p>How long do you think that would take?</p>

**Assessment Resources. Coming soon!**

Please check the STEMterprise webpage at <https://goodineverygrain.ca/ontario-farming-stemterprise/>