K-12 IYS Activity

Soil Science Society of America

The Soil Management Farming Game

Summary

This game investigates the ways in which the choices farmers make—the crop to grow, to plow or not to plow (till or no-till), and the amount of fertilizer to use—can influence both crop yields and greenhouse gas emissions. Soil organic matter (SOM) has large amounts of carbon, which is also an important part of the greenhouse gases carbon dioxide (CO_2) and methane (CH_4). Microorganisms decompose SOM, obtaining energy and producing either CO_2 if there is lots of oxygen in the soil or CH_4 if there is little oxygen. Tillage adds oxygen to the soil, but water can fill the spaces in the soil that would otherwise contain oxygen. Plants need both oxygen and water to grow. Other management choices, including combinations of the crops raised and the tillage methods chosen, have the ability to increase SOM, effectively removing CO_2 from the atmosphere.

Learning Objectives/ Outcomes

1. To learn about greenhouse gases that can be emitted from soils
2. To learn how agricultural management decisions can influence the rates of emissions of those gases

Materials

- A computer lab or a classroom with computer stations with internet connection for each participant.
- Copies of worksheets supplied with the activity

Celebrating the 2015 International Year of Soils

soils.org/IYS

Ages of Audience

Elementary, particularly grades 3-6.

Recommended group size?

1. Less than 20
2. 20-50

Where could you offer this?

1. Your university
2. Local school
3. Library
4. Anywhere with internet-connected computer facilities

What type of room do you need?

Computer stations

Type of Lesson (may be more than one)

1. Indoor
2. Small group exercise/discussion critical thinking

Time Needed

1. Scientist prep time + clean up time: Minimal
2. Participant/class time: 30-45 minutes

If the activity costs money, how have you funded this in the past/suggestions for others?

Minimal cost—only photocopying expenses.

Methods/Procedures

1. Give each participant a worksheet.
2. Go to http://forces.si.edu/soils/interactive/web/index.html to play the "Greenhouse Gas Calculator" farming game.
3. Change your choices to see how those choices influence greenhouse gas emissions. Try each crop, both till and no-till, and different levels of fertilization.
4. Record the results from each set of choices on the supplied worksheet.
5. After playing the game for some time, discuss the results.

Discussion Questions

(Some questions repeat concepts covered by other questions, but approach the concept in a different way. Select from the proposed questions to customize the activity to the level and ability of the participants.)

1. Which tillage technique, no-till or till, resulted in lower greenhouse gas emissions? Why? (*No-till resulted in lower greenhouse gas emissions. No-till does not introduce high levels of oxygen into the soil, so the decomposition of soil organic matter does not take place as rapidly, and decomposing organic matter releases greenhouse gases into the atmosphere.*)
2. If you elected to till your soil, many objects shown as gray and red balls went into the atmosphere. What do those gray and red balls represent? (*Carbon dioxide gas being created and given off by decomposing soil organic matter.*)
3. If you elected no-till management for your soil, fewer gray and red balls went into the atmosphere. Why is that? (*No-till does not introduce as much oxygen into the soil as tilling; this slows the decomposition of organic matter and the production of carbon dioxide.*)
4. Which crop resulted in fairly high greenhouse gas emissions regardless of what tillage and fertilizer choices were made? Why? (*Corn resulted in the highest greenhouse gas emissions. This is because corn has a high nitrogen fertilizer requirement, and nitrogen fertilizer that is not used by the crop can be converted into greenhouse gases by soil microorganisms.*)
5. Which crop resulted in the lowest greenhouse gas emissions? Why? (*Switchgrass, because it does not require nitrogen fertilizer and instead adds nitrogen to the soil when it grows.*)

continued...

6. Soybeans result in less greenhouse gas emissions than corn, but more than switchgrass. Why? (*Soybeans add nitrogen to the soil, so unlike corn they do not require nitrogen fertilizers. However, the nitrogen the soybeans add can be converted into greenhouse gases by soil microorganisms, so they release more greenhouse gases than switchgrass, which stores excess nitrogen in its roots.*)
7. Greenhouse gas emissions were high if you elected to apply high levels of nitrogen fertilizer, regardless of the crop and tillage selections. Why is that? (*Soil microorganisms convert excess nitrogen from the fertilizer into greenhouse gases.*)
8. Which combination of choices gave the lowest greenhouse gas emissions? (*Switchgrass, no-till, and low fertilizer*)
9. Which combination of choices gave the highest greenhouse gas emissions? (*Corn, till, and high fertilizer*)

References

The farming game was developed as a part of the Smithsonian Dig It! soils exhibit.

Greenhouse Gas Calculator Farming Game Data Sheet

NAME ____________________ DATE ____________________

Management Choices	Results: Yield (circle one)			Results: Greenhouse gas emissions (circle one)		
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High

Management Choices	Results: Yield (circle one)			Results: Greenhouse gas emissions (circle one)		
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High
Crop: ______ Tillage: ______ Fertilizer: ______	Low	Medium	High	Low	Medium	High