CANADA
4-H Ontario

www.4-hontario.ca

4-H ONTARIO PROJECT

Loyal to the Soil

REFERENCE MANUAL

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4-H Ontario

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The 4-H Pledge

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service and
my Health to better living
for my club, my community and my country.

The 4-H Motto

Learn To Do By Doing

Project Resource Information:

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INTRODUCTION

Welcome to 4-H Ontario's 'Loyal to the Soil Project!'

No matter what we call it - soil, earth, dirt - it is one of the world's most basic and important natural resources. Every day we step on it, build on it and produce food from it; and we do most of these things without giving it much thought.

You will be getting your hands dirty in this project, but we hope by the end you'll appreciate how valuable our soil is. In this project you'll learn how soil is made, how we grow crops on it and some practical ways to keep it where it belongs. Have fun!

Objectives

1. Expand your knowledge of soil and water conservation as it relates to agriculture in Ontario.
2. Become more familiar with the different ways of properly managing soils to reduce soil loss and deterioration.
3. Develop your ability to recognize a soil erosion problem and figure out what action, if any, is needed.
4. Gain experience working co-operatively as a member of a group by participating in club activities.
5. Further develop judging and public speaking skills.
6. Have fun, dig in the soil, and "Learn To Do By Doing!"

How to Use This Manual

4-H Ontario's Loyal to the Soil project is made up of two parts:

1. The Reference Book:
The reference book is laid out into six meetings:

Meeting 1 – Are You Loyal to the Soil?
Meeting 2 – Soil is Not a Dirty Word
Meeting 3 – Fertility Facts
Meeting 4 – Water, Water, Everywhere!
Meeting 5 – Blowing in the Wind & Compaction Action
Meeting 6 – SOS: Save Our Soils

Each meeting has been broken down into an Introduction with Sample Meeting agendas, References and Resources, Topic Information and Activities.
Sample Meeting Agendas: are at the beginning of each meeting. The agendas give suggestions for topic information, activities, recipes and judging and/or communications activities along with suggested times for each section. These are only suggestions – you will know your group best and will know the skill and attention level of your members. There is more topic information and activities than what can be completed in a two hour meeting. Be creative!

Activities: should be used in combination with the discussion of topic information to teach members in a hands-on, interactive learning environment.

2. The Record Book

This booklet is designed to make it easier for members to record information throughout the club. Members are to record their expectations and goals for the project in addition to contact information, meeting dates, roll calls and records of activities completed at the meetings and at home. Print or photocopy pages from the Reference Book that you think will benefit the members either as a resource or an activity. Answers for the Activity Pages can be found at the back of the Record Book.

The Record Book should be given to each member at the beginning of the first meeting. Ask members to keep it in a binder or duotang so they can add to it easily.
Go through the Record Book with the members and explain the charts and forms. Encourage them to use their Record Books at every meeting and record as much information as possible. As an added incentive, a prize could be given at the end of the project for the best Record Book.

Including STEM in the 4-H Loyal to the Soil Project

What is STEM and why is it important?

Since 1915, 4-H in Ontario has engaged youth in science, technology, engineering, and math (STEM). This has traditionally meant a solid focus on agricultural science, mechanics, entrepreneurship, natural sciences and household science. Today, 4-H has grown to include rocketry, robotics, computer science, environmental sciences, and more. 4-H provides hands-on learning experiences to encourage learning about the world around us. Our lives are completely immersed in science and technology.
Understanding how science, engineering, and technology impact our lives, solve problems and create new ones makes it easier to navigate our modern world.

In school, science classes need to cover a broad range of topics in a limited amount of time while STEM in 4-H allows members and leaders time to dig deeper into ideas and concepts and to spend as much time as desired to work on projects based on personal interests, questions, and skills.

STEM in 4-H allows a person to work on their own questions, design their own tests, create their own models, build their understanding, and share their work with others – learn to do by doing. That's what science and engineering are, trying to understand the natural universe and develop solutions to the problems faced in our world today. Science is inquiry that uses a specific approaches and skills. But all learning is an inquiry process so working with science helps develop your learning muscles.

Within 4-H, the STEM process can go even further to include the Arts, thus changing the acronym to STEAM – Science, Technology, Engineering, Art & Math.

STEAM in 4-H Ontario Projects

As you work through the Loyal to the Soil Project, you will see STEAM integrated throughout the project within almost all of the activities provided. Examples of activities include 'Underwear Soil Test', 'Slaking Test' Soil Air', Building An Erosion Model', amongst many others.

STEAM can be challenging but it can also be fun! Be sure to try out the activities. Observe what works and what doesn't and how activities can be changed slightly to get different results. It's all a part of the STEAM learning process!

Planning a Meeting

Plan your meetings well. Review all the information well in advance so you are prepared and ready!

Before Each Meeting:

• Read the topic information and activities and photocopy any relevant resources for the members' Record Books.

• Be familiar with the topic information for each meeting. Think of imaginative ways to present the information to the members. Do not rely on just reading the information out loud. Review available resources, plan the meetings and choose activities and themes that complement the ages and interests of your members. The Record Book contains extra activities that can be used if you need to fill in time or if one of the suggested meeting activities does not suit your group of members.

• Gather any equipment and/or resources that will be needed to complete the meeting.

• At least 12 hours of club meeting time is required for every project; including club business, specific project information and social recreation. The delivery format for that material is left to the discretion of the leaders. Before each meeting, create a timeline to ensure that you are providing an adequate amount of instructional time for club completion. Note: the best practice recommendation is that a club have multiple meeting times for each project.

Included on the following page is a Leader's Planning Chart to help with the planning of meetings. In addition to the chart, keep track of what went well and what should be changed next time. That way, each time this project is run, the content of the meetings can be different!

When planning each meeting, a typical 4-H meeting agenda should include the following:

• Welcome & Call to Order
• 4-H Pledge
• Roll Call
• Parliamentary Procedure:
    ○ Secretary's Report
    ○ Treasurer's Report (if any)
    ○ Press Report
    ○ New Business: local and provincial 4-H activities/opportunities, upcoming club activities
• Meeting content, activities and recipes
• Clean-up
• Social Recreation and/or refreshments
• Adjournment

Judging and Communications:

Each meeting must include either a judging or public speaking activity.

• Judging gives the members an opportunity to use judging techniques as part of the learning process. Through judging, members learn to evaluate, make decisions and communicate with others. They also develop critical thinking skills, confidence and self-esteem. Many examples are used in this reference book but use your imagination! As long as members are setting criteria and critically thinking about where items fit within that set of criteria, they are learning the basic skills of judging!

• A communications activity has been provided for each meeting but can be included in the Roll Call or social recreation time. These activities do not need to involve the topic of pollinators as the outcome is more about understanding the concepts of effective communication.

Leader's Planning Chart

Mtg.#	Date/Place	Topics Covered	Activities	Materials Needed

As a club volunteer your responsibilities are to:

• Complete the volunteer screening process and to attend a volunteer training session.
• Notify the local association of the club, arrange a meeting schedule and participate in club meetings, activities and the Achievement program.
• Review the project material in the Reference and Record books to familiarize yourself with the information and adapt it to fit your group. Be well organized and teach the material based on your group's age, interest and experience level.
• Organize the club so members gain parliamentary procedure, judging and communication skills.
• Have membership lists completed and submitted along with fee collected (if applicable) by the end of the second meeting.
• Have members fill out a Participant Agreement Form and identify any health concerns. Ensure that all members, leaders and parent helpers know the appropriate actions during any emergency. Check with members for any food allergies or dietary restrictions and plan snacks accordingly.

As a club member your responsibilities are to:

• Participate in at least 2/3 of his/her own club meeting time. Clubs must have a minimum of 12 hours of meeting time.
• Complete the project requirement to the satisfaction of the club leaders.
• Take part in the project Achievement Program.
• Fill in and complete the Record Book.
• Complete any other projects as required by the club leaders.

Achievement Program Ideas/Suggestions

• Host a Soils Day for other 4-H agriculture clubs (including livestock clubs) in the area and demonstrate soil sampling techniques and other soil related activities in this project. Discuss why this is important for everyone involved in agriculture.
• Attend a local crop supplier's field crop day.
• Make a display for a local fair, school or community event about a topic found in this project.
• Have members make a presentation at school about why soil is so important.
• Attend a Farmer's Market and sell produce grown in this project.

Special Projects

Individual clubs will decide if junior and/or senior members will be required to complete a special activity. These projects are often done outside of meeting time, but could be used during a meeting, and are for members interested in doing more – often senior members. It's up to you as the leader to decide if you will require members to complete a Special Project for club completion.

Here are some activities to get you started, but feel free to think of more!

1. Each member could plant, cultivate, harvest and keep records on a crop. This crop can be a food crop such as sweet corn or cucumber, or a field crop such as grain or seed corn, forages, barley or soybeans. The size of the plot will depend on the crop being grown and the size of plot available.

2. Plant a plot of cover crops and observe the plant growth. Estimate the ground cover and compare between different cover crops. Dig up and look at the roots to compare.

3. Be a myth buster. Put common myths and urban legends to the test to find out which farming/soil myths are true and which are not. Here are a few examples:
a. Does soil type greatly affect how well crops grow?
b. Do organic materials affect the absorbency of water in soil?
c. Do organic worm castings and non-organic fertilizers affect the growth of annual rye grass?
d. Do different fertilizers (inorganic and organic) affect earthworm mortality rate and cocoon production?

4. Create a video showing the raindrop "bomb" detachment part of erosion. Post on social media. For more information about raindrop bombs, review the information starting on page 12.

5. Have members draw a map of their farm indicating field boundaries. Using the guidelines given in the Soil Is Not a Dirty Word meeting, classify the soils using the Canada Land Inventory System and mark them on the map. Also indicate limitations which affect the classification of different fields.

6. Many of the land features in Ontario, such as drumlins, moraines and eskers were formed by the movements of glaciers during the ice age. Make a presentation on how the movement of glaciers affected the topography in your area.

7. Find the cost of installing tile drains in a particular field. Figure out what increase in yield would be required to offset this cost, assuming tile drains last 20 years. How many years would it take to pay the tiling off? Be sure to have members state all of his/her assumptions such as projected crop prices, interest rates, etc. This could be a group project.

8. Put together a photographic essay or video of an erosion problem. Using photos, document the progression of an erosion problem showing wind or water erosion on a field or part of a field over several weeks or months. Be sure to measure rainfall and/or wind speed to add to the report. Make recommendations on how soil could be conserved at this site. This could be a group project.

9. If members live near a subdivision expanding onto agricultural land, do some soil horizon tests. A woodlot is also a good comparison place. Dig several holes at least 60 cm deep each on the subdivision site and sketch or photograph the soil horizons at each location. Then, move to an adjoining piece of agricultural land and do the same thing. What happened? Prepare a presentation of findings using photographs and sketches. Be sure to get permission from landowners before beginning this project. This could be a group project.

10. Make a display of different tillage practices. Show the differences between conventional moldboard plowing, minimum till and no-till. Show the equipment used, number of passes required in a field, residue cover, etc. Prepare a presentation. This could be a group project.

11. Prepare a rainulator using the Rainfall Kit that can be borrowed from the 4-H Ontario office. Measure the soil runoff that occurs on each box when rainfall is simulated. Record results and make a report and/or presentation.

12. Prepare a display of different soil types. Explain their makeup and how the type of soil affects the crops that are planted, tillage practices a farmer would use and drainage installations that might be needed.

13. Compare the yields of the same crop cultivated with two different tillage practices. The crops should be grown in the same type of soil and under the same conditions. Assistance could be sought from a local crops inputs supplier for help setting up this side-by-side demonstration. This could be a group project.

14. Choose a field or your backyard. Using a soil probe or a shovel, create a transect (draw a line and examine spots along that line), looking at soil type, depth of topsoil, compaction etc. Discuss or create a display showing the variability in the soil.

15. Have members participate in the Journey 2050 program. This program takes participants on a virtual simulation that explores world food sustainability. The program encourages participants to make decisions and adjust them as they see their impact on society, the environment and the economy at a local and global scale. Participants experience the lives of three farm families in Kenya, India and Canada. As participants interact with each family they learn the role of best management practices in feeding the world, reducing environmental impacts and in improving social performance through greater access to education, medical care and community infrastructure. The program can be found at: http://www.journey2050.com/

16. Any other project approved by the leaders of the club.

OKLAHOMA COOPERATIVE EXTENSION SERVICE PSS-2252

Raindrops And Bombs: The Erosion Process

Jason Warren
Soil and Water Conservation Extension Specialist

Oklahoma Cooperative Extension Fact Sheets are also available on our website at:
http://osufacts.okstate.edu

Useful Trouble

The role of raindrops in the erosion process can easily be envisioned as being similar to bombs. A raindrop and a bomb may strike some as an exaggerated comparison. After all from our perspective, a typical rainfall seems innocent enough. However, from the perspective of a soil particle, there is not a better analogy than a bomb. During a rainfall, millions of drops fall at velocities reaching 30 feet per second. They explode against the ground, splashing soil as high as 3 feet in the air and as far as 5 feet from where they hit.

Without raindrops, there would be little soil erosion caused by water. But, of course, without raindrops there also would be no crops. As one person put it, rain is a "useful trouble."

Geologic Violence

To understand how soil loss can be controlled, the first step is to understand how erosion occurs and what role raindrops play in the process.

Soil erosion has always taken place and it always will. It is a natural process. The surface of the earth is continually undergoing what might be called a "face lift in slow motion." Slowly, the coastline is receding, the hills and mountaintops are being carried down to the valleys, and the river deltas are being enlarged.

The form of erosion that occurs naturally, without man's influence, is called *geologic* erosion. Some of the best examples of geologic erosion are the Grand Canyon, the Badlands of South Dakota, the canyons of Utah, and many great river valleys.

If conditions in Oklahoma today were pristine, geologic erosion would occur at a low rate on level land; and on gentle slopes, erosion would only be a minor problem. With the state's humid conditions and ideal environment for plant growth, there would be a protective cover for most of the soil.

But needless to say, conditions today are not pristine. Agriculture has replaced some of the protective cover with plants that are more valuable to man – plants that do not cover the soil as effectively as the natural prairie does. Some farmers leave the soil totally bare during fallow periods between crops.

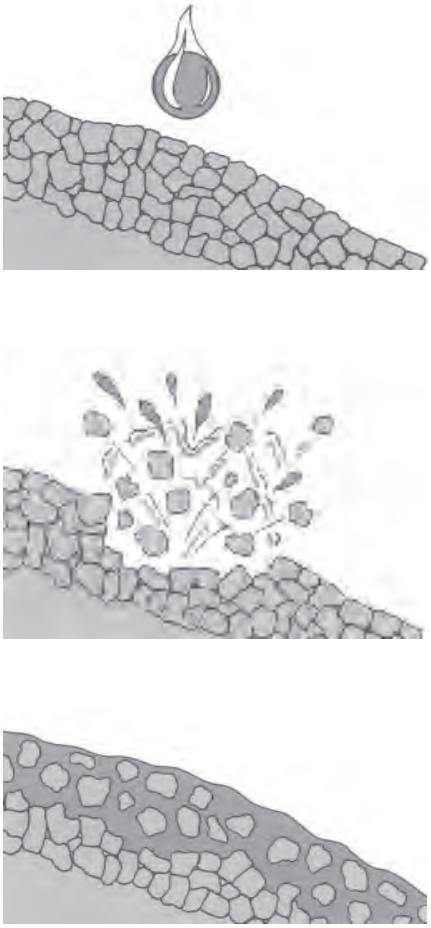
The result? Erosion has increased to destructive proportions on some soils, carrying away topsoil and nutrients, washing pollutants into streams, filling waterways with sediment, and reducing the natural productivity of the land (Table 1).

Although wind has caused significant erosion in the past in Oklahoma, water causes most of the problem today. And here is where raindrops come into the picture.

Splash Erosion

Erosion caused by water can be broken into four categories—*splash* erosion, *sheet* erosion, *rill* erosion, and *gully* erosion. The first part, splash erosion, is the stage when raindrops strike the soil surface as shown below.

When rain falls vertically on a flat surface, splash erosion is equal in all directions. On a slope, more of the soil is splashed downhill than uphill; and in a wind-driven rainfall, splash movement depends on wind direction and slope steepness.



Tour & Guest Speaker Ideas

• Visit a local farm inputs supply company/store.
• Tour a fertilizer plant.
• Attend a field crops day in your area.
• Have guest speakers attend meetings to supplement the material in the Reference Manual. Speakers could include an agronomist, researcher, college or university professor, farmer, greenhouse grower, owner of a farm inputs company. For a current listing of agrologists, visit the Ontario Institute of Agrologists website at: http://oia.on.ca. To learn more about crop advisors and for contact information, visit the Ontario Certified Crop Advisor Association website at: http://ccaontario.com/
• Visit a greenhouse.
• Tour area farms, preferably with different soil types.
• Tour a machinery dealership that has various types of tillage equipment.

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CANADA
4-H Ontario

Additional References and Resources

Agriculture & Agri-Food Canada http://www.agr.gc.ca
Alberta Agriculture & Forestry http://www1.agric.gov.ab.ca
Alberta Farmer Express http://www.albertafarmexpress.ca
Anne Verhallen, Soil Management Specialist (Horticultural Crops) OMAFRA
Atlantic Agriculture – Farm Drainage in the Atlantic Provinces http://nsfa-fane.ca/wp-content/uploads/2011/06/Farm-drainage.pdf
Canadian Foodgrains Bank http://foodgrainsbank.ca
Canadian Society of Soil Science http://csss/ca
Ducksters Education Site www.ducksters.com
Encyclopedia Britannica https://www.britannica.com
Environment and Climate Change Canada https://www.ec.gc.ca
Environmental Science & Forestry – State University of New York College http://www.esf.edu
ENet Learning http://www.enetlearning.org
ESchool Today http://www.eschooltoday.com
Fertilizer Canada http://fertilizercanada.ca/nutrient-stewardship/
Gale Science in Context http://ic.galegroup.com
Grain News http://www.grainews.ca
Integrated Pest Management – Iowa State University Extension http://www.ipm.iastate.edu/ipm/icm/2002/5-13-2002/cropresidue.html
Kidz Search Encyclopedia for Kids http://wiki.kidzsearch.com
Kitchen Garden Foundation https://www.kitchengardenfoundation.org.au
Life is a Garden https://www.lifeisagarden.co.za
Madison Arboretum – University of Wisconsin https://arboretum.wisc.edu
Michigan State University Extension http://msue.anr.msu.edu
Minnesota Department of Agriculture http://www.mda.state.mn.us
National Audubon Society www.audubon.org
No Till http://www.notill.org/
OMAFRA – Considerations when Planning to Drain Land Factsheet http://www.omafra.gov.on.ca/english/engineer/facts/13-033.htm
OMAFRA Field Crop News http://fieldcropnews.com
OMAFRA – Cover Crops Factsheet http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm
OMAFRA – Grassed Waterways Factsheet http://www.omafra.gov.on.ca/english/engineer/facts/09-021.htm
OMAFRA - Operating and Maintaining a Tile Drainage System Factsheet http://www.omafra.gov.on.ca/english/engineer/facts/10-091.htm

OMAFRA – Soil Erosion – Causes & Effects Factsheet http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm
OMAFRA – Soil Fertility and Nutrient Use: Manure Management http://www.omafra.gov.on.ca/english/crops/pub811/9manure.htm
OMAFRA - Vermicasting (or Vermicomposting): Processing Organic Wastes Through Earthworms Factsheet http://www.omafra.gov.on.ca/english/engineer/facts/10-009.htm
Ontario Grain Farmer http://ontariograinfarmer.ca
Ontario Ministry of Agriculture, Food & Rural Affairs www.omafra.gov.on.ca
Ontario Soil & Crop Improvement Association
Soils for Kids http://www.soils4kids.org
Soils for Teachers http://soils4teachers.org
Soil Quality for Environmental Health http://soilquality.org
Soil Science Society of America https://www.soils.org
Statistics Canada http://www.statcan.gc.ca
The Colour of Soil – University of Illinois Extension https://extension.illinois.edu/soil/
TVO http://tvo.org
United States Department of Agriculture – Natural Resources Conservation Service http://www.nrcs.usda.gov
University of Guelph www.uoguelph.ca
Utah Agriculture in the Classroom http://utah.agclassroom.org
World Wildlife Fund http://www.worldwildlife.org

MEETING 1 - Are You Loyal to the Soil?

Objectives:

• Introduce members to the Loyal to the Soil project
• Familiarize members with the 4-H club process (pledge, parliamentary procedure)
• Learn the election procedure for establishing an executive
• Learn what soil is and how it is made

Roll Calls

• Why did you decide to participate in the Loyal to the Soil project?
• What is your reason for wanting to learn more about soil?
• Do you call it soil or dirt? Why?

NOTE FOR FUTURE MEETINGS: Be sure to wear work clothes and a sturdy pair of shoes or work boots to future meetings.

Sample Meeting Agenda – 2 hrs. 5 minutes plus activities

Welcome, Call to Order & Pledge		5 min
Roll Call		5 min
Introduction	Get to know each other/Introductions – Activity #1 (found at the end of this meeting)	15 min
Parliamentary Procedure	Elect executive, hand out Record Books and discuss club requirements. Fill out club and member information in Record Books and have each member fill out their “Member Expectations and Goals” page.	20 min
Outline of Club Project	Discuss: what you plan to cover at meetings and expectations of club members for club completion: meeting attendance, judging event, achievement event, future meeting dates, etc.	15 min
Public Speaking/Judging Activity	Activity #2 (found at the end of this meeting) - Introduce members to public speaking and judging. Check out the 4-H Ontario Judging Toolkit found on the 4-H Ontario website.	20 min

Topic Information, Discussion & Activities	***Topic Information*** • What is soil? • Why is soil important? • How is soil made? ***Activities*** • Activity #3 - How much soil is there? • Activity #4 - Is it organic matter? • Activity #5 - Shake it to make it • Activity #6 - Underwear soil test	30 min + Activities
At Home Activity	Choose one Before the Next Meeting activity to complete.	5 min
Wrap up, Adjournment & Social Time!		10 min

Electing Your Executive

Elections can be chaired by a youth leader, senior member or club leader. The person chairing the elections is not eligible for any positions.

Procedure:

1. All positions are declared vacant by the chairperson, who indicates this by saying “I’d like to declare all positions vacant.”
2. The group decides on the method of voting (i.e. show of hands, ballot or standing).
3. The chairperson accepts nomination from members for each position being filled. Nominations do not require a seconder. Nominations are closed by motion or declaration by the chairperson.
4. Each member nominated is asked if he/she will stand for the position. Names of members who decline are crossed off.
5. Voting takes place by selected method and majority rules (i.e. member with most votes).
6. Announce the name of the successful member. Offer congratulations and thank all others that ran for the position.
7. If ballots are used, a motion to destroy the ballots is required and voted on.

Steps in Making a Motion

The motion is a very important key to having good meetings. Motions are a way of introducing topics for discussion and allowing each member to speak and vote. Any member can make a motion.

Steps in Making a Motion:

1. Address the chairperson (i.e. raise your hand).
2. Wait for the chairperson to acknowledge you.
3. Make the motion: "I move that…"
4. Another person seconds the motion: "I second the motion."
5. Chairperson states the motion.
6. Chairperson calls for discussion of the motion.
7. Chairperson restates the motion.
8. Chairperson calls the vote: "All in favour? Opposed?"
9. Chairperson announces the result of the vote: "Motion carried" or "Motion defeated."

Topic Information

What is soil?

Soil is the loose upper layer of the Earth's surface where plants grow. Soil consists of a mix of organic material (decayed plants and animals), broken bits of rocks and minerals, air and water.

Soils are complex mixtures of minerals, water, air, organic matter, and countless organisms that are the decaying remains of once-living things. It forms at the surface of land – it is the "skin of the earth." Soil is capable of supporting plant life and is vital to life on earth.

What are the ingredients to make soil?

To remember what soil is made up of, think of the acronym IOWA
- I - inorganic materials (minerals, rocks)
- O - organic materials (decomposing leaves, insects and wood)
- W - water
- A - air

Organic matter

Organic matter, or humus, is made up of living organisms such as live plants and animals, dead plants and animals, and nutrients that have come from decomposed plants and animals. Organic matter makes up only a small fraction of the total materials in soil, yet it is extremely important. If you pick up just a small handful of soil, you likely hold millions of different microscopic forms of life!

Why is soil important?

At first you may think of soil as just dirt. However, soil plays a very important role in supporting life on Earth.

• Plants - Many plants need soil to grow. Plants use soil not only for nutrients, but also as a way to anchor themselves into the ground using their roots.
• Atmosphere - Soil impacts our atmosphere releasing gasses such as carbon dioxide into the air.
• Living organisms - Many animals, fungi, and bacteria rely on soil as a place to live.
• Nutrient cycles - The soil plays an important role in cycling nutrients. This is the movement and exchange of organic and inorganic matter back into the production of living matter.
• Water - The soil helps to filter and clean our water.

Fun Fact
Soil by the Numbers!
• It takes 500 years (or more) to form one inch of topsoil.
• As many as 5,000 different types of bacteria are found in one gram of soil.
• .01 percent of the earth's water is held in soil.
• 15 tons of dry soil per acre (0.404686 hectares) pass through earthworms each year.
• 1,400,000 earthworms can be found in an acre of cropland (depending on crop rotation, tillage).

How is soil made?

It takes several thousand years to turn rock dust, gravel or clay into soil. Most of the soils in Ontario are thousands of years old. Most of the soils in Huron County (located along the shores of Lake Huron) are approximately 10,000 years old!

How long it takes to make soil depends on the climate, time and the number of earthworms, bacteria, fungi and plant roots present. But it all begins with rocks, also known as parent material.

Five factors have a part to play in forming soil:

1. ***Climate:*** The sun, rain and wind help to break up the rocks and biota (plants and animal life) into tiny pieces so they will begin to form soil. The warmer the climate is, the faster the rocks will break down.
2. ***Biota*** (flora and fauna of the area): Flora is the plant life occurring in a particular region or time; the corresponding term for animal life is fauna.
3. ***Relief:*** Elevation or evenness of the ground.
4. ***Time:*** It takes hundreds of years to make soil.
5. ***Parent material:*** The rocks and sediment from which the soil is made.

Every soil originally formed from parent material. The material could have been bedrock that weathered in place or smaller materials carried by flooding rivers, moving glaciers or blowing winds. Over time, sun, water, wind, ice, and living creatures help change the parent material into soil.

The weathering of rocks:
The weather helps make soil. Weather elements (such as freezing and thawing), temperature, rain, winds, waves and water pressure all cause rocks to break up into tiny pieces which eventually become soil.

This is how rocks are weathered:

1. When the weather gets hot, rocks can get bigger. When the weather turns cold, rocks can get smaller. The sun's energy can heat up rocks to very high temperatures. This causes rocks like granite to expand. As temperatures fall, the rocks cool down and contract. Continuous expansion and contraction causes pressure on the outer layers of the rock. Cracks develop as a result, and eventually, the outer layers of the rock wear off.
2. In Canada, glaciers scraped across the rock. The glacier's weight, combined with its gradual movement (grinding), drastically re-shaped the landscape over hundreds and thousands of years. The ice eroded the surface and carried broken rocks and soil debris far from their original places.
3. Rain and ice can also get into rocks and break them apart. Winds, water and waves pound on rocks and wears them out. Continuation of this action causes larger rocks with rugged surfaces to smoothen. During runoff, water carries sand and smaller debris and smashes them against larger rocks in their path. The resulting scraping causes wearing of rocks.
4. When all of this kind of weathering of rocks happens often enough, the rocks will crack and break up into small pieces that break into even smaller pieces.
5. When they get really small, the rocks form the base that could develop into soil. It is not a soil on its own as soil also requires organic matter.

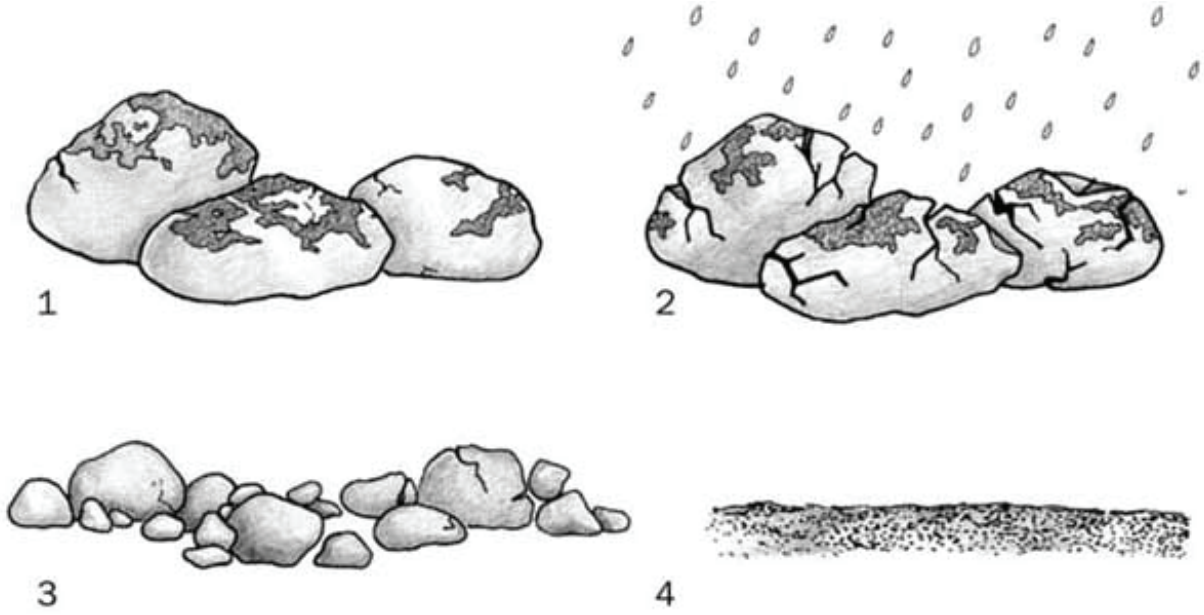


Image credit: Gale Science in Context http://ic.galegroup.com

Soil Biology

Soil biology refers to all the things living and growing in the soil. This includes earthworms, bugs, microbes and fungi. It is important to have more things living in the soil as this helps improve soil structure and the availability of nutrients for the plants. While earthworms and bugs are easy to find by digging in the soil, a lot of the stuff living in the soil is way too small for us to see with our naked eye.

To measure how many of these tiny organisms are living in the soil, food can be placed in the ground and the amount eaten or gone after a period of time will tell you where there are more things eating. There is a scientific test that uses cotton swatches to measure activity. The cotton provides carbon for the microorganisms. You will get a chance to do this test using men's underwear! You will bury it in the soil, and after two months, the underwear can be dug up and the more that has been eaten (or that has disappeared) means the more microbes there are in the soil. A healthy soil will result in the underwear being mostly or completely "eaten", but an unhealthy soil will result in the underwear remaining intact.

Videos (optional)

• What is Soil? https://www.youtube.com/watch?v=I6HGPoQ3dZY
• Biology of Soil in Canada http://www.agr.gc.ca/eng/news/science-of-agricultural-innovation/biology-of-soil-in-canada/?id=1438269490047

Additional Resources

• Soils Ontario (OMAFRA) http://www.omafra.gov.on.ca/english/landuse/gis/soils_ont.htm
• Soil (Natural Resources Canada) http://www.nrcan.gc.ca/forests/canada/conservation-protection/13205
• Canadian Soil Information Service (Agriculture & Agri-Food Canada) http://sis.agr.gc.ca/cansis/
• Canadian Society of Soil Science http://csss.ca
• Soil Quizzes (University of British Columbia) http://soilweb200.landfood.ubc.ca/quizzes/
• Soil Conservation Council of Canada http://www.soilcc.ca
• Interactive Video Game: The Dirt on Soil (Discovery Education) http://school.discoveryeducation.com/schooladventures/soil/soil_safari.html

BEFORE THE NEXT MEETING

Try one of the following activities.

1. ***Take a decomposition hike:*** Look around outside of your home (or nearby) and notice where the leaves pile up and where they don't. Why is that the case? Does the wind blow them to certain areas? Do they decompose faster in some places than others? Report back your observations to club members at the next meeting.

AND/OR

2. ***Experience decomposition in action***: Leave a banana peel outside where you can observe it each day. Predict how many days it will take before the peel completely disappears. Go back and check each day to see what happens. Is anything eating the banana peel? How will it disappear? Will the peel just get shorter? Will the stem last longer than the rest of the peel? Share your observations with club members at each meeting (and take photos, too!)
.

MEETING 1 DIGGING DEEPER

DIGGING DEEPER #1

For Senior Members

Soil is one of our most important and useful natural resources. From soil we get food, clothes and materials for the houses we live in. We get vegetables and fruits. Trees give us lumber and the wood can be used to make paper, paints and other products. Wheat and corn are used to make flour to make our bread, crackers, pasta, and so many other foods. Nuts and berries come from our farms and forests. Our animal food also comes from the soil. Cows eat grass, hay, and grain to produce milk, meat, and leather products. All animals eat plants; and plants grow in the soil. Most everything can be linked back to the soil.

Activity

Pick any one of the objects listed below, and using a flow chart, (a flow chart uses lines and arrows to show the relationships or direction of flow between an object or group of objects) connect the objects back to the soil.
Example: A plastic jug

Feel free to draw the objects, too!
Draw a flow chart back to the soil for…
- Butter
- Pizza
- Cereal
- Pickle
- Book
- Leather shoes

Activity and images courtesy of Utah Agriculture in the Classroom
http://utah.agclassroom.org/files/uploads/estore/unit_dirt.pdf

DIGGING DEEPER II

For Senior Members

In time for the next meeting, research a soil lab where you will send a soil sample (to be collected at the next meeting) and the types of soil tests available at that particular lab. Be prepared to share this information at the next meeting for the group to decide what to test. See resource at the end of Meeting 2: Accredited Soil Testing Laboratories in Ontario.

DIGGING DEEPER III

For Senior Members

Research one career in soil using online resources. Find your own resources or consider these web links. Be prepared to share your information with club members at the next meeting.

a. Soil Scientist: http://www.eco.ca/career-profiles/soil-scientist/
b. Soil Conservationist: http://www.eco.ca/career-profiles/soil-conservationist/
c. Agrologist: http://www.eco.ca/career-profiles/agrologist/
d. Agronomist: http://www.eco.ca/career-profiles/agronomist/

ACTIVITIES

Activity #1

Get to Know Each Other Activities

Select either activity to introduce members to each other and to begin the group bonding process.

• ***Finish the sentence*** (activity found at the end of Meeting 1 activities): Have a list of incomplete sentences on a handout- one handout per member- as they walk around the room to each member asking each to complete one of the sentences and writing down the name of the person who completed the sentence. See handout at the end of this meeting.

• ***Me too!:*** One person says her or his name and starts to describe herself or himself. As soon as another person hears something in common, that person interrupts, giving her or his name (e.g., "I'm _____ and I have two older sisters, too"). Then that person begins a self-description until yet another person finds something in common and interrupts in turn. Continue until everyone in the group has been introduced.

Activity #2

Get to Know Each Other Activities

Public Speaking/Judging

Choose either a public speaking activity OR a judging activity.

Public Speaking Activity

If you could only grow one crop for yourself or to sell as a farmer, what would that crop be?

• You have one minute to think about your answer;
• You have one minute to share with the group your answer with reasons; and
• Remember: An important part of critical thinking is learning to give reasons; this is your chance to explain why you made your choice. You don't have to agree with everyone else, but you do have to have an organized and thoughtful explanation of your choice.

ACTIVITIES

Judging: Give Reasons

Giving reasons can be the most rewarding part of the judging process but it takes practice- and confidence! The ability to give a good set of reasons depends on knowing what you're looking at, knowing the right words to use, knowing the right way to give your reasons and being able to convince everyone that you're right!

How to give reasons

1. Reasons should be short, clear and convincing. They shouldn't take more than two minutes to give.
2. Stand straight and look right at the person to whom you are speaking.
3. Start by naming the class and giving the order of placement.
4. Explain why you placed the first over the second, the second over the third, and the third over the last.
5. Never go back. Say everything you want to say about one placing and then move on to the next one.
6. Keep a clear picture in your mind of what you are judging.
7. Be positive. Talk about the important points that were better in each exhibit.
8. Don't be too hard on the exhibit that was the last. Talk about two or three things that were wrong and then quit.
9. Speak loudly enough for the judge to hear you and with confidence.
10. Know the right words to use and use them correctly. Don't get stuck using the same words over and over.
11. Always do your best.

Judging Activity

Judging is really comparing objects, whether they are seed samples, pencils or anything else. You are judging when you decide which pair of jeans to buy. Select from one of these two judging activities:

1. Judging apples (if you are doing Activity 1- How much soil is there, use the same apples for both activities) Consider: What are the qualities you look for in an apple? What are you looking for when judging? Why do you think one apple is better over another one?
2. Use any item(s) on hand to give members a chance to practice the art of judging and to receive constructive feedback on which to build their skills and confidence.

You can probably think of a lot more questions to ask yourself when you are thinking of the perfect apple or any item. That's how you start to learn how to judge.

Activity #3

How much soil is there? (10 minutes)

Objective:
• To learn the importance of soil as a limited, natural resource.

Materials:
• Apple(s)
• One sharp knife (for leader demonstration) or plastic knives (for member participation)
• Cutting board(s)
• Paper towels

Instructions:
Club leader(s) can demonstrate the activity to the members or provide each member with his/her own apple/materials to follow along.

1. Pretend that this apple is planet Earth. Notice how its skin hugs and protects the surface. Cut the apple in quarters. Three of the four quarters represent how much of the earth is covered with water- oceans, lakes, rivers, and streams. Set three of the four quarters aside. Discuss: Do you know what percentage that is?
2. Left is just one quarter (25 percent) representing the portion of our earth that is dry land. Take this quarter and cut it in half. One of these halves represents land that is desert, swamps, polar, or mountainous regions where it is too hot, too cold, or too high for humans to be productive. Set this half aside.
3. The other half (one-eighth or 12.5 percent of the apple) represents where humans can live and grow crops. Slice this section lengthwise into four equal parts. Now you have four 1/32nds (3 percent each) of an apple. The first of these represents land too wet for food production. It isn't swamp land, but it may flood during the growing season. The second section represents land that is too rocky and poor to grow food. A third 1/32nd represents areas that are too hot. Set these three sections aside.
4. The last section (1/32nd or 3 percent of the apple) represents the area of the world developed by humans. Now, carefully peel the last 1/32nd section. This small bit of peel represents the portion of our planet that is soil on which humans depend for food production and similar uses. So, like water and air, soil is a very important and limited natural resource!

Discussion:
All living things depend on soil to live.
• What are some of our important natural resources?
(Your answers might include materials such as oil, water, coal, trees, animals, and gold. All of those are important natural resources, but we often forget to mention one of our most important natural resources: soil.)

• Are you surprised how little soil there is in the world in which to grow food and other crops?
• With good quality soil being so limited, what do we all need to do to ensure this valuable resource is available to future generations? (You will learn more about this as you progress through the Loyal to Soil project!)

Activity #4

Is it organic matter? (10 minutes)

Objective:
• To learn the difference between organic and inorganic matter.

Materials:
Any combination of the following organic and inorganic materials:
• Leaves and twigs
• Compost
• Soil
• Sand
• Minerals
• Rocks
• Metals

Instructions:
1. Put each of the types of organic/inorganic matter in their own pile.
2. Ask members to feel/look at each pile and to decide if it is organic or inorganic matter and how they decided.

Discussion:
• What is organic matter versus inorganic matter? Did you notice a difference between items that have been produced by/associated with living organisms versus items created by non-living natural processes or human intervention?
• Think about the ground of a forest (or visit one as a club). What is happening to the soil under all of those leaves and other natural items?
(In a forest, leaf litter and woody material falls to the forest floor. When it decays to the point it is no longer recognizable, it is called soil organic matter. When the organic matter has broken down that resists further decomposition, it is called humus.)

Activity #5

Shake it to make it (10 minutes)

Objectives:
• To learn about and experience how soil is made.

Materials:
• Cans with plastic lids
• 2-3 small, rough-edged rocks per container

Instructions:
1. Collect (or have pre-collected, dependent on time) some small, rough-edged rocks.
2. Put them in a can with a plastic lid and shake them, vigorously! When you get tired, pass it on to your partner to continue shaking. You will need to shake the rocks in the can for at least five minutes.
3. Carefully, open the can and run your finger around the inside of the can. What do you feel? You've just made sand!

Discussion:
• What happened to your rock? Are the edges worn down a bit?
• How long would it take to turn those rocks into sand/soil? (Thousands of years.)

Activity #6

Underwear Soil Test (Day 1- 20 minutes; Day 2- 30 minutes)

Visit the Innovative Farmers Association of Ontario website at:
http://www.ifao.com/soil-health to view a video about this activity.

Objective:
• To measure how many organisms are living in the soil

Materials:
• Clean pair of new 100% cotton underwear (one pair per location)
• Shovel

Preparation:
Prior to starting the experiment, choose differently managed fields and predict how much of the underwear will be gone after the decided period of time. When the period of time has elapsed, dig up the underwear and compare between the different fields.

Instructions:

1. Sites for the test should have similar soil types, however under different management (i.e. pasture, no till, conventional till, with and without cover crops, continuous crop vs. three-year rotation).
2. For each location you wish to test, you will need one pair of new, washed 100% cotton underwear (except for the waistband).
3. Write an identifying number or name on the waistband of each pair. Optional: Weigh each pair of underwear and record values.
4. Dig a small trench in the field where you want to place the underwear.
5. Place underwear on the end of the shovel and slide it into the trench so it is completely under the soil surface save for the waistband.
6. Cover the underwear with soil so it is completely buried, with only a portion of the waistband above the soil surface.
7. Place a stake or flag next to where the underwear is buried to ensure you will find it.
8. Leave all underwear for the same amount of time (recommended: approximately two months).
9. When ready, dig up underwear carefully to avoid ripping severely decayed pieces. Optional: Wash underwear gently to remove soil, allow to dry completely and weigh again.
10. Compare weights of underwear from start to finish, including the changes in weight between fields.

Discussion:

After two months the underwear can be dug up.

- How would you describe the condition of the underwear?
- What do you think the condition of the underwear should tell you about the condition of the soil?
- Compare the results between the different fields. Are there any differences? Explain.

Explanation:

The more that has been eaten (or that has disappeared) the more microbes there are in the soil. A healthy soil will result in the underwear being mostly or completely “eaten”, whereas an unhealthy soil will result in the underwear remaining intact.

Activity courtesy of OMAFRA http://www.omafra.gov.on.ca/english/crops/hort/news/hortmatt/2015/22hrt15a2.htm

Finish the Sentence

1. If I could travel anywhere in the world, I would go to _____

Name:

2. Last night I _____

Name:

3. My favourite breakfast food is _____

Name:

4. The hobby I'm most obsessed with is _____

Name:

5. By the time I'm____ years old, I want to _____

Name:

6. If I won the lottery, I would _____

Name:

7. On the weekend, I will _____

Name:

MEETING 2 - Soil is Not a Dirty Word

Objectives:

- Learn what is in soil and the importance of each part that makes up soil.
- Learn the importance of high quality soil for best growing results.
- Determine the type of soil one has by practicing basic test methods.

Roll Calls

- Do you think soil is important? Why or why not?
- Other than farming, what are some other uses for soil?
- (Senior Members) What did you learn about careers in soil?
- (Senior Members) Which soil lab did you research? Why did you select this lab?

Sample Meeting Agenda – 1 hrs. 20 minutes plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	10 min
Judging Activity	Activity #7 - Judging: Soil Samples	10 min
Topic Information, Discussion & Activities	***Topic Information*** • Soil profile • Texture; Structure; Porosity; Colour • Abuse of soil ***Activities*** • Activity #7 - Three methods to identify soil texture by feel • Activity #9 - Gathering a soil sample • Activity #10 - Guest speaker: soil expert • Activity #11 - Particle size demonstration • Activity #12 - Soil air • Activity #13 - Soil profile	30 min + Activities
At Home Activity	Choose one At Home activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

Soil Profile

If you take a picture of yourself from the side, it is called a profile. Well, soil has its own profile too! Soil is made up of distinct layers, called horizons. Each layer has its own characteristics that make it different from all of the other layers. These characteristics play a very important role in what the soil is used for and why it is important. There are five soil horizons (A, B and C) with possibly two more.

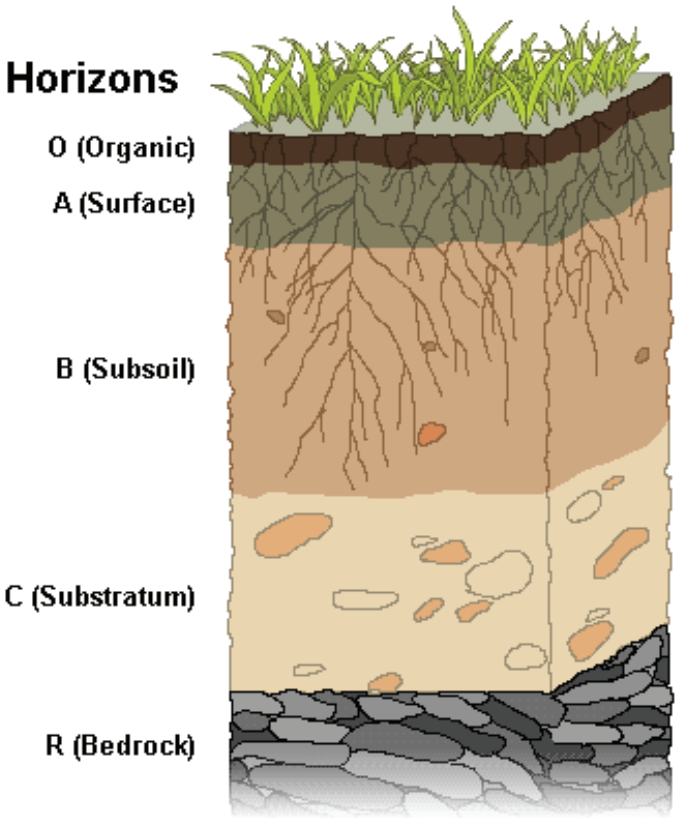


Image Credit: https://en.wikipedia.org/wiki/Soil_horizon

O- Organic Layer

This layer is made up of living and decomposed materials like leaves, plants and bugs similar to the layer of decomposing leaves on top of the soil in a forest. But, most agricultural soils have this mixed in with the A (Topsoil) horizon.

A- Topsoil (Surface Horizon)

This is the layer that we call “topsoil” and it has the most organic matter and soil life. It is located just below the O Horizon. This layer is made up of minerals and decomposed organic matter and is dark in colour. This is the layer that many plant roots grow in.

B- Subsoil Horizon

This layer has clay and mineral deposits and fewer organic materials than the layers above it. This layer is also lighter in colour than the layers above it. There are fewer living things and not very much organic matter. There is little food for plants to take up.

C- Parent Material (also known as Substratum)

Parent material is the material that soil develops from and may be rock that has decomposed in place, or material that has been deposited by wind, water or ice.

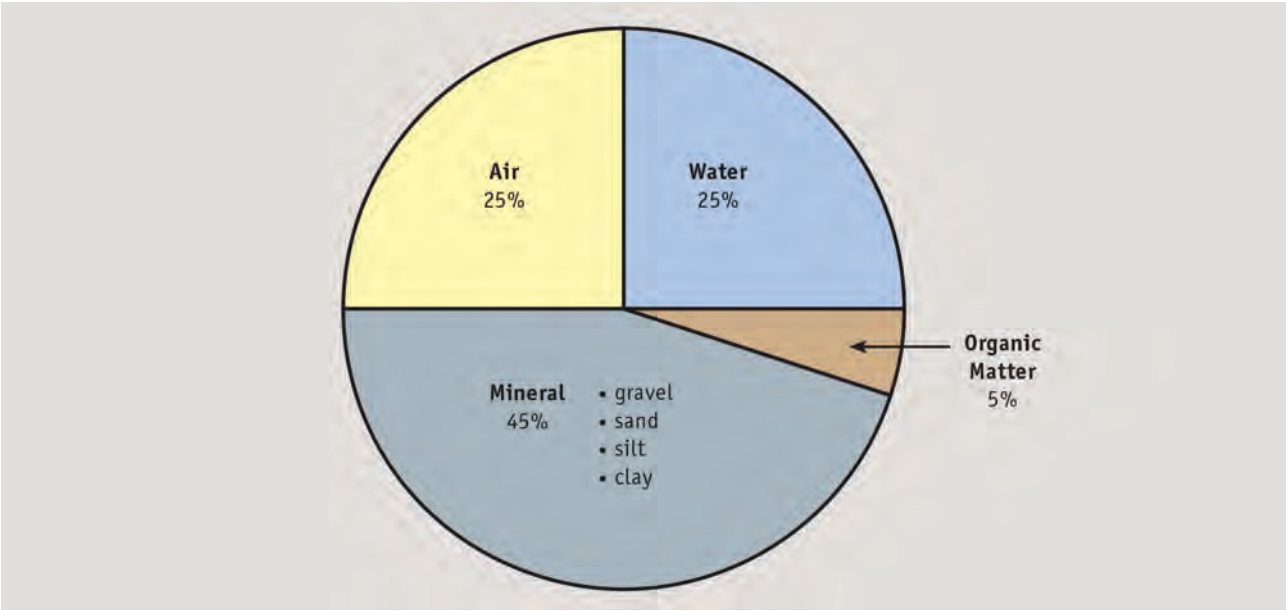
R- Bedrock

Bedrock is the hard, solid rock beneath surface materials such as soil and gravel. Bedrock also underlies sand and other sediments on the ocean floor. Bedrock is consolidated rock, meaning it is solid and tightly bound. In Ontario the depth of bedrock can range from a few inches to several hundred feet below the other soil horizons.

Topsoil

Did you know that one teaspoon of soil can have millions of organisms in it? These organisms can be simple bacteria and fungi or they can be earthworms and insects.

The ***ideal*** topsoil for growing most plants has 45% mineral matter (from the parent material), 5% organic matter, 25% water and 25% air. This is called mineral soil because it has a lot of minerals in it. Farmers and gardeners are always working hard to have this balance, but it is difficult to achieve or to maintain. As you progress through the Loyal to the Soil project, you will learn many reasons why it's so hard to have ideal soil.



This is the "ideal" soil to have.

Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Sometimes there is more than 5% organic matter in soil. When there is more than 30% organic matter in the soil and the topsoil is more than 40 cm (16 inches) deep, the soil is called organic soil. There are three kinds of organic soil: peat, muck and bog.

Fun Fact

Organic soils are usually found in low-lying areas and they are usually marshy, waterlogged areas such as the Holland Marsh. To grow crops in organic soil, a farmer has to drain some of the water away using drainage ditches and drainage tiles.

Texture

Pick up a small amount of soil and rub it between your fingers. Does it feel coarse? Does it feel like sugar or finer like flour? What you're feeling is the soil texture. There are three size fractions considered in determining soil texture: sand, silt, and clay. Sands are the most apparent to us because the individual particles are visible. At the other extreme are the clays, which are much smaller. A single gram of coarse sand would have approximately one thousand particles. A gram of clay would have approximately ninety billion particles. Silts are in the middle, but behave much more like small sand grains than clays.

A particle of sand is about 2mm to .05mm
A particle of silt is 0.05mm to 0.002mm
A particle of clay is less than 0.002mm
(In comparison, the lead in a pencil is about 2 mm thick and a dime is 1mm thick.)

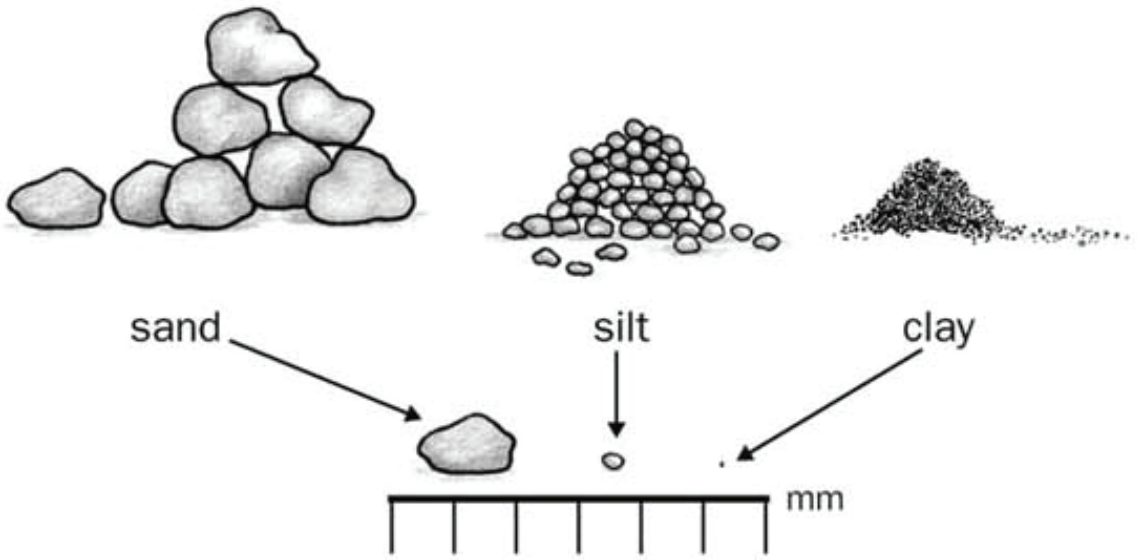


Image credit: Gale Science in Context http://ic.galegroup.com/ic

Soil texture in most fields is highly variable. It also changes dramatically within the soil profile. When assessing soil-texture related problems, such as drainage, it is valuable to identify the soil texture at depths below the plow layer.

A shovel, soil probe or soil auger will give easy access to the soil profile for texturing.

Soil Texture Triangle

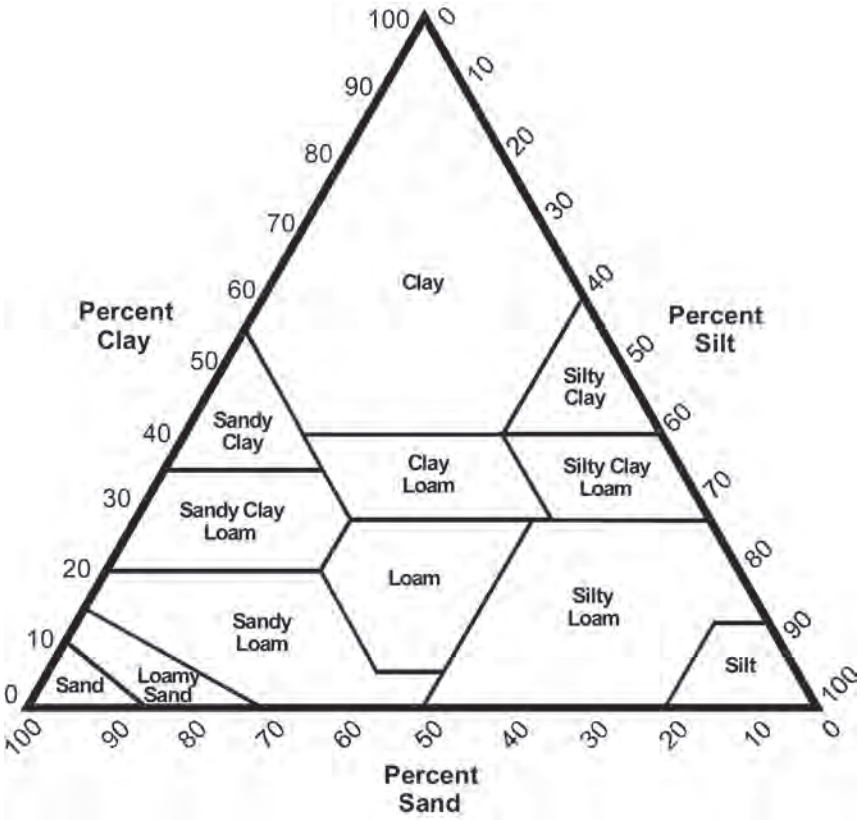


Image Credit: OMAFRA Soil Fertility Handbook Publication 611 (2006) http://www.omafra.gov.on.ca/english/crops/pub611/pub611.pdf

Structure

The way soil particles fit together in a soil is called soil structure. Soil structure is very important because it controls how air and water move through the soil and how wind and water could erode it. It also determines how well soils will drain, hold moisture, and support plant growth.

A good soil structure has lots of space for air and water. One way you can make a soil's structure better is by adding more organic matter, such as animal manure, green manure (plow-down crops) or the stubble and root residues of current crops, and other organic amendments like compost. It can also be improved by reducing tillage and foot traffic.

Well-structured soil versus poorly structured soil

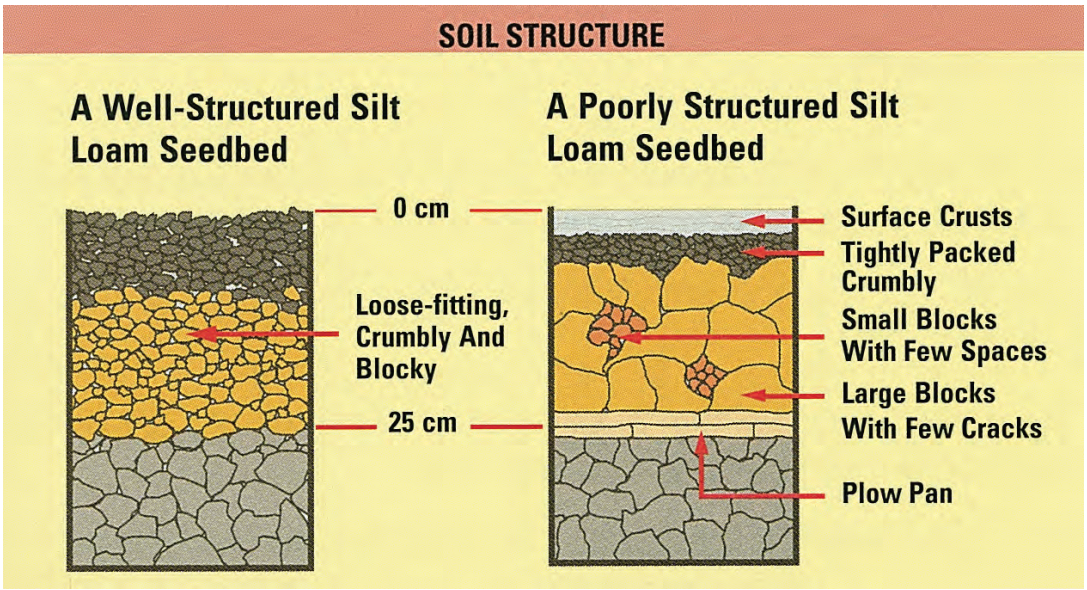


Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Management (1997)

Porosity

Soil porosity refers to the amount of open space (pores) between soil particles. In between the soil particles there is space for air and water. Having lots of space between soil particles means the soil will drain better and there will be more air in the soil which is important for plants. Roots also have an easier time growing in coarse soils. What affects pore spaces in soil? Movement of roots, worms, and insects help to create more spaces; soil texture can also affect soil porosity. Ideal soil is composed of about 50 per cent solids (sand, silt, clay and organic matter) and about 50 per cent pore spaces.

Colour

The first thing you notice when you look at soil is its colour. The colour of soil can tell you a lot about it. So, if you had your choice, would you want your soil to be gray, red, white, black or brown? Generally speaking, the darker a soil is, the more organic matter in the soil. However, it does not really indicate fertility which can be checked with a soil test.

Geologists officially recognize over 170 different soil colours. Most of these are shades of black, brown, red, gray, and white.

Fun Fact
Paint stores have colour chips and soil scientists use a book of colour chips, too! It is from the Munsell System of Color Notation (www.munsell.com) and it allows for direct comparison of soils anywhere in the world.

Abuse of Soil

Abuse of soil, called soil degradation, is the decline in soil quality caused by its improper use. There are many ways that soil can be abused, including:

- Erosion: (you will learn more about erosion in Meeting # 4: Water, water everywhere)
- Pollution: pesticides, heavy metals, salt, and other pollutants
- Soil Health: becomes poorer due to nutrient depletion, compaction, excess tillage, and loss of soil structure
- Urban Sprawl: building (houses, commercial buildings, etc.) on rural land

BEFORE THE NEXT MEETING

Try one of the following activities.

1.Start growing a plant from seed. Keep notes of your daily observations. Optional: You can even try growing the plant with different soils in different pots and compare the results. Bring your notes (and even your plant) to future meetings to discuss/share the progress. Or consider recording the results using photos or video.

AND/OR

2. Go to different fields where there are different crops. Take a look at the soil and the crop. Take notes and observe any differences. Talk with the farmer about the soil (and if you can, take a sample).

AND/OR

3. Find out what's in soil by doing this jar test. Get a large jar with a lid; add a few handfuls of soil; add water. Screw the lid on tight and shake the jar well and let is sit, undisturbed, for a few days. What happens?

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MEETING 2 DIGGING DEEPER

DIGGING DEEPER I

For Senior Members

Do sandy soils (with large pore spaces) need more water? Will sand, silt, or clay hold more water? Investigate how different soil types are impacted by water.

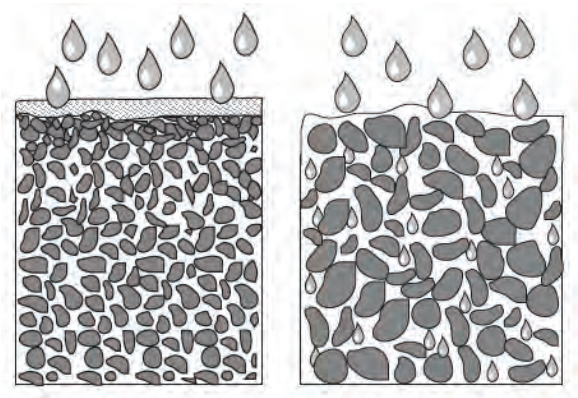


Image Credit: Oregon State University Extension Service http://extension.oregonstate.edu/gardening/soil-texture-determines-how-much-and-how-often-water

The difference is not how much water the lawn or garden uses but how much and how often it needs to be applied in coarse-versus-fine soils.

DIGGING DEEPER II

Senior members can fill out the soil testing form(s) required for the sampling decided by your club. Make sure the sample is collected correctly and accurately, as described in the soil testing forms and from the research you did last week.

DIGGING DEEPER III

For Senior Members

Either individually, in pairs or as a group, decide on a sample area close to your club meeting. Draw a map (by hand or computer). Label different areas on your map, for example: highway, homes, commercial buildings, farm, river, gas station, etc. Take a soil sample from each of these areas and create a coded list for all the soil samples as a key to the map. Test each sample by feel, getting it wet and rolling the soil between your fingers. Describe and record the texture and feel for each sample. When finished, analyze if there are any differences in the soils for each of the areas on your map. Explain why there might be any differences, if any.

ACTIVITIES

Activity #7

Judging Activity

1. Have different types of soil for members to examine using their senses of touch and sight to decide which of the soils is best to grow crops and why. Have members rub some of the soil between their index fingers and thumbs, feeling for the presence of sand, silt and clay. Ask them to describe what they are feeling and what they see. Be sure members wash/wipe their hands clean in between feeling the different types of soil. Tell members this is an introduction to the topic and activities they will learn in this meeting.

2. Alternatively, bring in any items (Leader or members) to judge.

Activity #8

Three Methods to Identify Soil Texture by Feel (15 minutes, each method)

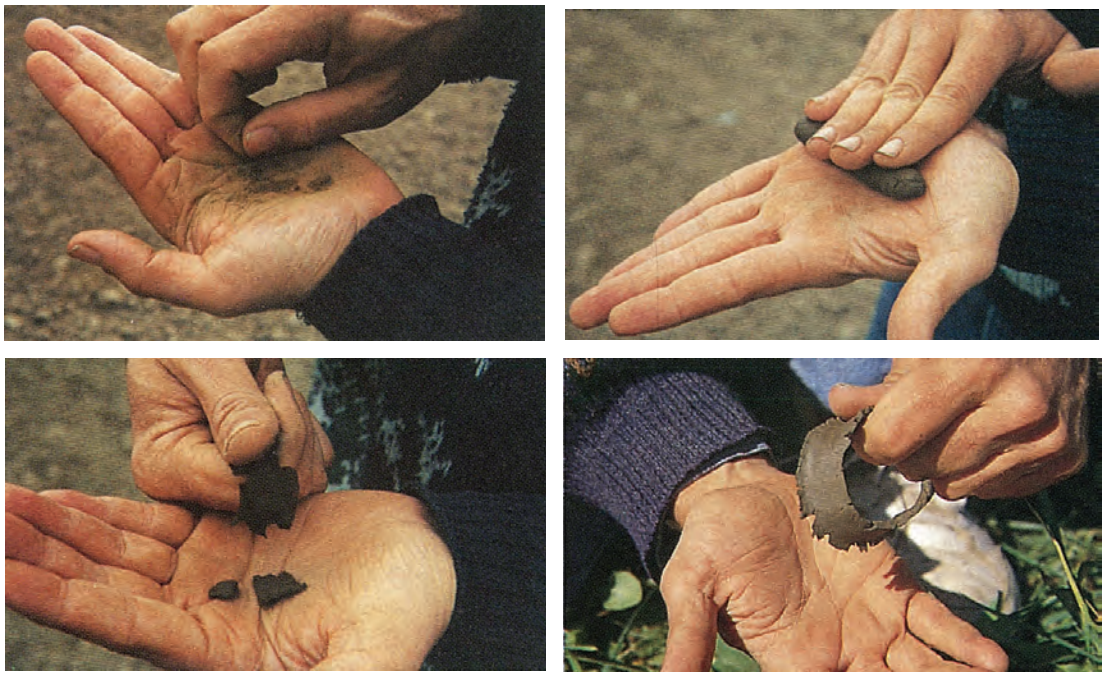


Image Credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Management (1997)

Objective:

• To practice identifying soil texture

Materials

• Soil samples: sand, silt, clay.

Instructions:

1. Have members do one or all three 'feel' tests listed below. Alternatively, divide members into three groups and ask each group to test each soil sample using only one method.
2. Members compare their answers.

Feel Test

Rub some soil between your thumb and fingers.

• If it feels gritty, it's sand.
• If it feels smooth, it's silt.
• If it feels sticky, it's clay.

Ball Squeeze Test

Take a handful of moist soil and make a fist (to turn the soil into a ball).

• If the soil holds together, it has clay in it.

Test how much clay is in the ball of soil by tossing it gently from hand to hand.

• Sandy soil breaks with slight pressure.
• Medium texture soils stay together but change shape easily.

Ribbon Test

Roll some moist soil into the shape of a pencil, then squeeze it between your thumb and index finger to form a ribbon.

• The longer and thinner the ribbon, the more clay there is in the soil.

Discussion:

• How would you identify the soil texture for each sample?
• Why would you want to do a feel test like this? What's the purpose?
• Which soil would you want to amend?
• How would you amend it?

Additional Resource:

Members can use the "Soil texture by feel flow chart" to determine the soil texture found at the end of this meeting.

Activity #9 - Backyard Brainstorm

Gathering a Soil Sample (30 minutes)

Objective:

• To learn the importance and value of testing soil; to learn how to take a proper soil sample.

Materials:

• A spade or trowel or soil probe
• Clean plastic containers
• Plastic bags
• Resource: Soil Sampling Reference Guide.

NOTE: Soil probes are available to borrow from the 4-H Ontario office.

Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Instructions:

1. Ask members to think about this statement: "***A soil test is only as accurate as the sample taken."***
2. Discuss the importance of taking a proper sample of soil and teach the steps to take a sample.
3. Discuss with members the various kinds of tests available and determine which tests the club will do.
4. Ask Senior member(s) to share their research about which lab to send the soil sample.

The basic steps to collect a soil sample are as follows:

1. Decide on the sampling area (the size of the area can affect the sample).
2. The normal sampling depth for nutrients is about 15 cm (6 inches), however, when sampling for soil nitrates, a sample down to a depth of 30 cm (1 foot) will provide a more accurate indication of the amount of nitrate available to the crop.
3. Collect a representative sample from the field, including enough cores collected randomly from across the entire area. Use a shovel or a spade, but a probe or auger is more accurate. NOTE: Soil probes are available to borrow from the 4-H Ontario office.
4. Often the most overlooked step in collecting a soil sample is the thorough mixing of soil cores before the sub-sample is collected. Sampled soil cores should be mixed in the bucket until no evidence of soil cores exist. Heavy clay soil cores sometimes need to be dried before they can be sufficiently mixed to allow for a suitable sub-sample. The sub-sample should be no more than 400 grams or about 1 cup of soil.
5. Store collected samples at room temperature, with the exception of soil nitrate samples, which should be kept cool (below 4°C) and delivered to the lab within one day for immediate analysis.

To find further information to accurately select, collect and submit a soil sample for testing, review the OMAFRA guide: Soil Sampling and Analysis for Managing Crop Nutrients (2006) at this web link: http://www.omafra.gov.on.ca/english/engineer/facts/06-031.htm

Alternatively, instructions for taking a soil sample can be found in the OMAFRA Soil Fertility Handbook (Publication 611) (2006), available from your 4-H Association Resource contact or by visiting: http://www.omafra.gov.on.ca/english/crops/pub611/p611order.htm to download a copy.

Discussion:

- Why is it important to use a plastic (or stainless steel) container to collect the soil samples? (Metal from other containers can contaminate the soil and alter the test).
- Why is it necessary to take samples from a variety of areas?
- Why bother to take a soil sample? Is it really necessary?

NOTE: the results of the soil test will be used for future meetings, especially the "Fertility Facts" meeting.

Additional Resource- See handout "Accredited Soil Testing Laboratories in Ontario" listing at the end of this meeting.

Activity #10

Guest Speaker (30 minutes)

Objective:
• To learn about soil from an expert and to learn about occupations in soil.

Materials:
• None

Instructions:
In advance of the meeting, invite a guest speaker who is an expert in soil to talk to the members not only about soil, but the various occupations in soil. Suggested guest speakers: professional agrologist (contact Ontario Institute of Agrologists), soil scientist, soil conservationist, certified crop advisor, farmer.

Discussion:
• Allow members to ask questions and participate in discussions.

Activity #11

Particle Size Demonstration (15 minutes)

Objective:
• To learn that not all soils have the same particle sizes.

Materials:
• 2 clear plastic water bottles (or mason jars) with lids
• Water
• Spoons
• Soils: sand, silt, clay.

Instructions:
1. Using the spoon, add clean sand to a plastic bottle filled with water.
2. Add silt and clay to the second bottle filled with water.
3. Shake each of the bottles and observe how long it takes for the particles to settle.
4. Observe the difference in the clarity of the water.

Discussion:
• Which soil settled quicker? Why did this happen?
• Which bottle of water is clearer after the soil settled to the bottom?
• What are you noticing is different between the particle sizes of the different soils?

Sand will settle rapidly. Silt and clay will settle more slowly. The water is mostly clear in the bottle with the sand. Note the sediment in suspension in the water of the silt and clay bottle.

Activity #12

Soil Air (15 minutes)

Objectives:
• To predict and demonstrate how much air is in different types of soil.

Materials:
• A can of spray polyurethane
• Some soil clods, (a soil clod is just a clump of soil that sticks together, not loose), clear jar half full of water.

NOTE: Be sure to get soil clod samples from both the surface of the soil and some from the subsoil.

Instructions:
1. Note whether you have a soil clod from the soil surface or subsoil. Spray the clod with the polyurethane and wait a minute or two before dropping it in the jar of water.
2. Watch the bubbles. Air will bubble from some clods for up to 20 minutes or more. Time how long it bubbles.

Discussion:
• What happened to your clump of soil (clod) after you dropped it into the jar of water?
• For how long did your clod bubble?
• Was there a difference between the air in the soil clod from the surface of the soil versus the subsoil?

Explanation:
• Soil clods from surface soils from orchards, pastures, and lawns generally will have a high soil air content and will bubble longer.
• Soil clods from subsoils, or soils from conventionally cultivated fields will generally have lower soil air content and will bubble less.

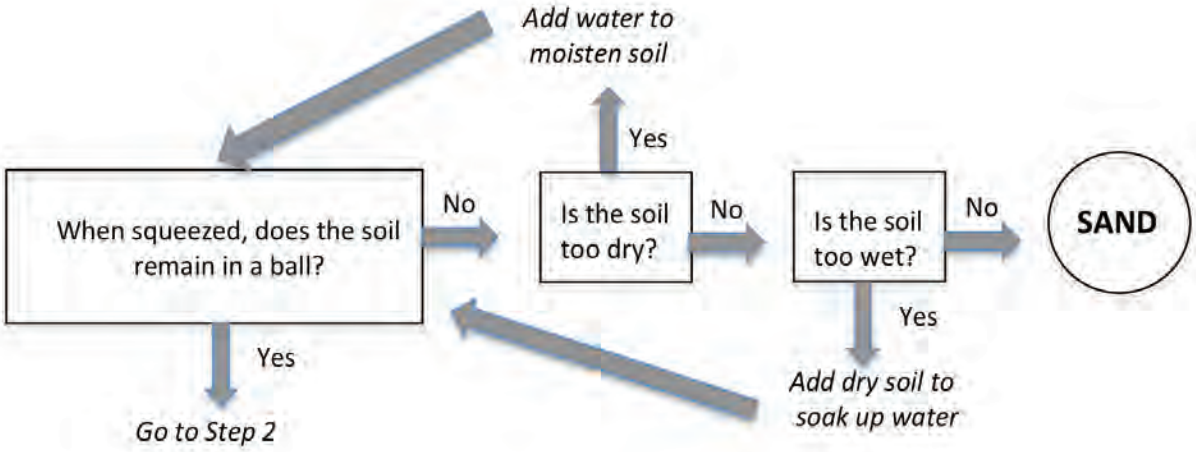
Soil Texture by Feel Flow Chart

Step 1: Ball test

Place approximately 25 g (about one to two tablespoons) of soil in your hand.

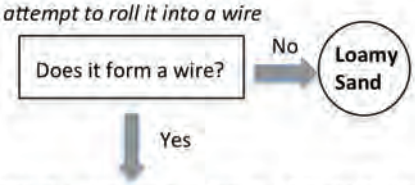
Moisten the soil and work it to break down all aggregates (this can be time-consuming in a clay soil).

Squeeze the soil and try to make a ball.



Step 2a: Wire test

Place soil in in your palm and attempt to roll it into a wire

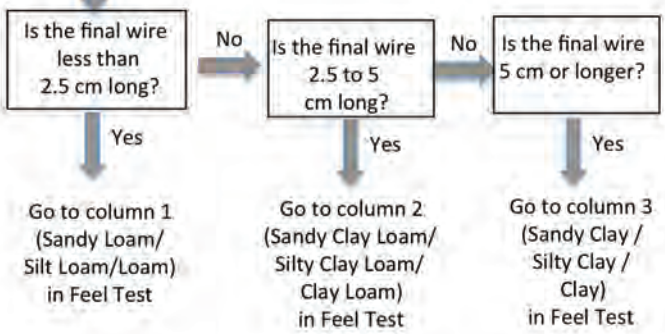


Dangle the soil from two fingers. A piece of the wire will break off.

Pick up the piece that dropped and dangle it again.

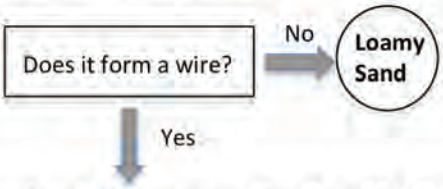
If it breaks again pick that piece up and dangle it again.

Repeat this process until the piece you are holding no longer breaks. Measure the length of this piece



Step 2b: Ribbon test

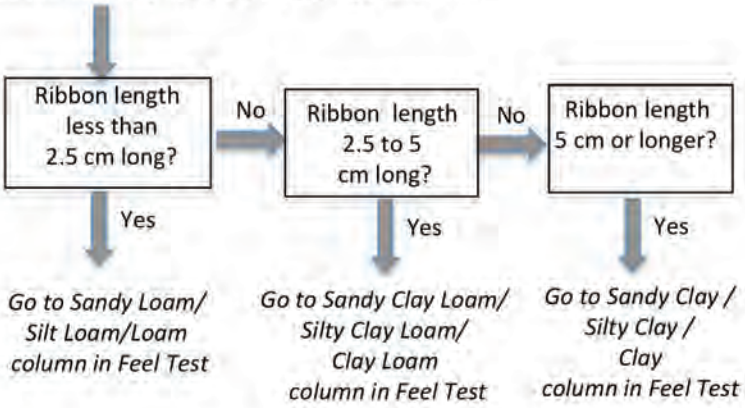
Place soil in in your palm and attempt to roll it into a wire.



Extrude the wire between your thumb and forefinger to form a ribbon.

Continue to extrude ribbon until it breaks.

Measure the length of the broken piece of the ribbon.



STEP 3: Feel Test

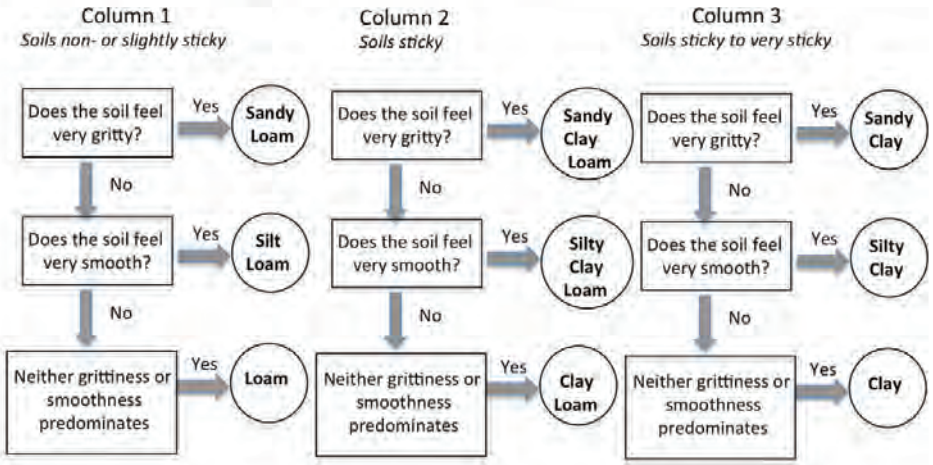
Select column based on Wire or Ribbon test

Wet a small amount of soil and rub between thumb and forefinger

Sand: Feels grainy/gritty; grains are visible for all but very fine grains

Silt: Non-sticky; feels smooth like flour or powder

Clay: Sticky –wet soil adheres to fingers and stretches before breaking when fingers are separated



Credit: Soils of Canada Field Handbook (2016) http://www.soilsofcanada.ca/fieldhandbookpdfs/Soil_Profile_Description.pdf

Accredited Soil Testing Laboratories in Ontario

(As of November 2016)

NOTE: Please check the OMAFRA website for a current list of accredited soil labs. http://www.omafra.gov.on.ca/english/crops/resource/soillabs.htm

Laboratory Name	Address	Telephone/Fax
A & L Canada Laboratories Inc. http://www.alcanada.com	2136 Jetstream Road London, Ont. N5V 3P5	tel: (519) 457-2575 fax: (519) 457-2664 aginfo@alcanada.com
Exova Canada Inc. (Ottawa) http://www.exova.com	8-146 Colonnade Road, Ottawa, Ont. K2E 7Y1	tel: (613) 727-5692 fax: (613) 727-5222
SGS Agrifood Laboratories http://www.agtest.com	200 White Mountain Drive New Bremen, OH 45869	tel: (519) 837-1600 1-800-265-7175 fax: (519) 837-1242 ca.agri.guelph.lab@sgs.com
Brookside Laboratories, Inc. http://www.blinc.com	200 White Mountain Drive New Bremen, OH 45869	tel: (419) 977-2766 fax: (419) 977-2767 jbrackman@blinc.com
University of Guelph, Laboratory Services http://www.guelphlabservices.com	University of Guelph P.O. Box 3650, 95 Stone Rd., West, Guelph, Ont. N1H 8J7	tel: (519) 767-6299 fax: (519) 767-6240 aflinfo@uoguelph.ca
Stratford Agri-Analysis http://www.stratfordagri.ca	1131 Erie St., Box 760 Stratford, Ont. N5A 6W1	tel: (519) 273-4411 1-800-323-9089 fax: (519) 273-2163 info@stratfordagri.ca
Activation Laboratories Ltd. http://www.actlabsag.com	41 Bittern Street Ancaster, ON L9G 4V5	tel: 905-648-9611 or 1-888-228-5227 fax: 905-648-9613 victoriapechorina@actlabs.com

The OMAFRA-accredited soil testing program is the main guide, along with help from plant analysis and nutrient deficiency symptoms, in determining the fertilizer requirements for a specific crop on a specific field. The OMAFRA-accredited soil-testing program provides assurance of appropriate analyses to support recommendations for nitrogen, phosphate, potash and magnesium fertilizer, along with recommendations for the amount and type of lime to apply. The analytical methods used are chosen to provide accurate results on the range of soils found in Ontario.

MEETING 3 - Fertility Facts

Objectives

- Recognize the different types of soil nutrients and their importance to soil and crop production.
- Describe the various methods to apply fertilizer.
- Learn what soil pH is and its importance.
- Compare and judge a variety of soil testing methods.

Roll Calls

- Do you think plants need fertilizer or can they grow without it? Why or why not?
- Do you think too much fertilizer can be used on a plant? Explain why you think this.
- Why do think farmers, gardeners and greenhouse owners use fertilizer?
- Name a type of fertilizer.

Sample Meeting Agenda – 1 hr. 15 minutes plus activities

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes and Business	5 min
Judging Activity	Activity #13 - Judging: Plants or Sample Crop	10 min
Topic Information, Discussion & Activities	***Topic Information*** • Food for plants: Fertilizers • Applying fertilizers • Soil pH • Fertilizers and the environment ***Activities*** • Activity #14 - Is it acidic or alkaline? • Activity #15 - Testing soil for pH • Activity #16 - Cabbage pH test	30 min + Activities
At Home Activity	Choose one At Home activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

Food for Plants: Fertilizers

Plants need food or nutrients to grow, just like we do. Some of the food plants need comes from air and water, but soil also has important nutrients that make plants grow. There are three major nutrients:
Nitrogen
Phosphorus
Potassium

Nitrogen gives plants lush, green, leafy growth.
• Too little: small, pale or yellow leaves.
• Too much: rapid growth, nitrogen burn, disease, pollution.

Phosphorus helps stimulate flower, fruit, and root growth.
• Too little: purplish leaves or stems, poor flowering, stunted growth.
• Too much: could cause deficiencies of iron or zinc, pollution.

Potassium helps with growth and disease resistance
• Too little: crispy brown leaf edges, curled lower leaves.
• Too much: poor quality for processing (e.g. Sugar beets).

Fertilizers: How much and what kind do you need?
Plants need a lot of nutrients to grow and sometimes we have to add them to the soil. The way you find out if your soil needs any of these nutrients is to have it tested at a lab. To get a soil sample from your field, you have to take a bit of soil from different parts of the field and mix them together. When you have your soil tested, you have to tell the lab what crop you are planning to plant in that field. Then, when the lab sends you the soil test report, they will tell you how much fertilizer you have to add to the soil in that field to grow a good crop. Having your soil tested before you plant can save you time and money because you will add only the amount of fertilizer you need to grow your crop.

You can also learn about the quantity and type of fertilizer needed for a specific crop by doing some research. For example, see the OMAFRA web page:
Soil Fertility and Nutrient Use: Fertilizer Recommendations (2009) http://www.omafra.gov.on.ca/english/crops/pub811/9fertilizer.htm

Alternatively, information can also be found in the OMAFRA Soil Fertility Handbook (Publication 611) (2006), available from your 4-H Association Resource contact or by visiting: http://www.omafra.gov.on.ca/english/crops/pub611/p611order.htm to download a copy.

Having you soil tested before you plant can save you time and money because you will add only the amount of fertilizer you need to grow your crop while protecting the environment from excess nutrients.

Macronutrients and Micronutrients

Micronutrients are just as important as macronutrients, but they are needed in smaller quantities.

Environment	Macronutrients	Micronutrients
Carbon	Nitrogen	Iron
Hydrogen	Phosphorus	Boron
Oxygen	Potassium	Manganese
	Sulfur	Copper
	Calcium	Zinc
	Magnesium	Molybdenum
		Chlorine
		Nickel
		Cobalt

Adding Nutrients to the Soil

One of the most common ways to add nutrients to the soil is to use a commercial fertilizer. On a bag of fertilizer, you will see the letters, N-P-K, which stands for:

N- Nitrogen,
P- Phosphorus
K- Potassium

The amounts of nitrogen, phosphorus and potassium are always listed on the bag in the same order. For example, if you see a fertilizer bag with the numbers “6-24-24”, it means there is 6% nitrogen, 24% phosphorus and 24 % potassium in that bag of fertilizer (on the basis of its weight). Fertilizer may be blended in many combinations of N, P and K. The fertilizer you choose will depend on what crop you are growing and how much nitrogen, phosphorus and potassium your soil already has in it.

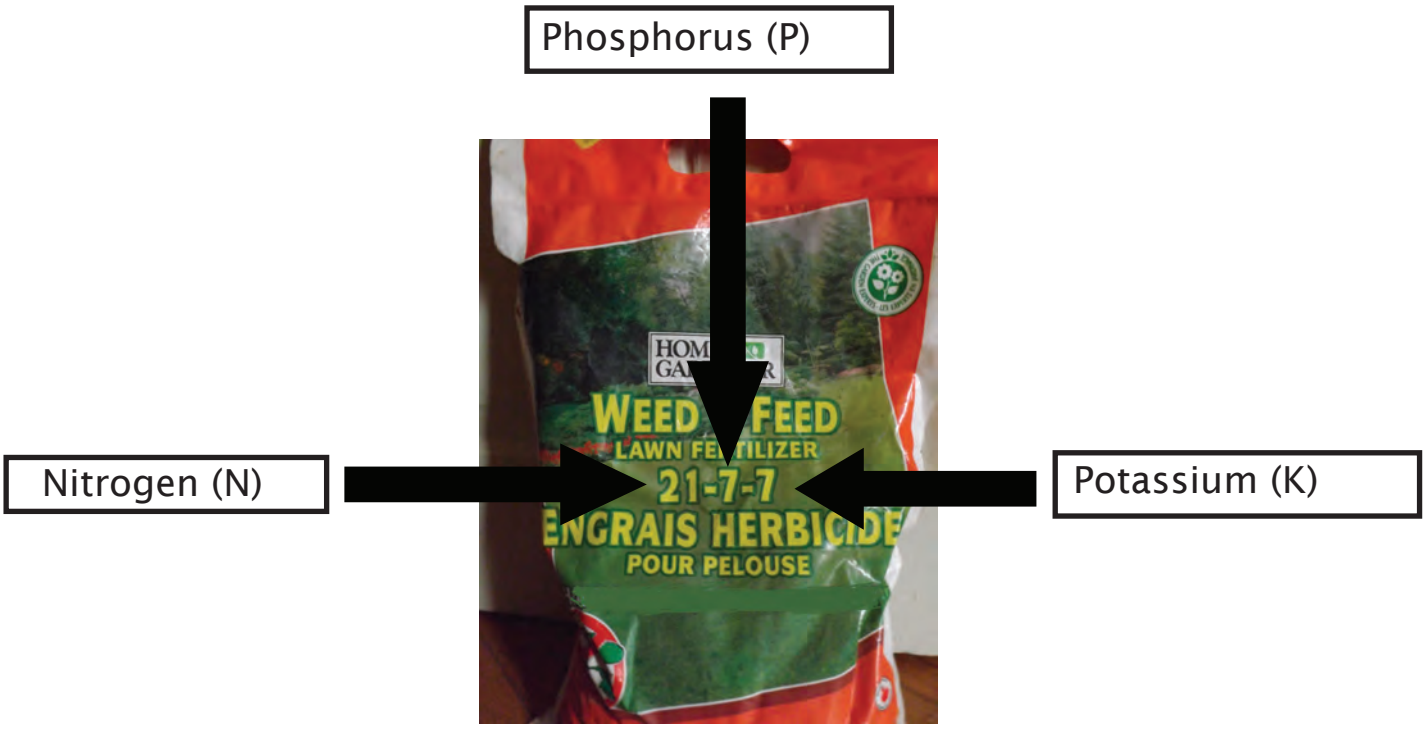


Image Credit: Elizabeth Johnston

Types of Commercial Fertilizers

What's the difference between organic and synthetic fertilizers?

• Synthetic fertilizers are manufactured to meet high standards of nutrient availability, and that they are generally highly soluble. Organic fertilizers are mixtures of naturally occurring ingredients. They both have the same nutrients, N-P-K, but come from different sources and may have different levels of fertility.

What is a quick release fertilizer?

• Fertilizers that provide nutrients to plants immediately.

What is a slow release fertilizer?

• Nutrients are released slowly over a period of time (e.g. 3 to 6 months).

Legumes & Manure as Nutrient Sources

Farmers can also use liquid/solid manure or plowed down sod to add nutrients to the soil. It must be a legume crop to be effective as a fertilizer. This resource should be used before commercial fertilizer is applied. If you use either manure or plow down crops, you can reduce or eliminate the amount of commercial fertilizer you will need to use on your fields while adding organic matter to the soil to improve the soil structure.

The value of manure in crop production is often underestimated. Manure contains all of the nutrients needed by crops but not necessarily in the proportions needed for specific soil and crop conditions. In addition to nitrogen, phosphorus and potash,

manure contains many secondary nutrients and micronutrients, as well as organic matter that help build and maintain soil structure.

Topsoil is basically composed of animal feces of varying ages. Soil animals, such as earthworms, ingest organic matter and mineral components of soil and mix them together before depositing the combined material as fecal pellets or casts.

Fun Fact
Worms are champion recyclers!
An earthworm can recycle its own weight in soil every 24 hours by eating and digesting plant material.

Image Credit: OMAFRA Vermicasting (or Vermicomposting): Processing Organic Wastes Through Earthworms Factsheet (2010) http://www.omafra.gov.on.ca/english/engineer/facts/10-009.htm

Fun Fact
How many worms do you think could live in one hectare (2.47 acres) of land?
A single hectare of land can contain 2.5 million worms or up to one million per acre!

Highly specialized microbes, mostly bacteria, are involved in the transformation of nitrogen through the nitrogen cycle. Nitrogen is essential for plant growth and microbial activity. The rate of the decomposition is governed by the availability of carbon and nitrogen.

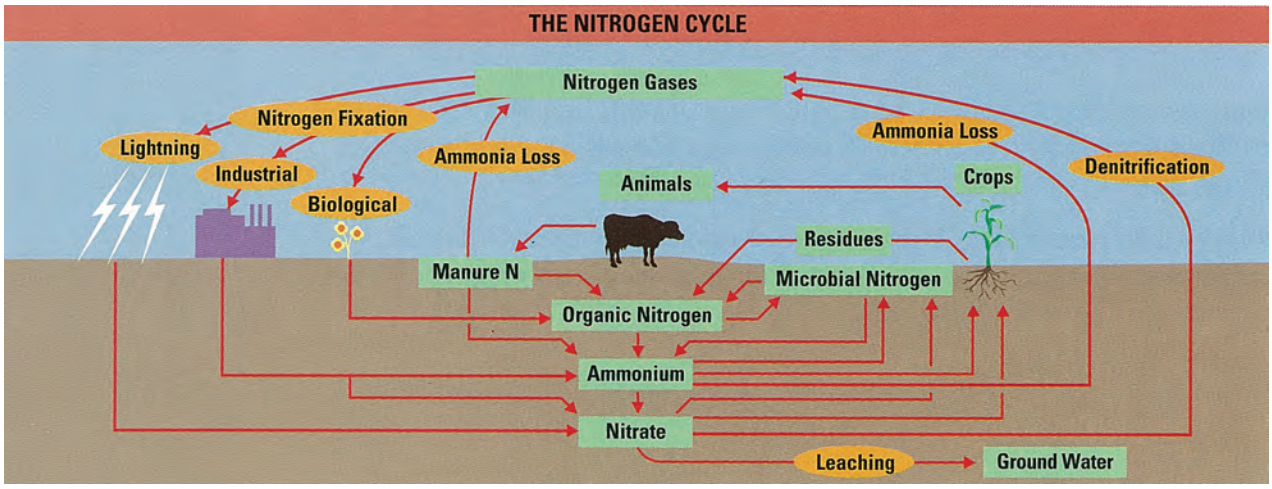


Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Management (1997)

Applying Too Many Nutrients

You can add too many nutrients. A successful fertility program is about achieving balance. If you apply too many nutrients, it can be potentially harmful to the crops; it is wasteful; and it can be harmful to the environment. Too many nutrients can harm the environment by:

• Contamination of water resources

• Eutrophication: A type of pollution that causes an explosive growth of algae that reduces the water of oxygen when the algae die and are eaten by bacteria. The water may become low in oxygen or completely depleted of oxygen. This can then cause aquatic animals to become stressed and even die.

• Volatilization: The process when something turns into gas. For example, nitrogen gets lost as it changes to ammonia gas and goes into the atmosphere

Applying Commercial Fertilizers

There are many ways to apply commercial fertilizers to your soil. The way you choose to apply the fertilizer will depend on:

1. The type of fertilizer being applied;
2. The amount of fertilizer being applied;
3. The type of crop being fertilized;
4. The soil conditions; and
5. The tillage system used.

Here are four ways you can apply commercial fertilizers.

1. Band application (as a starter and nitrogen as a side dressing)

• Used for wide-row crops such as corn, beans and potatoes.

• Placed about 5 cm (2 inches) to the side and 5 cm (2 inches) below the soil.

• Amount of nitrogen and potassium in the starter is critical; too much and the seed will burn; too little and the seed will not receive the required nutrients to grow properly.

2.Applied with the seed

• For small grains such as oats, wheat and barley.

• Seed drill drops seed and fertilizer together.

• Amount of nitrogen and potassium in the fertilizer mixture is critical; too much and the seed will burn; and the seed will not receive the required nutrients to grow properly.

3. Broadcast Application

• Fertilizer spread on the surface of the soil.

• Used for forages and other perennial crops and as part of the fertilizer program for annual crops such as corn.

• If spread onto an unplanted field, fertilizer is usually worked into soil after it is applied.

4. Liquid and gaseous applications
• Gaseous fertilizers such as ammonia are injected directly into moist soil.
• Some liquids may be broadcast, banded or applied through an irrigation system.

Applying Animal Manure

Animal manure can be applied to field in either a liquid or a solid form. The amount of nitrogen contained in manure that is available to crops will depend on the characteristics of the manure, the time that it is applied and how soon following application the manure is incorporated into the soil.

Liquid Manure Application

Image Credit: TVO http://tvo.org/article/current-affairs/the-food-chain/can-ontario-farmers-get-one-step-ahead-of-fertilizer-regulation

Dry Manure Application

Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Nutrient Management Plans

A nutrient management plan matches the nutrients available from manure, cover crops, commercial fertilizer and the soil to the nutrients required by the crop. Analysis of nutrients contained in the manure, along with soil test results and crop requirements, help determine the manure application rate and additional commercial fertilizer requirements.

Soil pH

Your soil test report will tell you the soil pH in your field. Soil pH is a measure of the acidity of the soil and it is measured on a scale that goes from 0 to 14; 7 being neutral. There are three ways to describe soils when you test for pH level.
1. Soils with a pH of less than 7 are acidic.
2. Soils with a pH greater than 7 are basic (alkaline).
3. Soils with a pH of 7 are neutral.

Healthy soils range from a pH of 6.0 to 7.5. Neutral soils with a pH of 6.0 to 7.5 are good for growing most crops and other plants.

Acids (acidic) are 1-6 on the pH scale. Bases (alkaline) are 8 and over on the pH scale. Neutral is 7 on the scale.

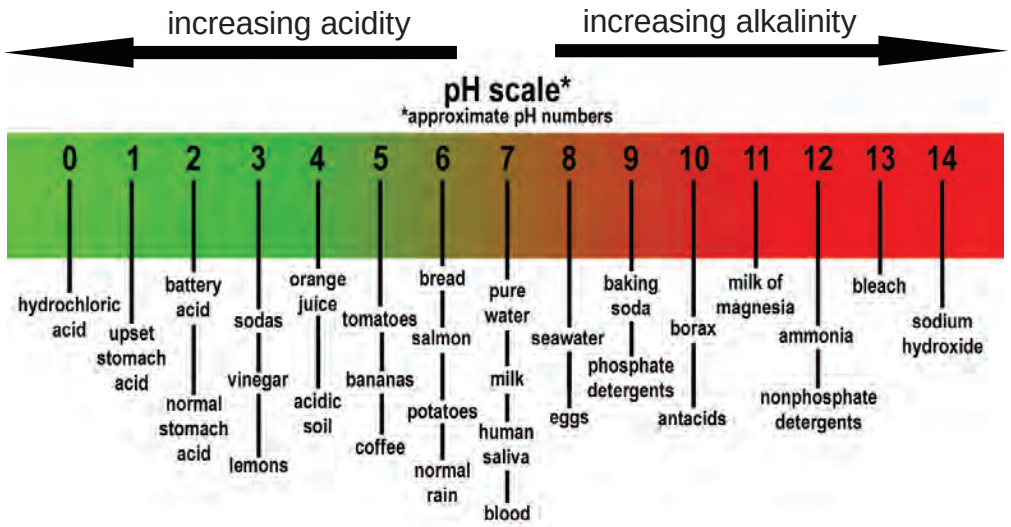


Image Source: Science Summative https://sciencesummative.wordpress.com/sciences/chemistry/ph-scale/

Activity #16: Is it acidic or alkaline? gives a better idea of what it means for soil to be acidic, alkaline, or neutral.

Why is Soil pH important?

Knowing your soil pH is important because it affects the availability of nutrients. For example, legumes depend on bacteria associated with the plant roots to fix nitrogen. These bacteria do not perform well under acidic conditions.

Your soil test report will tell you if your soil is acid or alkaline and what you can do about it. You can change the pH level of your soil by adding sulphur or agricultural lime.

Buffer pH

A simple measurement of soil pH does not show its ability to resist changes in pH. Buffer pH is a pH measurement after the soil sample is mixed with a buffered solution. Buffer pH is a simple, inexpensive and accurate means of determining lime requirements. The actual lime recommendation depends on the target pH for the crop as well as the buffer pH. Different crops require different pH ranges.

Reducing Soil pH

Although it is not practical for most farm crops, farmers growing flower or berry crops (primarily blueberries) on a small scale can reduce soil pH by adding sulphur. Some soils (e.g. sandy soils) are easier to reduce pH.

Raising Soil pH

This is a more common problem in Ontario. Soil may be too acid because of the parent material of the soil because of leaching or because of chemical fertilizer residues. Agricultural lime is used to raise soil pH.

Fertilizers & the Environment

4-R Nutrient Stewardship

4-R Nutrient Stewardship (4R) works to increase production/profitability for farmers while enhancing environmental protection and improving sustainability. To achieve those goals, the 4Rs include:

- Right Source: fertilizers that are in – or are easily converted to – compounds best used by the target crop.
- Right Rate: of fertilizer to match nutrient supply with crop requirements.
- Right Time: apply fertilizers at the right time so nutrients will be available when crop demand is high.
- Right Place: apply or maintain fertilizers where the crop can access the nutrients most effectively.

Image Credit: Fertilizer Canada http://fertilizercanada.ca/nutrient-stewardship/

Video (optional)

- Plant Nutrients & the Environment https://www.youtube.com/watch?v=hMkiT52ufp8

Phosphorus & the Great Lakes

Like people, a lake requires many nutrients in proper amounts to stay healthy. In the Great Lakes, phosphorus is the nutrient that has the most influence on the health of lake ecosystems. Phosphorus is contained in common items like fertilizer, manure, human waste and decaying plants. These can come from many sources including runoff from agricultural and urban land, airborne particles, septic systems and industrial discharges, and fertilizer. There are also naturally-occurring sources of phosphorus in lakes such as decaying organic matter and eroding rocks and soils.

Some areas of the Great Lakes have more phosphorus than they need to be healthy and intervention is required to reduce phosphorus back to appropriate levels. When the balance is lost and phosphorus levels are too high, the excess phosphorus contributes to excess algae growth. Certain types of blue-green algae like Microcystis and other species may produce toxins that are harmful to both humans and wildlife. When the algae die, it creates low-oxygen conditions that are fatal to fish and some aquatic organisms.

To learn more, review these two web pages:

- Ontario Soil Crop, “Crop Talk”, November 2015. http://www.ontariosoilcrop.org/wp-content/uploads/2016/02/Crop-Talk-November-2015-final-1.pdf
- Ontario Soil Crop, “Manure and Biosolids Management Program”. http://www.ontariosoilcrop.org/wp-content/uploads/2015/12/MBMP-Brochure.pdf

BEFORE THE NEXT MEETING

Try one of the following activities.

1. Dig a square 20cm x 20cm x 20cm of soil from three different spots in a nearby field or your home (get permission first!) and count the earthworms present in the soil. The best time to do this would be very early in the morning after a heavy dew or night rain.

AND/OR

2. Visit a local store that sells fertilizer for vegetable and flower gardens. Write down the various mixtures of NPK available as well as the price and the size of package. Figure out the price per kilogram and create a chart comparing the price/kilogram versus the NPK ratio.

MEETING 3 DIGGING DEEPER

For Senior Members

There are 18 essential elements in soil. Three come from the environment, six are called macronutrients, and eight are called micronutrients.
• Can you name all of them?
• If it's a micronutrient, is it as important as a macronutrient? Is it as important as the elements from the environment?
• What are the factors that determine the ratio in which these essential elements should be applied to soils?

DIGGING DEEPER II

For senior members

Most of us love to go to all-you-can-eat buffet restaurants, but can you give too much food (fertilizer) to a plant?
• Can you over-apply nutrients?
• Can over-application of fertilizers be harmful to the environment?
• If you can over-apply nutrients, what are some of the consequences of doing this?

DIGGING DEEPER III

For senior members

Investigate the tools and processes of how to apply liquid/gaseous applications. In addition to tools required and the application process, find out the following (but your investigation does not need to be limited to the following!):
• Is a special license required to purchase or apply liquid/gaseous applications?
• Where can these products be purchased?
• Are there any safety hazards?

DIGGING DEEPER IV

For senior members

Find three soils of the same soil type of which one has been conventionally farmed; one is farmed using conservation methods; and one field that has been forested. Collect three soil samples from each site, each filling a 250 mL container. Carefully observe the soil properties (structure, earthworm activity, texture, colour).

a. Prepare a Soil Sample Report and share results and comparisons with club members at the next meeting. See below to learn how to prepare a soil sample report.

b. Take samples back home and test them for the following chemical properties: pH, nitrate nitrogen (N), phosphorus (P), potassium (K) using any of the methods listed in today's meeting. Add the results to your Soil Sample Report.

Preparing a Soil Sample Report

Based on the test results from your soil sample, prepare a written report that states:

1. The soil texture and characteristics of that soil texture;
2. The nitrogen, phosphorous, and potassium levels, including an explanation of why each of these elements are important in soil, and if needed, ways to increase the levels for optimum crop growth;
3. The pH of the soil and its implications; and

An explanation of what the test results mean for the quality of the soil and what type of plant life will thrive or struggle in those soil conditions.

ACTIVITIES

Activity #13

Judging Activity

1. Bring in plants or crops- one that had fertilizer added and one without- for members to judge. Criteria to consider when judging: What is different about the two plants/crops? Is the colour of the crop true to its type? Is there a difference in insects/disease? Any differences in: the colour or size of the leaves? The size of the plant?
2. Bring in any items (Leader or members) to judge.

Activity #14

Is it acidic or alkaline? (15 minutes)

Objective:
• To understand the concept of soil pH levels by classifying items.

Material:
• Any common items that represent acidic/alkaline along the pH scale. For example: can of cola, vinegar, orange juice, lemon, tomato, water, baking soda, milk, etc.

Instructions:
1. Depending on the number of participants, arrange them in teams/pairs/individually and give them the materials brought in to represent acidity and alkalinity.
2. On a whiteboard, flip chart paper, or on a table using paper headings, create a pH scale from 0 to 14.
3. Ask members to take the items and to place them where they think they belong along the pH scale. You can make the activity more competitive by giving a time limit (1 minute) and awarding points for every correct answer.

Discussion:
• This activity gives you a comparison to get an idea of the difference between something that is acidic and something that is basic (alkaline).

Extremely acid	< than 4.5	lemon=2.5; vinegar=3.0; soda=2–4
Very strongly acid	4.5–5.0	tomatoes=4.5
Strongly acid	5.1–5.5	carrots=5.0; asparagus=5.5; boric acid=5.2; cabbage=5.3
Moderately acid	5.6–6.0	potatoes=5.6
Slightly acid	6.1–6.5	salmon=6.2; cow's milk=6.5
Neutral	6.6–7.3	blood=7.3; shrimp=7.0
Slightly alkaline	7.4–7.8	eggs=7.6–7.8
Moderately alkaline	7.9–8.4	sea water=8.2; sodium bicarbonate=8.4
Strongly alkaline	8.5–9.0	borax=9.0
Very strongly alkaline	> than 9.1	milk of magnesia=10.5, ammonia=11.1; lime=12

Activity #15

Testing soil for pH (30 minutes)

Objective:

• To demonstrate and interpret soil pH testing.

Materials:

• Handout: Soil pH Testing Worksheet (found at the end of this meeting)
• If using method #1: Soil pH meter, area of soil to test (outdoors).
• If using method #2: Soil test kit, soil sample(s), water
• If using method #3: Teaspoon, soil sample, two small plastic or glass containers, distilled water, stir stick or similar implement (optional), coffee filter, pool pH strips.

Instructions:

Various types of home soil tests are available to test the pH of soil. Use any one (or all) of these methods. Members (in teams) can compare the results, accuracy, and ease of use. If you did a professional soil test as suggested in Meeting #2, members can compare the results. Alternatively, select only one method to test the soil pH. Have members record their observations.

Method #1: Soil pH Meter

1. This requires no tablets, paper strips or batteries. You check the pH level of the soil with a quick-read meter. The chemical reactions between the probe and acidic or alkaline soil produce enough voltage to make the indicator needle move, measuring pH from 3.5 (strongly acidic) to 9 (strongly alkaline).
2. Record the results on the handout: Soil pH Testing Worksheet.

Method #2: Soil pH Test Kit (follow directions on the test kit)

1. Take a sample of soil, mix with water and transfer some of soil to the test kit.
2. Add powder from the capsule, shake, and watch the colour develop.
3. Record the results on the handout: Soil pH Testing Worksheet.

Method #3: pH Strips:

1. Place 1 to 3 teaspoons of soil in a small plastic or glass container such as a test tube or small beaker.
2. Fill the container with distilled water (it must be distilled water) to the same level as the soil sample.
3. Stir, shake or swirl the sample vigorously for a minute. Following this agitation, let the sample rest for a minimum of 30 minutes before continuing.
4. Hold a coffee filter over the second plastic or glass container, and pour the sample through the filter to capture the solid soil particles but allow the liquid to pass through.
5. Dip the pH test strip into the solution in the second container.
6. Compare the colour on the pH test strip to the chart provided by the manufacturer to determine the pH of the sample.
7. Repeat the test multiple times using soil samples from various areas in the field and during different seasons throughout the year to achieve as accurate a pH estimate as possible by averaging the various results.
8. Record the results on the handout: Soil pH Testing Worksheet.

Activity #16

Cabbage pH Test (30 minutes)

Objective:

• To experiment and predict the outcome of a pH test.

Materials:

• Red cabbage (about ½)
• Knife
• Chopping board
• Kettle for boiling water
• A large bowl, jug, strainer (for boiling water)
• Several very clean, clear glass jars (all same size)
• Measuring spoons
• ½ tsp each of: baking soda (bicarbonate of soda), lemon juice, vinegar (or anything else you want to test)

Instructions:

Preparation

1. First, chop half a red cabbage into small pieces. Shredding it as you would to make coleslaw works well. Put the cut cabbage in a large, clear glass bowl.
2. Boil a litre of water and pour the boiling water on the cabbage.
3. Let it sit until it cools. You will see that the water is a rich purple-red colour.
4. Strain the cabbage, keeping the purple-red liquid in another bowl or a jug. You could do the preparation to this point before the meeting. The pale cabbage can go in the compost now.
5. Make sure you keep all the purple water – it's best if it's in a white or transparent jug so that the members can see what colour you started with. You can keep this cold purple water in the fridge for 2–3 days if you need to.

Doing the demonstration

1. Set up your clean, clear glass jars or cups in a space where members can see them.
2. You can put white scrap paper under them so that the colour change will be obvious; you can also write the substance on the paper next to each jar – e.g. 'Baking soda'.
3. In each jar, measure a half teaspoon of each of the substances you want to test: a half tsp of baking soda, half tsp lemon juice, etc.
4. Add 1 tbsp. of fresh water and stir until the powder has become a paste. (Important: Use a clean spoon for each one, otherwise you will contaminate each substance and ruin the results!)

Predicting Results

1. Ask members to predict what will happen before you mix each one.
2. Measure 60 mL of the purple cabbage water and add it to each of the cups or jars in sequence. You will see a sudden change of colour in each one as the purple liquid mixes in.
    a. Pink is acid; red slightly acid.
    b. Dark blue is neutral.
    c. Greenish yellow is alkaline.
3. Get the members to arrange the jars in a row according to how acidic they think they are. Don't show them the full scale just yet.
4. If they need prompts, talk about mixing light or paint colours (blue and yellow make green, therefore a green liquid goes between a yellow and a blue liquid).

pH scale for Red Cabbage Water

pH number	1–2	3–4	5–6	7–8	9–10	11–12
Colour	Pink	Dark Red	Violet	Blue	Blue–Green	Greenish–Yellow

Image Credit: Kitchen Garden Foundation https://www.kitchengardenfoundation.org.au/uploads/09_resources/whats_happening_in_the_classroom/Yrs56_AcidityInTheSoil_WEB.pdf

Discussion:

- How accurate were your predictions?
- Describe what happened during the experiment. Compare with other members.
- What were the challenges in doing this test?

UNIVERSITY of GUELPH
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SOIL TEST REPORT

Printed on: Thursday, May 01, 2014

Submission Number: 14-

		CROP TO BE GROWN	FERTILIZER REQUIREMENTS				SOIL TEST VALUES AND RATINGS											
							PHOSPHORUS		POTASSIUM		MAGNESIUM		SOIL pH	BUFFER pH	MANGANESE		ZINC	
Sample No.	SUBMITTER ID	USUALLY A CHANGE IN CROP REQUIRES A CHANGE IN FERTILIZER	LIMESTONE tonne/ha	NITROGEN kg/ha N	***PHOSPHATE kg/ha P_2O_5	***POTASH kg/ha K_2O	SOIL TEST mg/L P	RATING	SOIL TEST mg/L K	RATING	SOIL TEST mg/L Mg	RATING			SOIL TEST mg/L Mn	SOIL TEST Index Mn	SOIL TEST mg/L Zn	SOIL TEST Index Zn
0001	Garlic Field	Garlic		110	160	130	8.3	HR	90	HR	86	MR	7.9					
0002	East Field	Garden		60	0	0	75	RR	200	LR	140	RR	7.6					
0003	Flower Field	Garden		60	0	0	92	*NR	330	*NR	170	RR	7.8					

HR, MR, LR, RR, and NR denote, respectively, high, medium, low, rare and no probabilities of profitable crop response to applied nutrient. * Divide kg/ha by 100 to obtain kg/100m²**

Nitrogen is not part of a regular soil test, since the interpretation of the results is only valid for a deeper sample taken at planting, nitrogen levels are based on general requirements.

*NR (No or Negative Response) ratings signify that applications of this nutrient in fertilizer or manure may lower crop yield or quality. Phosphate additions to soils with excessive phosphorus levels can induce zinc deficiency on soils low in zinc and can increase the risk of water pollution. Potash additions may induce magnesium deficiency on soils low in magnesium.

PHOSPHATE AND POTASH FERTILIZER REQUIREMENTS ON THIS REPORT BASED ON ONTARIO RESEARCH WILL PROVIDE HIGHEST ECONOMIC RETURNS WHEN CROP MANAGEMENT IS ABOVE AVERAGE.

* 100 kg/ha = 90 lb/ac.
10 tonne/ha = 4.5 ton/ac.

** Note: Fertilizer requirements have not been corrected for manure application, please see page 2 of the report to determine the reductions in fertilizer requirements due to manure application. Liquid manure rates are in m^3/ha. Solid manure rates are in metric tonnes/ha.

Sodium bicarbonate (Olsen) method was used for P extraction

If further assistance is required, contact:

OMAFRA contact Centre 1-877-424-1300
http://www.omafra.gov.on.ca/english/crops/soils/test-categories.htm

Source: Agriculture and Food Laboratory, Laboratory Services, University of Guelph, Guelph, Ont in collaboration with the Ontario Ministry of Agriculture, Food & Rural Affairs (OMAFRA) database

Soil pH Testing Worksheet

NOTE: Be sure to use the same soil test site that you used for the professional lab test if you want to compare the results to your own home tests! Note, your results still won't likely be the exact same as there will likely some variability in how the soil samples were taken and how the tests are conducted. But try it and see how close you can be!

Date:

Soil Test Site:

	pH meter	pH test kit	pH pool strips	Professional lab test
Colour				
pH				
Acidic, alkaline or neutral?				

Discussion:

- Which method was the most accurate to the professional lab test?
- Which method did not work at all (and was a waste of time and money)?
- If the pH is not at the correct level, what will you do to amend the soil?

MEETING 4 - Water, Water Everywhere

Objectives

• Learn what erosion is, how it happens and how it affects soils.
• Discuss different methods and tools to use to reduce erosion.

Roll Calls

• Soil gets moved around all the time, both by nature and by humans. Name one way that soil can be moved around.
• Have you ever seen a heavy rain over a field? What did you see happening to the soil in the field?
• There are a number of types of erosion. Name one of them.

Sample Meeting Agenda – 1 hr. 15 minutes plus activites

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	5 min
Judging Activity	Activity #17 Judging: Water Samples	10 min
Topic Information, Discussion & Activities	***Topic Information*** • What is erosion? • Types of water erosion • Draining away & Controlling the flow ***Activities*** • Activity #18 - Slaking Test • Activity #19 - Building an Erosion Model • Activity #20 - Make it Rain • Activity #21 - Let it Drain Away • Activity #22 - Visit a Farm • Activity #23 - Visit a Drainage Contractor	30 min + Activities
At Home Activity	Choose one At Home activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

What is erosion?

Erosion happens when soil is moved by water or wind from one place to another. There are really two steps to erosion. The first step is when the soil is loosened. The second step is when the soil is moved from one place to another. The soil is usually blown away by the wind or carried away by water. Some erosion is natural, but most erosion happens because people are doing things that speed up the rate of erosion.

When it rains, there are different places within a field that water can end up. The water can flow off the top of the surface and end up in a nearby ditch or stream. The water can end up in the soil and be used by plants for growth or remain in the soil and either stay in place or eventually flow through below the root zone of the plants. Plants need water to grow and survive and so it is important the water stays within the soil in an area that the plants can access it and use it. If the water flows off the top of the soil, not only does it not end up in the soil to be used by the plants, but when it flows off the surface it can carry bits of soil with it, leaving less soil on the surface for plants to grow in. This makes our streams dirty with soil and anything that is attached to the soil, like valuable nutrients, are also lost. If the water stays in the soil it can be used by plants, but if the soil cannot hold all the water, excess water will flow through the soil and go into groundwater or be taken away by drainage tile.

Healthy soil with good soil structure is capable of holding onto more water, resulting in healthier plants. Furthermore, rain will infiltrate (get into) the soil when it is healthy as opposed to less healthy soil which can have the water run off the top. When the soil is covered with plant residue or growing plants, the water will infiltrate more into the soil and less will run off the top. Finally, when water does run off the top of healthy and well covered soil, it is generally fairly clear. The water running off the less healthy soil will contain pieces of soil and will be cloudy.

Information Credit: Anne Verhallen, Soil Management Specialist (Horticultural Crops), OMAFRA

Slaking

Slaking is the breakdown of aggregates (pieces of soil) into smaller sized aggregates. This breakdown of soil chunks into smaller pieces can happen when soil is rained on. Better quality soils will be able to withstand the force of water and stay together better than poor quality soils. When each piece of soil is placed into a cylinder, the water rushes into all the pores (air spaces) within the soil and this is so forceful that it can break soil apart. High quality soil (soil with good structure) can withstand this force and will stay together. Unhealthy soil cannot handle the force of the water and will break apart. When the unhealthy soil breaks apart it will fall through the mesh, settle on the bottom of the cylinder and the water in the cylinder will begin to turn brown. Soil that has better structure and holds together under the force of water will withstand erosion from rain better than low quality soil. When the soil stays together, it will remain in the field. On the other hand, when the soil is broken up by water, it can move away from the field which is not good for supporting crop growth.

Courtesy of Anne Verhallen, Soil Management Specialist (Horticultural Crops), OMAFRA

The CCSS Factor (Climate, Cover, Slope, Soil)

Soil erosion just doesn't happen by itself or every time it rains or the wind blows hard. The CCSS Factor will tell us if the soil is likely to erode or not. The CCSS Factor is:

- Climate: the number of times and when it rains or snows heavily or is windy.
- Cover- how many old stalks and leaves (crop residue) are found on the soil or whether or not there is a cover crop.
- Slope- how steep or flat the land is and the length of the slope.
- Soil- what the soil texture and the soil structure are like.

Water Erosion: One Tiny Drop

Simply put, water erosion is the movement of soil by water. Every time a raindrop hits the bare earth, it can pick up particles of soil and move them away. This is the simplest kind of water erosion. In a heavy storm, a lot of soil can be detached by raindrops. The raindrops loosen the soil through impact and the flow of water on top causes soil movement. You can protect the soil with a cover crop or by leaving crop residue after harvest.

Types of Water Erosion

Water can cause erosion problems and is the focus of many soil conservation efforts in Ontario. If there is a steep slope in a field, or a creek running through it, water can change the way the field looks by eroding the land in different ways. The four types of water erosion include: sheet, rill, gully and streambank.

Sheet Erosion

When heavy rains fall on bare ground, not all of the water soaks into the ground right away. Even on land that is quite flat, a thin “sheet” of water can pick up soil particles and carry them away. It’s hard to see this kind of erosion, but it is the kind of erosion that happens the most often.

The accumulation of soil and crop debris at the lower end of this field is an indicator of sheet erosion.

*Image Credit: OMAFRA Soil Erosion – Cause & Effects Factsheet (2012) http://www.omafra.*gov.on.ca/english/engineer/facts/12-053.htm

The distinct path where the soil has been washed away by surface water runoff is an indicator of rill erosion.

Image Credit: OMAFRA Soil Erosion – Cause & Effects Factsheet (2012) http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm

Gully Erosion

Once water has cut a deep channel that cannot be crossed by a tractor, the channel is called a gully. It occurs where the water flow becomes trapped in a small concentrated stream and begins to erode. This reduces access to the site and being able to use it to grow crops.

Gully erosion may develop in locations where rill erosion has not been managed.

Image Credit: OMAFRA Soil Erosion – Cause & Effects Factsheet (2012) http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm

Streambank Erosion

This happens after the water runs off the field and goes into the stream. Streambanks can erode where water flows into the stream off the land or where the stream flows too fast or too high. This type of erosion can also happen where streambanks are walked on by cattle.

Bank erosion involves the undercutting and scouring of natural stream and drainage channel banks.

Image Credit: OMAFRA Soil Erosion – Cause & Effects Factsheet (2012) http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm

Draining Away

Putting a drainage system in a field can lead to higher crop yields for many reasons.

- The soil warms up faster when the extra water is taken off. This means the soil can be tilled earlier and seeds can be planted earlier and germinate more quickly. This is very important in areas with short growing seasons or where early harvests may bring higher prices.
- Larger soil pores are emptied out which gives the roots more room to grow.
- Plant roots will penetrate more deeply into a drained soil, producing healthier, more vigorous growth.
- Drainage promotes soil structure while reducing compaction.
- Less soil heaving and root damage during the winter on drained land.
- Drainage can increase infiltration and reduce surface runoff and soil erosion.

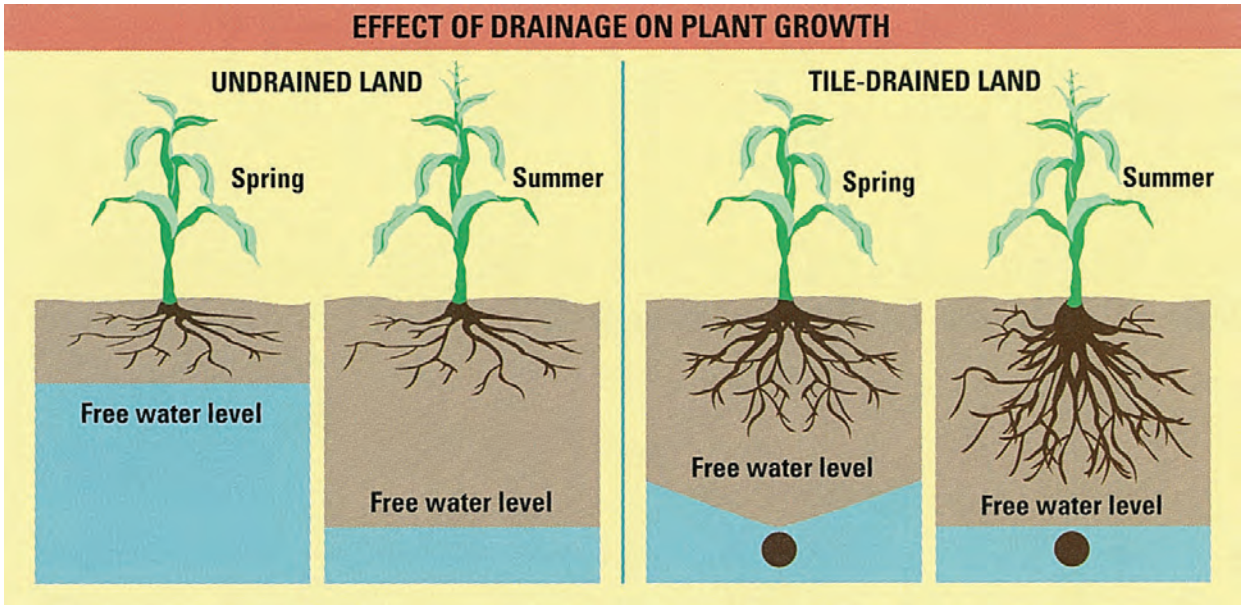


Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Management (1997)

Controlling the Flow

Farm land can remain wet for many days after a rain without adequate drainage, preventing timely fieldwork and causing stress on growing crops. Wet soils do not provide enough aeration for crop root development and can stress the plant. Artificial drainage and reducing the amount of runoff by encouraging rainfall to infiltrate into the soil will reduce damage to the land and crop profitability.

Water flowing over the land can be slowed down in many different ways.

Grassed Waterways

These are like sidewalks made of grass. They are wide, shallow strips of grass put in the lowest parts of the fields where water would naturally flow. Because the soil is held in place by grass, the water flows away without taking any soil with it.

Erosion

Grassed waterway to prevent erosion

Image Credit: OMAFRA Grassed Waterways Factsheet (2009) http://www.omafra.gov.on.ca/english/engineer/facts/09-021.htm

Drop Inlet Catch Basins and Rise Inlets

Catch basins are like big underground tubs. The water comes from the field into the top and goes out the bottom into a tile drain. They are like a storm sewer that you would see in town. Catch basins are generally put in the lowest parts of a field. Riser inlets work in much the same way in that the water comes in from the field into the rise oulet and goes out the bottom into a tile drain.

Rectangular catch basin

Image Credit: http://midstateconcrete.com/product/171/Catch-Basins-Rectangulars.html

Riser Inlet

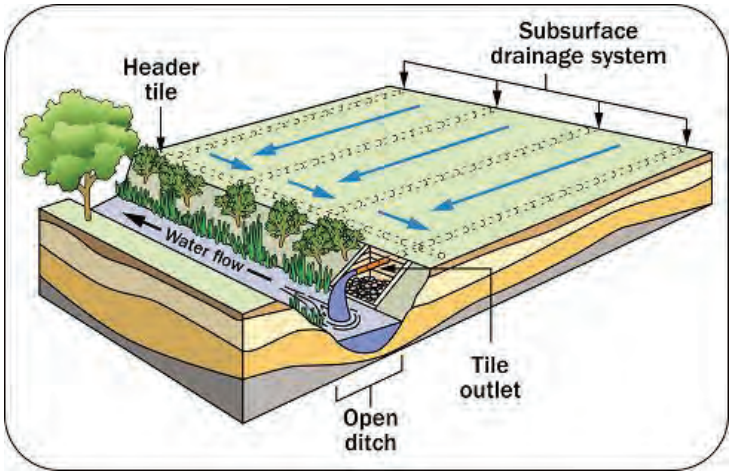
Image Credit: OMAFRA Factsheet: Operating and Maintaining a Tile Drainage System (2010) http://www.omafra.gov.on.ca/english/engineer/facts/10-091.htm

Rock Chutes

Sometimes rocks are put on small, steep slopes to stop erosion. Rock chutes are usually built where water flows out of fields into a stream or ditch.

Rock Chute

Image Credit: http://www.mowerswcd.org



Tile drainage is a sort of plumbing installed below the surface of agricultural fields that allow subsurface water to move out from between soil particles, into the tile line and deposited into surface water points—lakes, streams, and rivers—located at a lower elevation than the source. By adding drain tile, the water table is effectively lowered, and plants can properly develop their roots.

Clay tile installed below the surface of the field.

Modern drain plows can lay drainage tile with great precision.

Image credits: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Did you know?

In Ontario, the Agricultural Tile Drainage Installation Act (R.S.O. 1990), regulates the installation of agricultural tile drainage systems. Anyone other than the landowner doing the work on the farm must be licensed by the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA). It is important to ensure that the contractor hired has the required licenses under the Agricultural Tile Drainage Installation Act and has an appropriate level of liability insurance.

Source: OMAFRA – Considerations when Planning to Drain Land (2013)
http://www.omafra.gov.on.ca/english/engineer/facts/13-033.htm

Cover Crops

Cover crops cover the soil and result in many benefits:

- Reduces soil erosion;
- Adds organic matter to the soil;
- Reduces nutrient losses;
- Reduces compaction and improve soil structure;
- Reduces moisture loss;
- Improves soil fertility; and
- Reduces pest populations.

Buffer Strips

Buffer strips are small areas or strips of land in permanent vegetation designed to stop pollutants and manage other environmental concerns. They slow water runoff, trap sediment and enhance infiltration within the buffer. Buffers also trap fertilizers, pesticides, pathogens and heavy metals; they help trap snow and cut down on blowing soil in areas with strong winds.

Buffer strip

Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Thirsty Soils

A good, rich soil with lots of organic matter or humus in it can hold more water than a poor soil. This is because the humus is like a big sponge. This is another reason to take care of your soil. The more water the soil can soak up when it rains or as the snow melts, the less water will run off the field. That means that less soil will be taken away by the water.

Environmental Concerns with Drainage

Tiling a field has many benefits but if not managed right, it can also lead to environmental concerns.

A subsurface tile drainage system may result in increased soil macropores (small pores through the soil that lead directly to the tile). Unless properly managed, nutrients applied to the field (manure or commercial fertilizers) can travel easily through these pores, through the tile and into the receiving waterbody, resulting in environmental harm. Only apply nutrients to the land in accordance with the Nutrient Management Act. Some general recommendations include:

• Apply nutrients at the recommended rates, using proper methods and at the correct time of year.
• Avoid applying nutrients when the soil is saturated or the tiles are discharging water.
• After applying nutrients, periodically check the tile outlets for nutrient discharge.
• To avoid soil compaction in your fields, avoid repeated travel in one location when hauling manure.
• Do not apply nutrients in a wide area around surface inlets. If nutrients do enter the inlet, take appropriate measures to stop the flow such as using shut-off valves.

Videos (optional)

• Erosion by Bill Nye https://www.youtube.com/watch?v=J-ULcVdeqgE

Additional Resources

• Best Management Practices: Controlling Soil Erosion on the Farm, OMAFRA
36-page booklet filled with photographs to match field symptoms with erosion type and practical solutions. Hard copies of publications can be ordered through Service Ontario: 1-800-668-9938 or by visiting: http://www.omafra.gov.on.ca/english/environment/bmp/erosion.htm

BEFORE THE NEXT MEETING

Try one of the following activities.

1. Prepare a five-year cropping and tillage history for your project field or some other field you have access (always ask for permission, first). Include yields of crops too, if possible. Use the chart/handout found at the end of this meeting.

AND/OR

2. **Experiment: Erosion: The Great Race**
Water, wind, or glacial—which type of erosion causes the biggest changes? To find out, set up three identical pans with firmly packed dirt. Once a day, for three days, perform the following actions:

Pan A—spray the dirt with five squirts of water
Pan B—slide a piece of ice down the dirt pile five times
Pan C—use a straw to blow across the soil five times.

Each day, record your observations and predict which type of erosion is causing the most damage. At the end of the third day, make your final observations and conclusions. (Results may vary due to soil type and room temperature.) Then reveal the type of erosion demonstrated in each pan. Be prepared to share your results with the group at the next meeting.

NOTE: Results should be as follows: A—water, B—glacial, C—wind.
This experiment is soil dependent so results can vary.

Activity Credit: ENet Learning http://www.enetlearning.org/wp-content/uploads/2015/01/Erosion-The-Great-Race.pdf

MEETING 4 DIGGING DEEPER

DIGGING DEEPER I

For senior members

Imagine you are a farmer considering a subsurface drainage system. Research what needs to be considered before making a decision, hiring a contractor, or spending the money! Use any online resource (for example: “Considerations when planning to drain land” http://www.omafra.gov.on.ca/english/engineer/facts/13-033.htm) or contact a farmer, licensed drainage contractor, or anyone else knowledgeable about drainage to gather your information. Be prepared to share what you’ve learned at the next meeting.

DIGGING DEEPER II

For senior members

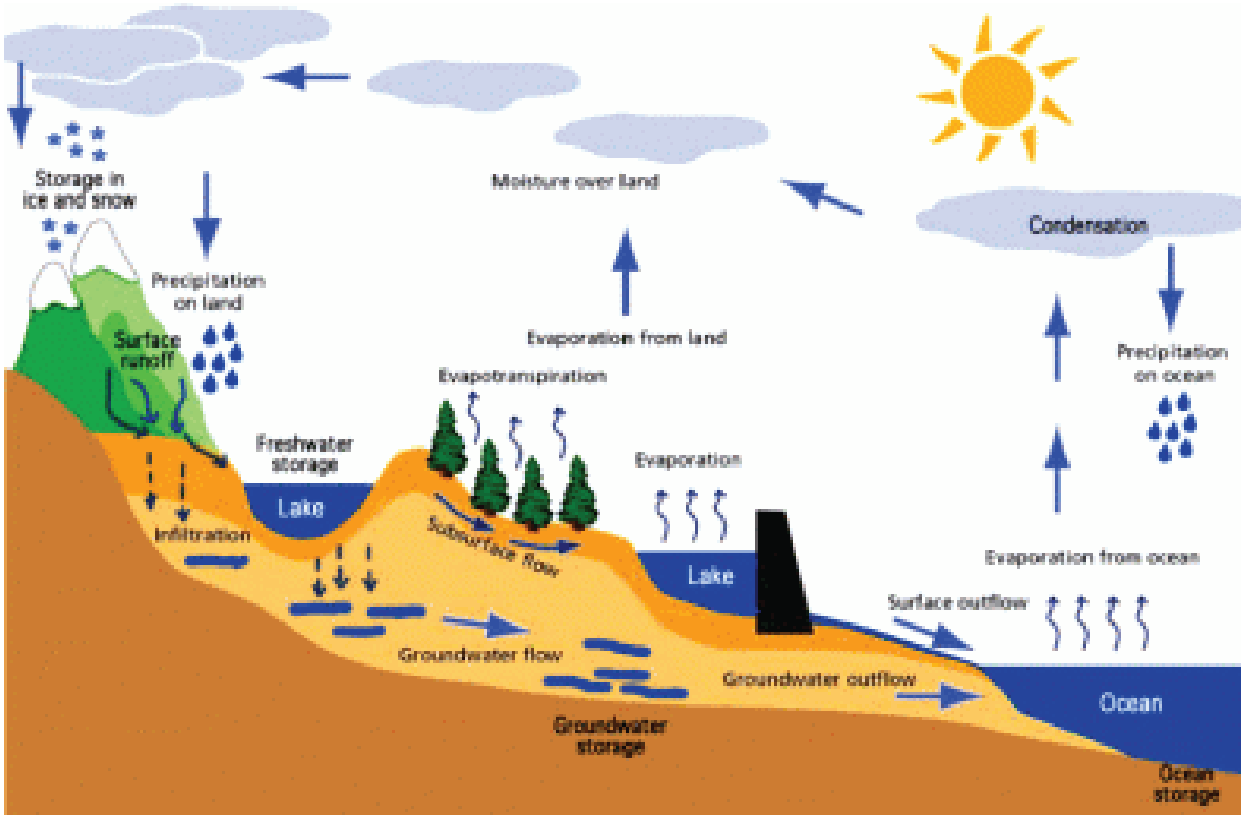
If you had to re-design your farm layout (or that of a friend/neighbour) how would you do it? What influences your decisions? What techniques would you use to support soil health? Draw your new layout and identify where buildings, etc. would be. Be prepared to describe your layout and the reasons you made the changes for the next meeting.

DIGGING DEEPER III

For senior members

What is a “hydrologic cycle” and how does it relate to excess moisture on fields?
Take a look at the diagram below and share your explanation with the rest of the group. If you have access to the internet, you can research more detailed information.
Definition: “The water cycle or hydrologic is a continuous cycle where water evaporates, travels into the air and becomes part of a cloud, falls down to earth as precipitation, and then evaporates again. This repeats again and again in a never-ending cycle. Water keeps moving and changing from a solid to a liquid to a gas, over and over again.”

Definition Credit: American Water Works Association https://www.fcwa.org/story_of_water/html/hydrocycle.htm



Hydrologic (Water) Cycle

Image Credit: https://civilsolution.wordpress.com/tag/hydrological-cycle/

ACTIVITIES

Activity #17 - Judging: Water Samples

1. What makes the best water? Tap water or a specific bottled brand? You be the judge, making your choice based on clarity of the water, taste (any after-taste?), and smell. Have all the water at the same temperature, in the same kind of containers (e.g. clear glass) and in the same amounts in order to be fair when you test it. Be sure it's a "blind test"; that is, you don't know which water is which (but be sure to have someone label it for you)!
2. Bring in any items (Leader or members) to judge.
3. Consider inviting other local 4-H clubs to have a judging competition.

Activity #18

Slaking Test (Day 1- 20 minutes; Day 2- 30 minutes)

NOTE: This activity could also be given to Senior Members for their At Home activity, since it requires multiple days to complete.

Objective:
• To predict and test the stability of soil aggregates and how well soil can maintain its structure.

Materials:
• Glass cylinders or large canning jars
• Mesh – wire or "hardware cloth"
• Soil clods (pieces of soil)

Instructions:
When doing this test, it is important to get soil from differently managed fields to ensure there will be differences when the test is performed.

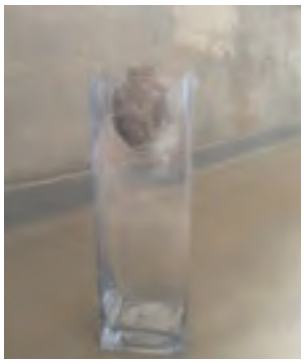
DAY 1
Collecting Soil Samples
1. Soil should be collected from sites with similar soil types but under different management (i.e. pasture, no-till, conventional till, with and without cover crops, continuous crop vs. 3-year rotation).
2. Using a shovel or hand trowel, collect the soil samples from the top 4-6" (8-15 cm) of soil.
3. Collect several chunks of soil. Samples should be similar in size and be able to easily fit inside the slaking jar and sit on the wire mesh (approximately 2"x2"x2").
4. Once samples have been collected, they should be completely air dried prior to use. The soil samples should be very hard.
5. Store samples in a well labeled air tight container until ready to use.

Note: When you collect soil for this demonstration, it is recommended you collect several chunks. It can take several days to dry the soil out; however, once it is dry, you can keep it for a long period of time in an air tight container.

DAY 2

Setting Up the Slaking Test Demonstration

1. Before you begin, record in your 4-H Record Book your prediction of how each clump will react when placed in the water.
2. Select the soil samples to be used in the demonstration. Ensure they are completely dry.
3. Fill the glass cylinders with water (room temperature tap water is fine) leaving 1-2 inches at the top to allow for displacement.
4. Place mesh in cylinder (to ensure proper demonstration use wire mesh with fairly large holes) (picture 1- left).
5. When ready to start demonstration, gently place each soil clump in the cylinder and let it sit on the mesh for the duration of the demonstration (picture 1- right).
6. Observe what happens to the soil and note the colour of the water.
7. After 10 minutes, jiggle or lightly move the cylinder.



Discussion:

- From where was your soil collected and how was that field managed?
- Were you able to predict correctly what would happen? Explain.

Explanation:

Healthy soil will stay together and can handle the water rushing into the pores while low quality soil will not be able to hold together and will begin to break apart. Overall, soils from no till fields, with good rotations and cover crops should stay together better. In these cylinders the water should be fairly clear and a minimal amount of soil collecting at the bottom of the cylinder. Soils from fields with conventional tillage and poor crop rotations (i.e. continuous corn) should break apart more easily, causing the water to turn brown and a lot of soil to collect at the bottom of the cylinder. By reducing the amount of tillage in fields and introducing new crops into rotation, we can improve soil structure and our soils will be less prone to erosion and stay in place when there is a rainfall even.

Activity and images courtesy of Anne Verhallen, Soil Management Specialist (Horticultural Crops), OMAFRA

Activity #19

Build an Erosion Model (30-45 minutes)

Objective:
• To demonstrate the effect ground covers have on soil erosion.

Ma***terials:***
• 2 or 3 plastic bottles of the same size (2 liter bottles work well)
• Soil (enough to fill bottles)
• 2-3 clear cups
• 2-3 wire hangers
• Cups or blocks to support your bottles
• Scissors or utility knife (utility knife works better)
• Mulch
• Seedlings (optional)
• Sprinkling-style watering can, spray bottle, or rain simulator
• Tape (or other materials to build your supports).

NOTE: A tabletop Rainfall Simulator kit is available to borrow from the Ontario 4-H office. Many local conservation authorities also have table top erosion demonstration units.

Instructions:
NOTE: A similar variation of this experiment can be seen on YouTube: https://www.youtube.com/watch?v=im4HVXMGI68&app=desktop

1. Decide if you will use two or three bottles for this experiment (one bottle filled with only soil; one bottle with soil and mulch on top; and optional, one bottle with seedlings).
2. Cut off one side of each bottle and fill each with the same type of soil (loam, not clay).
3. Add mulch or dead leaf cover to one of the bottles and leave the last bottle of soil bare. Optional: plant seedlings to the third bottle (or pre-planted).
4. Suspend the bottles over other cups or any other items at a 25 to 40-degree angle with the spouts facing downward. Get creative in finding ways to accomplish this. How they're held is unimportant as long as they're angled.
5. Before applying the water, have members guess what the water will look like in the cups.
6. Run water over the top of the soil in each bottle. (If your soil hasn't had time to settle, you should discard the first few centimeters from each cup.)
7. Use your rain simulator (or watering can) to apply equal amounts of water to each bottle.

Example 1 of a soil erosion model

Example 2 of a soil erosion model

Image Credit: Life is a Garden https://www.lifeisagarden.co.za/soil-erosion-experiment/

Discussion:

• How well did you predict what would happen?

• Compare the differences in the clarity of the water in each cup. How are they the same/different?

• What does this experiment tell you about the importance of conserving soil? What are the consequences if we don't conserve soil?

Activity #20

Make It Rain (Table top Rainfall Simulator) (45 minutes)

Objective:

• To predict and compare how different soils react during a rainfall.

Materials:

NOTE: A tabletop Rainfall Simulator kit is available to borrow from the Ontario 4-H office. This must be secured before doing this activity.

• Loaf pan with soil (a) on metal rack (b)
• Wooden board
• Rubber mallet
• Shovel or trowel
• Cheese cloth
• Plastic containers
    o Small container (c)
    o Large container (d)
    o Container with holes in the bottom (e)
• Metal holder (f)
• 500 mL of water

Instructions:

Background information

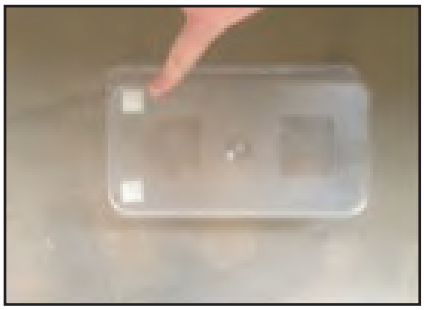
The purpose of the rainfall simulator is to see how different soils react during a rainfall. When doing this test, it is important to get soil from differently managed fields to ensure there will be differences when the test is performed. With healthier soil, the water should go into the loaf pan and less should run off the surface or drip into the container below the pan. Less healthy soil will result in more runoff from the top of the soil and more dirty water will drip into the container below.

Collecting soil samples

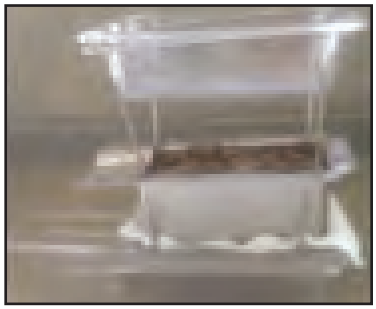
1. Soil should be collected from sites with similar soil types but under different management (i.e. pasture, no-till, conventional till, with and without cover crops, continuous crop vs. three-year rotation).
2. Using the loaf pan, place it on top of the soil from where you wish to collect the sample.
3. Place a wooden board on top of the pan and hammer it into the soil using a rubber mallet until the lips of the pan are flush with the top of the soil surface.
4. To remove the pan without disturbing the soil inside: dig a trench around the pan to the depth of the sides. Place the shovel in the trench and wedge under the bottom of the loaf pan – this may need to be done from two or even all four sides to lift up the pan. Using the shovel, carefully extract the loaf pan from soil.
5. Trim the soil on the bottom of the loaf pan so it is flush with the pan.
6. Place the loaf pan (a) on a cheese cloth covered metal sheet (b) using springs to secure the pan into place. If the sample is not being used immediately, it is recommended to wrap the loaf pan and sheet in plastic wrap to maintain the moisture in the sample.

Setting up the table top rainfall simulator demonstration

1. Place the metal sheet (with loaf pan on top) on the large plastic container (d). The feet on the bottom of the large plastic container (picture 1) allow for a slight incline to the loaf pan (picture 2).



1) Insert the metal holder in the loaf pan (picture 3) and place the plastic container with holes on top (the lip of the plastic container will rest on the metal edges) (pictures 4 and 5).



2) Place the small plastic container at the edge of the loaf pan to collect all surface runoff (picture 6).

3) When ready to start the demonstration, pour 500 mL of water into the top plastic container.

Discussion:

• Explain where the soil was collected from and how that field is managed.
• How well did you predict what would happen when you poured the water on top of each pan?
• Compare your predictions and results with the other club members.
• Which soils and managed fields resulted in increased infiltration of water?
• What does this experiment tell you about how we can improve soil and decrease erosion?

Explanation:

Overall, soils from no tilled fields, with good rotations and cover crops should result in more infiltration and less surface runoff. Soils from fields with conventional tillage and poor crop rotations (i.e. continuous corn) should result in more surface water runoff and this runoff will be very dirty.

By reducing the amount of tillage in fields and introducing new crops into rotation, we can improve soil structure and our soils will be less prone to erosion and be able to hold onto more water when it rains so there is more water available for crop growth.

Activity Information courtesy of Anne Verhallen, Soil Management Specialist (Horticultural Crops), OMAFRA

Activity #21

Let It Drain Away (15 minutes)

Objective:

• To investigate how much water different types of soil will hold.

Materials:

• 3 coffee filters
• 3 different soil samples (sand, loam, clay)
• 1 funnel
• 1 graduated cylinder
• Measuring cups (150 ml or more)

Instructions:

1. Place 150 ml of each soil type into its own coffee filter.
2. Place one of the filters into the funnel and place the funnel on the graduated cylinder.
3. Slowly pour 150 ml of water through the soil. Record your observations.
4. Repeat for the other two soil samples.

Observations

Sample	Amount of Water Used	Amount of Water Drained	Amount of Water Held
Sand			
Loam			
Clay			

Discussion:

• What differences do you see with each of the soil samples?
• How would you compare them to each other?
• Rank the samples, in order, from most drainage to least drainage.
• Which soil sample do you think is best for growing crops/plants? Why?
• Do you think all crops/plants grow best in the same soil?

Activity #22

Visit a farm / Local Conservation Authority (45-60 minutes)

Objective:
• To identify and describe at least one erosion prevention method used on a farm.

Materials:
• None

Instructions:
Take members to a farm with at least one type of soil erosion prevention method that you would like to examine up close. If possible, talk with the farmer about the method chosen and its effectiveness. If possible, visit a farm that has received a conservation award. Alternatively, visit a local Conservation Authority and ask about their conservation programs for farms.

Discussion:
• What erosion prevention method(s) do you see being used on this field? Describe the erosion method(s) used.
• What are the benefits and challenges of the erosion method(s) being using at this location?
• What other methods could be used?

Activity #23

Visit a drainage contractor (45-60 minutes)

Objective:
• To discuss and view different drainage options with an expert contractor.

Materials:
• None

Instructions:
1. Find a licensed drainage operator (Ontario). http://www.omafra.gov.on.ca/english/landuse/facts/contractors.htm
2. Take members to a drainage contractor to learn more about the process of water drainage in agriculture, the demand, the challenges and opportunities as a career. Many drainage contractors also do erosion control work as well.

Discussion:
• Encourage members to ask questions and to apply their learned knowledge to the discussion.

5-YEAR CROPPING & TILLAGE HISTORY

Size of project field: _____

Soil type: _____

Year	Crop Grown	Sample	Sample
This Year			

Senior Members

• Talk with a farmer and ask questions about his/her history. Compare crops and yields with each tiling method.

• Think about and compare the effects on the soil and crops with each tillage method.

  o Yield of crops, growth of plants/roots, structure and erosion of soil, leaching, runoff, etc.

• Talk with a farmer who uses a no-tilling method. Compare results.

MEETING 5 - Blowing in the Wind & Compaction Action

Objectives

- Learn about wind erosion and compaction and the damage they cause to soil.
- Compare and discuss different methods to control wind erosion.
- Understand the reasons why soil compaction is harmful.

Roll Calls

- Have you ever seen wind blowing at high speeds across a field? What did you see happening to the soil?
- What do you think happens to heavier soil particles (e.g. clay) that are too heavy to be lifted by the wind? How would they get moved around?

Sample Meeting Agenda – 1 hr. 15 minutes plus activites

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	5 min
Judging Activity	Activity #24 - Judging: Farm Tools	10 min
Topic Information, Discussion & Activities	***Topic Information*** • Wind erosion • Stopping the drift • Compaction action • Best practices to limit soil compaction • Worms and soil compaction ***Activities*** • Activity #25 - Checking for soil compaction • Activity #26 - Soil Impaction Investigation • Activity #27 - Field traffic pattern • Activity #28a - Wind erosion experiment • Activity #28b - Wind erosion prevention experiment • Activity #29 - Guest speaker(s): soil erosion	30 min + Activities
At Home Activity	Choose one At Home activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

Wind Erosion

Wind erosion is soil that has been removed by wind or air currents. It damages crops through
• Burial of plants or seed.
• Exposure of seed.
• Plants are also more vulnerable to disease.
• “Sandblasting” of young seedlings or transplants. This is damage to leaf tissue by the abrasive (scratchy) effect of blowing soil particles, resulting in small cuts on or shredding of leaves. It may even cause plants to be cut off at the soil surface in severe cases.

With wind erosion, soil particles can move in three ways.
• ***Suspension*** occurs when very fine soil particles are carried high into the air. This form of movement doesn’t account for much soil lost by wind, but it’s the most visible.
• ***Saltation*** occurs with fine-sized to medium-sized particles that are lifted only a short distance into the air, then fall back to remove more soil.
• ***Surface*** creep occurs when larger-sized soil particles are loosened by the bouncing motion of other soil particles. Accounts for 25% of soil movement by wind.

Wind erosion results in many problems and challenges:
• Crops can be ruined, resulting in costly delays and making reseeding necessary.
• Decrease in yield.
• Loss of quality and market value.
• Removal of topsoil and organic matter.
• Increase in runoff and reduces water storage.

Did you know?

Have you ever heard of The Dust Bowl? Also known as the Dirty Thirties, it was a period of severe dust storms that greatly damaged the ecology and agriculture of the US and Canadian prairies during the 1930s; severe drought and a failure to apply dryland farming methods to prevent wind erosion caused the phenomenon. Dryland farming refers to the practice of growing crops with little water in dry areas. Some crops that will grow with little water include: wheat, sorghum and millets.

Some places have more problems with blowing soil than others; it all depends on:
• Wind speed: The harder the wind blows, the more likely it is to pick up soil as it blows across a field.
• Soil moisture: The drier the soil, the more easily it will blow away.
• Soil surface: The smoother the soil surface, the more easily the soil will blow away.
• Soil texture: Silts and fine sands move the easiest.
• Tillage: The redistribution of soil through the action of tillage and gravity. It results in the progressive down-slope movement of soil, causing severe soil loss on upper-slope positions and accumulation in lower-slope positions.

Did you know?

It can take thousands of years to produce just one centimeter of new topsoil needed to sustain food and farm production!

Stopping the Drift

There are many different methods to consider to stop wind erosion.

Windbreaks

If you've ever stood behind a tree with a lot of branches, you know how well it shelters you from the wind. Slowing the wind down by planting windbreaks helps prevent soil erosion, too. Wind barriers are usually created by planting trees or shrubs, but in an emergency, a wind barrier can be created using almost anything, such as a snow fence or straw bales.

Cover Crops

Uncovered soil, especially loose, dry, bare soil, is susceptible to wind erosion. Keeping the soil covered with soil crops helps to prevent wind erosion. Cover crops may be planted over a whole field for erosion protection, or they may be selectively planted in the most erosion prone areas.

Image Credit: OMAFRA Cover Crops Factsheet (2001) http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm

Cover crop in a tomato rotation.

Reduce/alter tillage practices

Take a look at this picture.

Image Credit: OMAFRA Soil Erosion – Causes & Effects Factsheet (2012) http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm#6

Tillage erosion is the redistribution of soil through the action of tillage and gravity. It results in the progressive down-slope movement of soil, causing severe soil loss on upper-slope positions and accumulation in lower-slope positions. This form of erosion is a major contributor to water erosion. Tillage action moves soil together to areas of a field where surface water runoff concentrates. Exposed subsoil is highly erodible to the forces of water and wind. No till practices will prevent tillage erosion by helping with:

· Keeping residue on the soil surface to keep the wind from reaching the soil particles

· Maintaining soil surface roughness

· Avoiding over-tilling the soil that breaks down soil aggregates. Over-tilling can cause soil to become a fine powder which is very susceptible to wind erosion.

Tillage erosion has the greatest potential for the "on-site" movement of soil and in many cases can cause more erosion than water or wind.

Source: OMAFRA Soil Erosion – Causes & Effects Factsheet (2012) http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm#6

To prevent erosion, consider:

- No tillage.
- Strip tillage- crops planted directly into remaining residue that has been tilled only in narrow strips; the rest of the field is left untilled.
- Ridge tillage- crops planted in single-row raised beds, about 4-6 inches high (not widely practiced in Ontario)

By reducing the number and intensity of tillage passes, there will be less opportunity for mechanical soil movement.

You willl earn more about conservation tillage practices in Meeting #6: SOS (Save our Soils).

Create your own windbreak

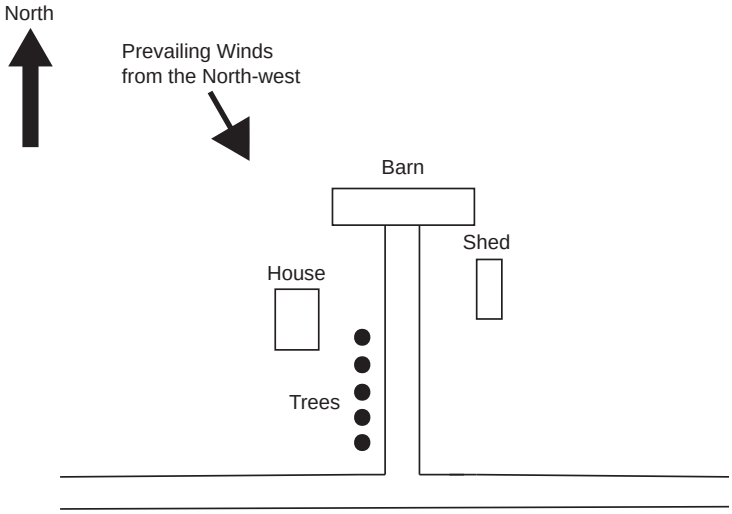
Now you can try planting your own windbreak! Here is a diagram of a farm, showing the house, barn, shed, driveway and fields. In this area, the winds usually come from the northwest, which makes them the prevailing winds. You have a choice of three trees to plant for your windbreaks: white pine (which usually goes on the side closest to the wind because it has a lot of branches and doesn't mind being blown around); Norway spruce (which can go in the second row); and Carolina poplar (which grows fast but is a deciduous tree- it loses its leaves in the fall).

Eastern white pine

Image Credit: http://canadiantreetours.org

Norway Spruce

Image Credit: Caledon Treeland
http://www.treeland.ca



White Poplar

Image Credit: Tree Names
http://www.treenames.net

Remember you want to protect your buildings and do what you can to keep your driveway clear of snow in the winter; and you want to have some land left to put into crops!

Videos created by the Ontario Ministry of Agriculture, Food & Rural Affairs
• Multifunctional Windbreaks: Planting https://www.youtube.com/watch?v=MYU2kxvtE4U&index=39&list=PLxmz9ERQlsZuqGYSGZglwIVFW9kV1Vjo2
• Multifunctional Windbreaks: Benefits & Planting https://www.youtube.com/watch?v=JsaxkB57quE&list=PLxmz9ERQlsZuqGYSGZglwIVFW9kV1Vjo2&index=41

Compaction Action

Compacted soil is like soil in a driveway. It is very hard to dig into and would not be a comfortable place for a seed to grow. Soil particles are packed close together, usually seen at the surface of the soil or at plow depth. Soil compaction has many causes:
• Heavy machinery
• Rainfall
• Tillage
• Foot traffic- people walking on soil and by animals, especially on confined pasture when soil is very wet
• Poor soil structure

As a result of soil compaction, air and water are pushed out from between the soil particles and becomes hard. This type of soil won't soak up water very fast, either. That means when it rains or when the snow melts, the water will probably run off the soil and it may cause erosion. It also negatively affects root development, as they try to spread out into the soil. Ultimately, compacted soil reduces crop yields.

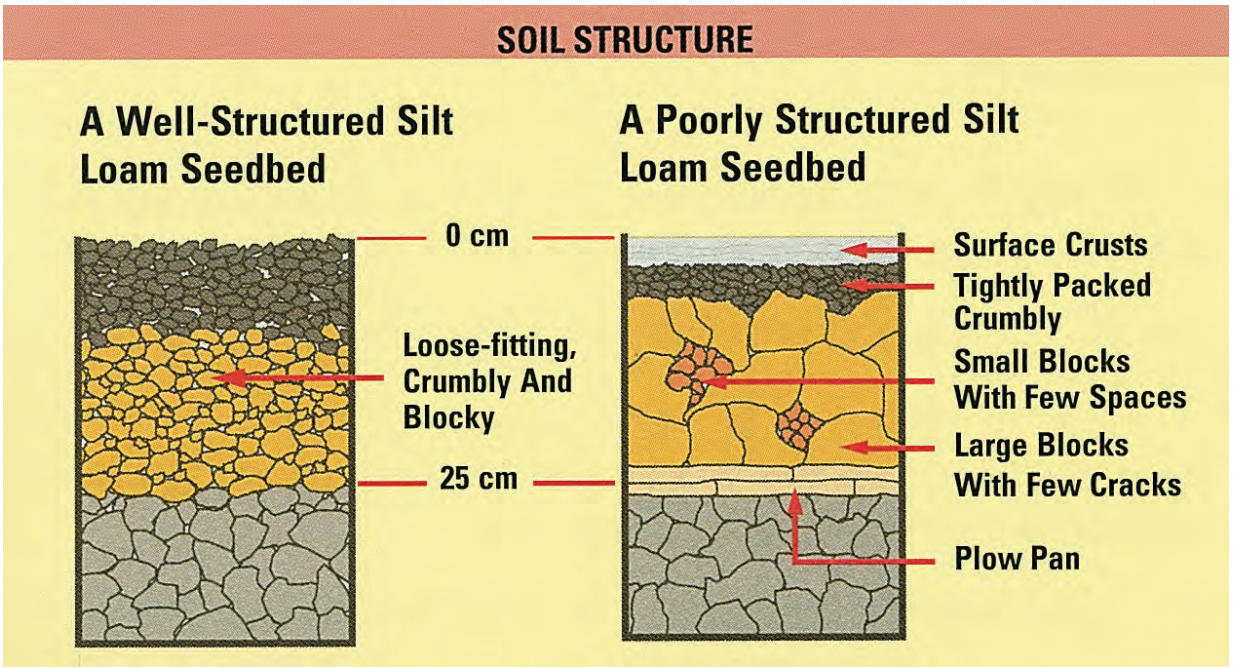


Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Management (1997)

Best practices to limit soil compaction

Avoid working wet soil

Soil is most susceptible to compaction when it is moist but not saturated. Saturated soil will deform but the water in the pores is not compressible so the pore space won't be reduced. A moist soil will allow soil particles to slide past one another easily and squeeze the pore space in the soil shut.

Plant or work the soil only when the soil conditions are right. Stay off the land when it is wet.

Ensure good drainage

Ensure there is good drainage for the soil. If needed, install tile drainage. See Meeting #4 "Water, Water Everywhere" for more information about tile drainage.

Limit traffic

Limit the amount of traffic on the field by equipment (including tillage).

Use alternative types of equipment

When planning the entire tillage system for a farm, the key is to reduce the number of tillage passes. It is also important to reduce the weight of the equipment and avoid wet soils.

The "plow pan" is a result of repeated smearing actions at the same depth over many years, in the fall when the soil is wet.

The traditional use of a moldboard plow has the potential to add to the problem of soil compaction. It turns the soil over and buries any crop residue that's on top. Moldboard plowing requires multiple passes by tillage equipment after plowing to prepare the soil for planting. This is energy and labour intensive.

Image Credit: USDA Plant and Soil Sciences eLibrary http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1088801071&topicorder=10&maxto=16

Moldboard Plow

There are several kinds of alternative tillage equipment to consider.

Deep rippers (also called subsoilers)

Deep rippers break up compacted soil layers with strong tines that loosen hard layers of soil (up to 40 cm below the surface). They rip hard ground to temporarily remove compaction. In order to alleviate soil compaction, deep rippers are used high traffic areas in fields and possibly wet spots because machinery isn't always the only source of soil compaction. Areas that pond frequently can be compacted from the weight of water sitting on the soil for an extended period. Deep rippers are used to help fix certain areas of fields that require extra attention and are not meant for regular tillage of all fields.

In areas that consistently have hard ground, the activities that are causing the compaction should be changed or the compaction will re-establish quickly.

Image Credit: GrainNews (2014) http://www.grainews.ca/2014/03/06/what-to-look-for-in-a-deep-ripper/

Image Credit: Great Plains Manufacturing Inc. http://www.greatplainsag.com/en/products/709/sub-soiler

Chisel Plow (Also referred to as a Shank/ Shank plow or Shank Soil Saver)

A Chisel Plow is a primary tillage tool and is used to break up and stir the soil 30cm or more beneath the surface without turning it. The shanks on the plow break up hard layers of soil. Chisel plowing, with twisted shovel teeth, will leave the soil ridged, which is good for soil erosion control but can require extra tillage passes in the spring and lead to uneven soil moisture in the seedbed.

When used properly, the chisel plow tills the soil and leaves 60 to 70% residue coverage on the surface. Prior to planting, a secondary tillage pass is normally required. (The residue is not completely turned over.)

Chisel Plow

Image credit: AgDealer.com http://www.agdealer.com

Vertical Tillage

Most vertical tillage equipment is comprised of vertical cutting blades at no angle or very shallow angles. Vertical tillage does not involve inverting (rolling) the soil during the tillage process. It can be accurately described as slicing and lifting rather than shearing. Vertical tillage machines do not move the soil from side to side and therefore, do not create a horizontal soil layer. This is important as eliminating soil layers allows roots to access nutrients and moisture previously unavailable which in turn produces more vigorous and productive plants.

Image Credit: Adam Hayes, OMAFRA

Worms & Soil Compaction

Tillage is one cause of soil compaction and it also destroys worm burrows and can cut and kill them. As a result, deep and frequent tillage can reduce earthworm populations.

The following practices boost earthworm populations:
- Tillage management (no-till, strip till, ridge till)
- Crop rotation (with legumes) and cover crops
- Manure & organic by-product application
- Pasture & hayland management
- Irrigation or drainage

Optional Activities
- Search for and show YouTube videos of each type of equipment in action.
- Bring in catalogues from equipment suppliers to show pictures of the different types of equipment.

Visit a farm or an equipment supply company to see the equipment up close.

BEFORE THE NEXT MEETING

Using your phone camera (or any camera), take pictures of a planted or pasture field, showing the slope, prevailing wind direction and the location of any erosion control structures in the field or nearby; things like grassed waterways, windbreaks, tile drainage, etc. You may want to do this individually or in pairs.

Note where the field is located.

What problems do you see? Take pictures of the problems.

What solutions and best practices do you see? Take pictures of the solutions.

MEETING 5 DIGGING DEEPER

For Senior Members

DIGGING DEEPER I

We know soil compaction has many negative effects on plant growth, including :
• Crops grown in compacted soils often have a restricted root system. This leads to poor nutrient uptake, stunted growth, a general lack of vigour and reduced yields.
• Compaction affected plants are also more vulnerable to diseases and insects.
• The root systems of affected plants often show signs of a physical barrier. The root tips may become stunted, or the plant may produce horizontal secondary roots in an attempt to outgrow the compaction.
• Transplanted crops grown on compacted soils often fail to leave the root plug, or they may develop a corkscrew-shaped taproot.

But are there any positive effects of compaction on plant growth?

Activity
Try planting the same seed type in two soil samples. One soil sample should be compacted soil and one should be loose and porous. Be sure to carefully observe and record your results to compare the differences, if any. Answer the question whether there are any positive effects of compaction on plant growth.

For Senior Members

DIGGING DEEPER II

Controlled traffic farming is a plan to reduce the damage to soils by limiting agricultural machinery on the soil. It's a permanent separation between crops and traffic zones.
In Australia, controlled traffic farming is more common and farmers have seen yield increases of between 10 to 15 per cent, as well as reduced fuel consumption, improved water infiltration, and increased water use efficiency. In Alberta, Controlled Traffic Farming Alberta (CTFA) is a farmer-led initiative aimed at evaluating, through on-farm research, controlled traffic farming systems. The group is interested in taking no-till and precision agriculture to the next level.

Research how to develop a controlled traffic plan or talk with a farmer. Visit a farm and sketch out how you would design a controlled traffic plan for that farm. Take photos.
Resources:
• Controlled Traffic Farming Alberta http://www.controlledtrafficfarming.org
• Department of Agriculture & Food, Australia https://www.agric.wa.gov.au/soil-compaction/developing-controlled-traffic-tramline-farming-system?page=0%2C2

Additional Resources

• Soil Erosion- Causes & Effects, OMAFRA http://www.omafra.gov.on.ca/english/engineer/facts/12-053.htm
• Soil Management: Best Management Practices, OMAFRA. ISBN # 0-7778-2686-0
    o Order online at www.publications.serviceontario.ca or call 1-800-668-9938

For Senior Members

DIGGING DEEPER III

Documentary: The Dust Bowl (240 minutes)

Objective:
• To learn about the relationship between humans and the ecology and how people's actions can greatly affect it.

Materials:
• DVD or download the documentary The Dust Bowl. http://www.pbs.org/kenburns/dustbowl/

Instructions:
Watch the PBS documentary by Ken Burns, The Dust Bowl, over a 2-meeting period (or longer). Description of documentary: "Vivid interviews with twenty-six survivors of those hard times, combined with dramatic photographs and seldom seen movie footage, bring to life stories of incredible human suffering and equally incredible human perseverance. It is also a morality tale about our relationship to the land that sustains us—a lesson we ignore at our peril."

Discussion:
• What are the lessons learned from the "dust bowl" of the 1930s?
• Do you think this could happen again?

For Senior Members

DIGGING DEEPER IV

Research the impact of machinery on the compaction of soil. Find out the weight of farm machinery such as a modern air planter, manure spreader, baler, harvester, combine, grain buggy, a gravity wagon full of grain and any other equipment that you can think of that is used in the field. Calculate the weight per axle.

Then, look up the limitations for trucks on the road.

How does the weight compare? Record your findings in your Record Book and be prepared to share your findings at the next meeting.

ACTIVITIES

Activity #24

Judging Activity

1. Farm tools, such as shovels. If possible, get a collection of ‘antique’ farm tools to compare with modern tools. When judging farm tools, consider: how they are used; weight/length/height; cost; material (wood, steel, etc.) and how easy (or hard) they are to use.
2. Alternatively, bring in any items (Leader or members) to judge.

Activity #25

Checking for Soil Compaction (15 minutes, each method)

Objective:
• To demonstrate the level of soil compaction using different techniques.

Materials:
• Method 1: shovel
• Method 2: shovel

Instructions:
1. Select the field/area from where you will take the soil samples.
2. Choose one method for all members to do, or divide into smaller groups, each trying one method and comparing results (ensuring all members are taking from the same soil area).

Method 1: Look at Crop Roots
• Use a shovel to dig up a crop root.
• Observe: Are the roots are restricted? Are the roots fine textured?

Method 2: Dig a Hole
• Select an area that has heavy traffic such as a pathway or the headlands of a field.
• Dig a 30-cm deep hole. As you dig you will be able to feel if there is a hard, compacted layer.
• With your shovel, take a slice off one side of the hole, lift it out, and lay it on its side.
• Make your observations: compacted soil shows up as a hard solid layer with large, deformed aggregates. The soil above it is usually looser and separates quite easily to expose the smooth surface of the compacted section. You may see plant roots growing horizontally along the top of the compacted layer because they cannot grow through it.

Discussion:
• What did you observe? Was the soil compacted?
• From where did you get the soil sample and do you think it affected the level of soil compaction? If yes, how?
• Compare the results of soil compaction for each method you used. Were they similar? Do you think one method is better than another? Why or why not?

Activity #26

Soil Compaction Investigation (60 minutes)

Objective:

• To examine the influence of soil compaction on plant and animal habitats and on water infiltration.

Materials:

• Ice pick or a soil probe
• Tin can with both ends cut out
• Water
• Measuring cup
• Paper; pencils
• Ruler or tape measure
• Stopwatch

Instructions:

You will need at least two sampling sights. One could be a high-traffic site where people often walk and the other site could be where there is little or no foot traffic. Or, samples could be taken in a field – one sample from the headlands where equipment turns and the second sample from the middle of the field that only receives one or a few passes with equipment.

1. Work in small groups to observe and classify the natural cover and litter (living and dead plants, insects, etc.) of each site. Sketch your findings or take photos.
2. Measure the soil's compaction at each site by recording the average depth to which an ice pick penetrates the soil when dropped four or five times from a height of three to four feet. Record the depths and calculate the average depth. Alternatively, use a soil probe.
3. Measure the water infiltration rate of each site. This can be done by placing a tin can, with both ends cut out, into the soil, filling it with a known quantity of water (the water amounts must be exactly the same for each site), and recording the length of time necessary for all of the water to penetrate into the soil.
4. Compare the data obtained from the two (or more) sites and discuss the effects and relationships of soil compaction and living organisms.

Activity #27

Field Traffic Pattern (60 minutes)

Objectives:
• To calculate how much of a field is covered with tire tracks in one year.

Materials:
• Paper
• Pencils
• Calculators
• Optional: Computer(s)/phone(s) with internet access

Instructions:
1. Either using a picture of a farm (with dimensions and information about the farm and equipment used) or visiting a farm in-person, members will calculate how much of that field is covered with tire tracks in a one-year period. (Alternatively, condense it to a one-month period or one day, etc.)
2. Consider the following information to gather and incorporate into your calculations:
    a. Field size and shape
    b. Field slope, that may influence crop row direction
    c. Drainage
    d. Entry point to field
    e. In-field obstacles
    f. Equipment size/tire size

In pairs or small teams, and either manually or using a free mapping software like Google Maps https://www.google.ca/maps, map out the traffic route of the field and calculate how much of the field you think is covered with tire tracks.

Discussion:
• How much (percentage) of the field was covered with tire tracks? Were you surprised at the results?
• How would you change the traffic pattern to reduce the amount of tire tracks (and therefore reducing soil compaction)?
• Compare your answers with other members.

Activity #28a

Wind erosion experiment (30 minutes)

Objective:

• To observe the effects of wind erosion on different types of soil.

Materials:

• Fan or blow-dryer
• 3 soil samples (loam, clay, sand) each on their own small tray
• 3 larger trays

Instructions:

1. Set up a system to create “wind” (a fan, a blow-dryer, etc.). Decide the distance to blow the wind towards the sand, keeping the distance the same for each soil test.
2. Start with the first small tray of soil and put it on top of a larger tray (to catch the movement of the soil).
3. Start the wind action and hold it for 15 seconds.
4. Observe/measure the amount of soil that was disturbed (eroded) from the small tray into the larger tray. Record your observations.
5. Repeat two more times with the other soil samples.

Discussion:

• Which soil had the most erosion? Was it soil with the largest soil particles or the smallest?

Activity #28b

Wind erosion prevention experiment (20-30 minutes)

Objective:

• To experiment with various methods to stop erosion.

Materials:

• Variety of gathered objects (popsicle sticks, twigs, leaves, branches, rocks, etc.) placed randomly on a table or box.

Instructions:

1. Now that you have observed wind erosion in action, do you think you can stop it? With a partner or in small teams, decide how you will try and stop soil erosion in this next experiment. Take a look at the materials provided for this acidity and decide how you will use them to prevent wind soil erosion. You can create anything you want.
2. Set up your soil erosion prevention method and then repeat the wind test you did in Activity 28a.
3. Observe and measure the amount of soil that was disturbed (eroded) from the small tray into the larger tray. Record your observations.
4. Repeat the experiment two more times with the other soil samples, using the same wind erosion prevention method you created.
5. Compare results to the first test and to the other members' prevention methods.

Discussion:

• Describe the wind erosion prevention methods you used. Why did you use this method?
• When you repeated your experiment with the other soil samples, did the results change? Explain.
• Which wind erosion prevention methods worked best from all the club members?
• If you could do the experiment again, what would you change about your wind erosion prevention method?

Activity #29

Guest Speaker(s) (30-45 minutes)

Objective:

• To learn and ask questions about wind erosion from an expert in the field.

Materials

• None

Instructions:

Invite a guest speaker to speak with members about erosion problems and solutions. Consider contacting: your local watershed board; woodlot association; conservation authority; a farmer; civil or environmental engineer; or any other authority.

Discussion:

Erosion problems and solutions, as presented by the guest speaker.

MEETING 6 - SOS: Save Our Soils

Objectives

• Recognize soil as a valuable, non-renewable resource.
• Learn about various tillage methods and equipment.
• Learn about methods to conserve soil.

Roll Calls

• Why is it important to keep soil safe and healthy?
• Based on what you have learned in this project, what would you do as a steward of the soil to protect your soil and to ensure the best success for crop growth?
• What is the most important/surprising/interesting information you have learned in this project?

Sample Meeting Agenda – 1 hr. 15 minutes plus activites

Welcome, Call to Order & Pledge		10 min
Roll Call		5 min
Parliamentary Procedure	Minutes & Business	5 min
Judging Activity	Activity #30 - Judging: Crop(s)	10 min
Topic Information, Discussion & Activities	***Topic Information*** • Importance of soil NOTE: Activity #3 (How Much Soil is There?) from Meeting #1 would also be appropriate for this meeting. • Conservation agriculture • Tillage • Soil conservation systems • Conservation cropping ***Activities*** • Activity #31 - A delicious tillage experiment • Activity #32 - Measuring crop residues • Activity #33 - Cut-can infiltrometer • Activity #34 - Reflection	30 min + Activities
At Home Activity	Choose one At Home activity to complete	5 min
Wrap up, Adjournment & Social Time!		10 min

Topic Information

"Soil is the earth's fragile skin that anchors all life on Earth"

Quote Source: World Wildlife Fund http://www.worldwildlife.org/threats/soil-erosion-and-degradation

Importance of Soil

Do you remember from Meeting #1 the importance of soil?
• Plants - Plants need soil to grow. Plants use soil not only for nutrients, but also as a way to anchor themselves into the ground using their roots and for water storage.
• Atmosphere - Soil impacts our atmosphere by releasing gasses such as carbon dioxide into the air.
• Living organisms - Many animals, fungi, and bacteria rely on soil as a place to live.
• Nutrient cycles - - The soil plays an important role in cycling nutrients. This is the movement and exchange of organic and inorganic matter back into the production of living matter.
• Water - The soil helps to filter and clean our water.

But you have also learned that soil is being threatened is a variety of ways; agriculture practices can result in soil erosion, compaction, decreased fertility, poor structure, and more. Half of the topsoil on the planet has been lost in the last 150 years.

Since it takes hundreds of years to make an inch or so of soil, it's important to act now to save our soils and to re-think agricultural practices, moving towards conservation agriculture methods.

What is Conservation Agriculture?

Conservation agriculture is a farming system that is based on three principles:
• Minimal soil disturbance through reduced or no tillage;
• Permanent organic soil cover using mulches; and
• Diversified crop rotations and associations (inter-cropping) with legumes.

Tillage

Tillage is preparing soil for planting or seeding by "turning" it with some kind of equipment. The most important reason for tilling the soil is to prepare a seedbed. If we till the soil properly, and the seeds get enough warmth, water and nutrients, they will germinate or sprout and grow into healthy plants. Tilling also helps control weeds, helps to reduce soil compaction, and mixes in organic matter or fertilizer into the soil.

But tillage also has its disadvantages. It can contribute to the loss of soil moisture, lead to increased wind and water erosion and consume significant amounts of fuel. As a result, farmers are moving towards other types of systems. Some Ontario farmers have been no-till for more than 20 years!

Did you know?

Do you know why worms are called "Nature's Plow?" Because as it moves through the different layers of the soil, it mixes them together.

Turning the soil

There are two kinds of systems to turn the soil:
• Conventional tillage
• Conservation tillage

These two systems are categorized based on the amount of crop residue (leaves, stalks, straw, etc.) left on the ground after the tilling process is complete.

Conventional tillage

Conventional tillage buries most of the crop residue into the soil and requires more than one pass in the field.
• Primary tillage is the first step of preparing the ground for seeds. It is usually done in the fall, when the farmer breaks up the soil by lifting and shattering it with a plow. Implements such as a moldboard plow, subsoiler, chisel plow, disk plow and vertical tillage can be used for primary tillage.
• Secondary tillage is when the farmer goes over the field a second and maybe even a third time in the spring to break up the clods of earth to make a smooth seedbed. This step is called secondary tillage and the farmer uses a disc, cultivator, harrow or all three to help smooth out the soil.

Did you know?

"Canadian farmers have had a major, positive impact on reducing Canada's greenhouse gas (GHG) emissions in recent years through soil management practices like zero-tillage. Farmers' actions have likely made the largest positive contribution to Canada's GHG inventory."

*Source: Grain News http://www.grainews.ca/2016/01/29/farmers-ahead-of-carbon-*curve/

Conservation Tillage

Conservation tillage involves a variety of soil cultivation methods that leaves the previous year's crop residue (e.g. corn stalks) on fields before and after planting the next crop. At least 30% of the soil surface must be covered with this residue after planting the next crop. Conservation tillage methods include no-till and strip-till.
Chisel plows, offset disks and vertical tillage can also be considered conservation tillage as long as there is enough residue to start with.

Each method requires different types of equipment.

No Till	The soil is left undisturbed prior to planting. Crops are planted directly into the remaining residue that hasn't been tilled.
Strip Tillage	The soil is left undisturbed prior to planting. Crops are planted directly into the remaining residue that has been tilled only in narrow strips; the rest of the field is left untilled. Can be done in the spring or fall.
Vertical Tillage	If used properly it is a conservation tool. Vertical tillage should just gently mix crop residue in the top 10cm (4 inches) of soil and it should leave a fair bit of residue at the surface.

Soil Conservation Systems

No-Till

If using a no-till tillage system, a farmer only goes over the field once at planting. In that one time, the trash wheels on the planter sweep crop residue out of a narrow path to allow for better seed germination. Care must be taken so that the trash wheels are not set too low; the wheels should not be making a trench in the soil.

With no-till cropping systems, crops are established with no or minimal soil disturbance.

Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Strip Tillage

This method of tillage only disturbs the portion of the soil that is to contain the seed row. The goal of strip tillage is to create a seedbed condition in the row that is similar to the result achieved by moldboard plowing, while leaving a relatively high amount of crop residue on the inter-row soil surface to reduce erosion. Strip tillage is often a separate operation, usually done in the fall although some implements and row crop planters are equipped to do strip tillage in the spring at planting.




Images Credit: Anne Verhallen, OMAFRA Soil Management Specialist (Horticultural Crops)

Vertical Tillage

The idea behind vertical tillage is to reduce the size of the crop residue and bring it into a closer relationship with the soil and soil microbes to help with decomposition. Vertical Tillage helps to control or minimize potential erosion and prepare a clean, level seedbed. It helps to provide improved soil aeration with minimal soil disturbance.

Image Credit: Adam Hayes, OMAFRA

The Best Way

Every field and farm is different and no one way of managing the soil is right for everyone. To be able to decide the best way to manage each field, you have to know:

- The soil texture of the field and drainage patterns;
- The crop grown before;
- The crop to be grown next year;
- Equipment available;
- Fertility; and
- Pest concerns.

Conservation Cropping

Conservation cropping limits the disturbance of soil and uses crops in ways that improve the soil and reduce soil erosion.

Contour Plowing & Planting

Fields can be plowed and crops can be planted across the slope on hills instead of up one side of the hill and down the other. If plowing is done and crops are planted around a slope, the ridges between the rows catch and hold water, giving it time to soak into the soil. Less water will run off, carrying soil with it. Contour farming works very well on short, gentle slopes.

Contour planting
Image credit: Ontario Ministry of Agriculture, Food & Rural Affairs - Best Management Practices: Soil Health in Ontario (2017)

Grass Field Borders

If you have a sloping field, you should think about seeding the borders to permanent grass. This will help control erosion and protect field edges which are used for turning and travel lanes by farm machinery. They should also be grown along waterways and erodible ditches.

Grass filter strips and other types of conservation buffers.
Image Credit: Dan Holm, Ausable Bayfield Maitland Valley Drinking Water Source Protection http://www.abca.on.ca/page.php?page=ausable-river-recovery-strategy-ARRS

Contour Buffer Strips

If you have a very steep field, you can plant permanent strips of grass across the slope of a hill to help stop erosion.

Strips of green alfalfa help curb erosion by providing breaks from the more erodible corn fields.

Image Credit: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_006620.pdf

Crop Rotation

Crop rotation, especially those that include forages, can reduce water erosion, improve the soil and slow insect and disease problems that often build up when you grow the same crop year after year. The best rotations include cereals (wheat, oats and barley) or hay crops (clover and alfalfa). One of the most popular crop rotations in southern Ontario is corn, soybeans and wheat.

Crop Rotation Plots, Ridgetown College, University of Guelph

Image Credit: OMAFRA Field Crop News (2016) http://fieldcropnews.com/tag/crop-rotation/

Strip Cropping

This involves alternating strips of forage and a row crop on the contour of a field. If you are not growing a forage crop, a cereal crop under-seeded with red clover is a good substitute.

Strips of oats and hay are interspersed with strips of corn

Image Credit: USDA National Institute of Food & Agriculture Plant & Soil Sciences eLibrary http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1088801071&topicorder=12&maxto=16

Crop Residue Management

Crop residues- stalks, stems, leaves, etc.- left in the field after the crop has been harvested can control erosion by covering the soil. The residue is left on the soil surface by reducing tillage and disturbing the soil less.

Corn stalk residue

Image Credit: Top Crop Manager http://www.topcropmanager.com/soil/crop-residues-the-big-picture-42

Cover Crops

Uncovered soil, especially loose, dry, bare soil, is susceptible to wind erosion. Keeping the soil covered with soil crops (or adding organic matter) has many benefits:

- Reduces soil erosion;
- Adds organic matter to the soil;
- Reduces nutrient losses;
- Reduces compaction and improves soil structure;
- Reduces moisture loss;
- Improves soil fertility; and
- Reduces pest populations.

There are different kinds of cover crops, depending on its purpose.

- **Winter cover crop** -planted in late summer or fall to provide soil cover over winter.
- **Catch crop**- planted after harvesting the main crop, primarily to reduce nutrient leaching.
- **Smother crop**- planted primarily to outcompete weeds.
- **Green manure**- incorporated into the soil while still green to improve soil fertility.

Some examples of different kinds of crops include:

<u>Non-Legume Broadleaves</u>
Buckwheat
Oilseed Radish
Other Brassicas
Marigold

Oilseed Radish cover crop

Image Credit: OMAFRA Cover Crops Factsheet (2001) http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm

Grasses
Rye
Winter Wheat
Oats
Barley
Sorghum
Sudan Ryegrass
Pearl Millet
Other (Corn, Fescue, Triticale)

Sorghum and pearl millet cover crop

Image Credit: OMAFRA Cover Crops Factsheet (2001) http://www.omafra.gov.on.ca/english/crops/facts/cover_crops01/cover.htm

Legumes
Red Clover
Alfalfa
Sweet Clover
Hairy Vetch
Field Peas
Other (Soybeans, White Clover, Crimson Clover, Berseem Clover)

Additional Resources

• Conservation Agriculture: Global Research & Resources http://conservationagriculture.mannlib.cornell.edu
• Midwest Cover Crop Council http://mccc.msu.edu/
• For a list of advantages and disadvantages of different types of tillage systems, visit this website: http://cropwatch.unl.edu/tillage/advdisadv

Resources to supplement the topic information (optional)

• Search for and show YouTube videos of each type of equipment in action.
• Bring in catalogues from equipment suppliers to show pictures of the different types of equipment.
• Visit a farm or an equipment supply company to see the equipment up close.

Additional Resources

• Soil Conservation of Canada http://www.soilcc.ca
• Soil Management: The Soil Resource http://www.omafra.gov.on.ca/english/crops/pub811/8soilresource.htm

MEETING 6 DIGGING DEEPER

DIGGING DEEPER I

For senior members

By plowing under the crop residue, the surface is not covered.
• What are the consequences of a bare soil surface?

DIGGING DEEPER II

For senior members

Make it Stay: Strategies for reducing Soil Movement

Tillage erosion takes place when soil is moved — by tillage and cultivation equipment — downslope into lower-lying areas of the fields. What this process does is scrape hilltops, leaving behind a light brown, tan, or even white soil that is missing the rich organic top layer. The good news is that not only is this movement of soil avoidable, but it's also reversible. Tillage erosion eventually leads to a highly variable field where overall yields are reduced. Those degraded lands will eventually get worse, especially when you factor in unpredictable weather events. But unlike wind or water erosion, which generally carry away soil from the field and destroy it, the good news about tillage erosion is that the soil is still nearby and completely intact. In many Ontario fields, you can often find two to three feet of soil at the bottoms of slopes where topsoil has accumulated. This creates an opportunity for growers to perform a process called soil-landscape restoration. Soil-landscape restoration is about picking up soil from lower-lying areas of the field and then dumping that soil back on hilltops where it's been lost.

How much can you increase the yield of a crop by adding topsoil? Set up an experiment by dividing a small plot that has suffered the effects of erosion into two areas. In the first area, plant your crop, but do not amend or change the soil at all. In the second area, add topsoil (you decide the amount) and plant the same crop at the same time as the first area. Carefully observe and record the results of your experiment. Did soil-landscape restoration work? How well, if at all?

ACTIVITIES

Activity #30

Judging Activity

1. Bring in a crop (corn, tomatoes, beans, etc.)- whatever is in season- for members to judge. Criteria to consider when judging: colour of crop (is it true to its type?); quality; freshness; insects/disease; cleanliness; size; etc.
2. Alternatively, bring in any items (Leader or members) to judge.

Activity #31

A Delicious Tillage Experiment (30 minutes)

Objective:
• To illustrate how compaction affects the infiltration, storage and rate of water movement through soils.

Materials: (this is enough for two teams; you can increase the amounts if you want to do the activity individually or in pairs)
• Balls of varying sizes: tennis, golf, bouncy balls, marbles, etc.
• 1 clear large jar or pitcher
• Water
• 2 cups sweetened chocolate rice cereal (e.g. “Cocoa Puffs” or “Rice Krispies”)
• 2 clear containers
• Closeable plastic bag
• Rolling pin
• 250mL (1 cup) (preferably whole milk or cream)
• 2 squirt bottles or measuring cups with pour spout
• Spoons for each participant

Instructions:
1. To demonstrate the varying sizes of soil particles, place balls of all different sizes into a clear jar or pitcher. Pour water into the jar to show where water sits between soil particles. Have members discuss how plants draw water from between soil particles and ways in which particle size makes a difference.
2. Divide members into 2 teams (till farmers & no-till farmers) and discuss the positive and negative aspects of both practices.

3. Pour one cup of chocolate rice cereal into the clear container of the no-till farmers. Place the other cup of cereal in a closeable plastic bag and roll with a rolling pin until approximately half of the cereal is crushed. Pour the crushed/compacted cereal into the clear container of the till farmers.
4. Pour 125mL (1/2 cup) of milk into each of two squirt bottles or measuring cups. Whole milk or cream is more desirable than skim or two percent milk because it is thicker and whiter, making it easier to see.
5. At exactly the same time and at the same rate, have one person pour a cup of milk over the compacted cereal and another person pour a cup of milk over the non-compacted cereal. Be sure to pour the milk into the center of the cereal so that the milk doesn't run down the sides of the container.
6. Compare the rate of milk flow through the two containers of cereal. How long does it take for the milk to reach the bottom of each container? Does the milk immediately infiltrate (enter) the cereal or does it "perch" on top or part way down?
7. Have members repeat the experiment on their own with the choice to crush (till), partially crush (partial till), or not crush (no till) their cereal/soil.
8. Discuss and eat the results.

Discussion:

• If this was water and soil instead of milk and cereal, how would this affect the growth of roots?
• Why do farmers till? Why might some farmers choose not to till?
• What would you do if you were a farmer?
• Which choice is better for the soil, the crops, the water, the farmer?

Activity #32

Measuring Crop Residues (30 minutes)

Objective:

• To learn how to measure crop residues and decide if it meets the 30 percent crop residue cover to be considered a conservation tillage practice.

Materials:

• Measuring tape or 30 metres (100 foot) rope
• Two stakes.

Instructions:

1. Count the number of times a marked line intersects with a piece of residue. Use a Use a 16 to 33 metre (50 to 100 foot) tape measure (or a rope with marks spaced at 30cm (one foot) intervals). Stretch the tape (or rope) between two stakes placed diagonally (at a 45-degree angle) of the crop rows.
2. Looking directly from above the tape (vertically), count the number of times where a “foot” mark intersects with crop residue. Make consistent judgments; use only the left or right side of the foot mark on the tape (or rope) to avoid over counting residue.
3. The resulting count converts directly into the percentage of crop residue remaining in that sample area. (Example: 38 occurrences of intersection equal 38 percent crop residue remaining).

Discussion:

• What were your results?
• If at least 30% of the soil surface must be covered with this residue after planting the next crop, does the tillage method used on this field meet conservation standards?

Activity #33

Cut-Can Infiltrometer (45-60 minutes)

Objective:

• Compare water movement through soil at different test sites and over time.

Materials:

• Metal cylinders (approximately 15 cm (six inches) in diameter and 13 to 20 cm (five to eight inches) in length)
• Hammer
• Scrap wood board (an 18 inch two by four works well)
• Stopwatch, or watch which reads in seconds
• Measuring cup with capacity for one half a liter (or 1 pint)

Instructions:

1. Carefully choose and prepare a test site. A level location will give the best results by allowing the water to infiltrate evenly into the soil. A site with gravel will most likely be difficult or impossible because of difficulties in sinking the cylinder into the soil. A heavy lawn sod will create similar difficulties because of the dense mat of roots. Option: consider testing multiple soil types or site locations, for comparison.
2. Sink the cylinder into the soil approximately five to seven centimeters (two to three inches) to create a tight seal between the bottom of the cylinder and the soil. You will most likely need to use a hammer to do this. It is best to place a wood board on top of the cylinder when hammering to keep from denting its top. Hammer in circles around the top to keep the cylinder perpendicular with the soil surface.
3. Have your stopwatch ready and add the water to the cylinder. Time how long it takes for all of the water to move into the soil with complete elimination of all puddles.

NOTE: During the test, if water leaks out the bottoms and sides of the cylinder, your results will be skewed. You will need to repeat the test with the cylinder either further in the soil or sunk more carefully so the soil is less disturbed along the cutting edge of the cylinder.

Discussion:

• Describe how different soil types and/or soil compaction influences water flow through soil.
• Based on the results of the infiltration tests, where would you locate your planting for best infiltration?
• What factors influence soil permeability?

Activity #34

Reflection

Use a few minutes at the last meeting to do an informal evaluation with the members. You could ask them to complete the following sentences (aloud) and record the answers to help plan for future projects:

- I joined this club because...
- I really enjoyed ...
- I didn't enjoy ...
- I had a hard time ...
- My favourite activity was ...
- If I was to take this project again, I would ...
- I learned ...
- I've changed ...
- I'm glad ...