FOOD FOR 9 BILLION

The Challenge of Feeding the World

Nourishing the Soil

Teacher Notes

Before You Start

Grade Level:
Grade 9-10

Concepts Covered:
Types of soil, arable land, cereal crop yield, soil fertility

Time Frame:
1 -2 50 minute class periods

Materials Needed:
Student Handout ***Nourishing the Soil***
Student computers with Internet access
Computer with Internet access and a projection system (for reviewing answers or viewing resources as a whole class)

Overview

To grow food crops we need healthy soil. What is soil and how do farmers make sure it remains productive? Using online resources and two stories from the Food for 9 Billion series, students will investigate how farmers in two different countries are addressing the need to nourish the soil.

Objectives

- Students will explore arable land and cereal crop yield data from around the world.
- Students will investigate some of the conditions that affect food production in two West African countries.
- Students will use online resources to collect data and information about productivity and soil types.
- Students will compare and contrast different soil types.
- Students will describe and evaluate the impact of various efforts to maintain soil fertility and to increase food production.

Prior Knowledge

For students unfamiliar with farming, explain that tilling soil means preparing it for crop production, often by plowing and shaping the soil. The definition of soil is the mixture of mineral and organic particles occurring in layers on the surface of the Earth. Dirt, essentially, is displaced soil.

Teaching Tips/ Activity Sequence

This activity can be done as a whole-group activity, individually, or in small groups. You know what works best for your class of students!

1. Introduce the activity briefly. Group students if you wish, hand out the student worksheet, and let students immediately begin collecting data from the interactive online map in part 1. Have students stop after part 1.

2. Discuss the answers to part 1 to activate student knowledge and develop a foundation for further discussion. Ask students what questions they have so far. Verify everyone can locate Niger and Ghana on a map.

3. Allow students to continue on with the activity. Actively monitor student activity and check student understanding as they work.
    - In part 3, students may need help working with the soil interactive. Clicking on the small colored buttons fills in the map. Clicking on the soil type picture brings up a description of the soil.
    - In part 4, students might need help understanding what tilling is and what "no-till" is. See the Resources section below for more about till and no-till approaches to agriculture.
4. Conclude by reviewing answers to each section and discussing students' thoughts about the strengths and weaknesses of the different approaches to maintaining soil fertility.

Extensions

- For an activity about the relationship between famine and recent African droughts, see The Complex Causes of Famine at http://ricediversity.org/outreach/educatorscorner/activity-new.cfm?activity_id=16
- Look at the map of current and potential arable land use in Africa at http://www.grida.no/graphicslib/detail/current-and-potential-arable-land-use-in-africa_a9fd.
- View this video about conserving topsoil: http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.organic/

Resources

- Wikipedia provides helpful background information (including pros and cons) about tillage at http://en.wikipedia.org/wiki/Tillage
- An easy summary of soil & agricultural methods: http://envirosci.net/111/soil/the_soil.htm and a chart http://envirosci.net/111/soil/the_soil.htm
- A summary of no-till farming, including pictures: http://gis.lrs.uoguelph.ca/agrienvarchives/gp/bmp/notillbmp.html
- Rodale Institute's research and information: http://www.rodaleinstitute.org/no-till_revolution

Standards

National Science Education Standards Grades 9-12	*Common Core State Standards for Literacy in History / Social Studies, Science and Technical Subjects 6-12*
Life Science Interdependence of organisms 4.1, 4.5 Matter, energy, and organization in living systems 5.3 Science in Personal and Social Perspectives Natural Resources 3.1, 3.2, 3.3 Environmental Quality 4.3 Science and Technology in local, national, and global challenges 6.2, 6.4	Reading Standards Key Ideas and Details RST1, RH1 Integration of Knowledge and Ideas RST7 Writing Standards Text Types and Purposes WHST2 Production and Distribution of Writing WHST4 Range of Writing WHST10

National Curriculum Standards for Social Studies	*National Geography Standards*
3. People, Places, and Environments 5. Individuals, Groups, and Institutions 7. Production, Distribution, and Consumption 8. Science, Technology, and Society 9. Global Connections	2. Knows the location of places, geographic features, and patterns of the environment 14. Understands how human actions modify the physical environment 18. Understands global development and environmental issues

Acknowledgements

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Name: ____TEACHER ANSWER KEY_____

Date: _____ Class:_____

Nourishing the Soil

Nearly everything we eat grows in soil. By 2050 there will likely be 9 billion people on this planet and they all need to eat! The soil will help, but only if we help it. Let's focus on Africa and learn more.

Part 1: Arable Land

Open up the World Food Statistics Map at http://cironline.org/reports/map-world-food-statistics-2971. Change the indicator to Arable Land and take a quick look to see where in the world there is lots of arable land and where there is not.

> The FAO defines arable land as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow.

1. Find Africa and then find Niger (it's pronounced nee-JAIR). How much arable land does Niger have? What is the climate like? What is the cereal crop yield?
   Niger has 1 ha/person of arable land, or 15.5 million hectares. The climate is desert-like. The cereal crop yield is 489 kg/hectare.

2. Now find Ghana. How much arable land does Ghana have? What is the cereal crop yield?
   In Ghana, there is .18 hectares of arable land per person, but the cereal crop yield is 1660 kg/ha.

3. What do you find interesting in the details above?
   Student answers will vary. Hopefully they will remark on the differences in the cereal crop yield per hectare in the two countries.

Part 2: The Soil in Niger

Watch the story, "Re-greening the Sahel" at http://cironline.org/reports/re-greening-sahel-3643.

4. Describe the re-greening effort and its impacts on the soil.
   Niger is a country in the Sahel region just south of the Sahara desert. It has frequent droughts and the south, where most of the food is grown, is becoming more desertified. Additionally, farmers cut down almost all of the trees. The re-greening program is an effort to reverse these processes.

   The government pays people to dig holes that trap water and in which seeds of trees – or parts of old root systems – will sprout. The trees provide leaves and twigs that create mulching material, helping the soil retain moisture and allowing crops to grow. They also reduce the impact of sandstorms.

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Nourishing the Soil

Part 3: Soils Around the World

Load Soils Around the World at http://www.teachersdomain.org/asset/ess05_int_soils/.

5. What is soil? Are all soils the same?
   Soil is a mixture of loose, weathered rock, water, gasses and decomposing organic matter (humus). There are many different types of soils. Some are young; some are more mature. Soils vary in color, texture and mineral composition.

Find Niger and Ghana on the soil map. Click the little bars of color under the soil types at the top to figure out the dominant soil types in the two countries.

	Soil Types
Niger	*Entisols, Alfisols (small amount), Vertisols (tiny amount), Inceptisols (tiny amount)*
Ghana	*Alfisols, Ultisols, Inceptisols (tiny amount), Oxisols (tiny amount*)

6. Compare the characteristics of the most common soils in Niger to those of the most common soils in Ghana.
   Niger has primarily Entisols and Alfisols. Entisols are young soils that lack distinct layers. Alfisols are well-developed soils that are very fertile. Like Niger, Ghana also has Alfisols, but it has more than Niger. Ghana also has Ultisols. Ultisols have high acidity (low pH), but if treated with lime, Ultisols can be used for agriculture.

7. What are the factors that affect soil fertility? (Hint: check Alfisols)
   The factors that affect soil fertility include the availability of minerals and nutrients, the microbe population, precipitation or moisture, and soil acidity.

Part 4: The Soil in Ghana

Listen to the story, "Soil is ground zero in African farming debate" at http://www.marketplace.org/topics/sustainability/food-9-billion/soil-ground-zero-african-farming-debate.

8. Dr. Francis Tetteh from the Soil Research Institute says that farmers are "mining the soil." What does that mean?
   He means that farming takes nutrients out of the soil and the nutrients are not replaced. Once the nutrients are gone, the soil doesn't grow crops.

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9. Describe what the 1980s development project brought to the region and why the successes were not sustained.
   In the 1980s, a development project brought things farmers had never had before: improved corn seeds, fertilizers and herbicides. This changed everything – bigger corn plants, bigger harvests and more money. But once that project ended, farmers couldn't afford fertilizers on their own. Even today with the Ghanaian government subsidizing fertilizer prices, the cost is still too high.

10. Agronomist Kofi Boa is an advocate of no-till farming. Describe no-till farming. Describe one advantage and one disadvantage of no-till farming.
    Farmers simply leave all the unused parts of crops to decompose on the field. That creates mulch that keeps moisture in and adds back nutrients. The soil stays covered and is restored by nature. However, no-till farming often results in a lot of weeds and requires either difficult hand weeding or the use of chemical herbicides.

11. What is glyphosate? Why is it used and what is a disadvantage of using it?
    Glyphosate (known by its brand name, Roundup) is an herbicide; it kills weeds with reduced labor. However, it reduces the amount of mulch available. In some places, weeds have evolved to resist glyphosate.

12. Why do some farmers prefer glyphosate and artificial fertilizers to planting cover crops?
    Many farmers feel it's easier to use herbicides to kill the weeds and fertilizers to add nutrients rather than to plant cover crops that function as mulch and add nutrients.

13. Alternatives to purchased fertilizer do exist, but they can be more work for farmers. Describe how the northern Ghana farmer's approach is different than what many farmers are doing in the south.
    Richard Dahaman manages every aspect of his farm, from water to waste, and makes use of everything. For example, he collects rainwater; he also collects his sheep's' droppings to nourish his soil rather than buy fertilizer.

Conclusion

You are a soil management expert advising a small country that is struggling to feed its increasing population. It has a mixture of dry and less fertile soils in the west and more fertile, but intensely farmed Alfisols in the east. The leaders want to increase cereal crop production and are asking your help in developing a plan. Respond to their request, explaining your philosophy about keeping soil nourished and productive, and indicating what further information or details you would need from them.

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