FOOD FOR 9 BILLION

The Challenge of Feeding the World

Farming In a New Climate Reality

Teacher Notes

Before You Start

Grade Level:
Grade 9-10

Concepts Covered:
Plant growth, limiting factors, impacts of climate change

Time Frame:
30-50 minutes

Materials Needed:
Student Handouts
Computers with Internet access
Computer with Internet access and a projection system

Overview

Will climate change lead to more or less food production worldwide? Students will learn about the factors that limit plant growth as well as how one small country, Bangladesh, is working to preserve its food production in the midst of changing climatic conditions.

Objectives

- Students will summarize the concept of limiting factors as related to plant growth.
- Students will identify the projected impacts of climate change on coastal farming communities.
- Students will evaluate alternative proposals to mitigate the impact of sea level rise on rice farming.

Prior Knowledge

Photosynthesis, climate

Teaching Tips/ Activity Sequence

1. Introduce and provide some context for the activity.
    a. Use the Timeline: Food Through the Ages at http://cironline.org/reports/timeline-food-through-ages-2972. Find the 1974 famine in Bangladesh. Read about the causes and impacts.
    b. Use the World Food Statistics map at http://cironline.org/reports/map-world-food-statistics-2971. Locate Bangladesh and read the summary provided. Calculate the population density and compare it to that of the United States.
2. Provide students with the handouts and have them do Part 1 alone or in small groups.
3. Gather the class together to discuss the answers and to review limiting factors. Ask students what they think the limiting factors on rice production in Bangladesh are.

4. Have students do Part 2 alone or in small groups.
5. Conclude the activity by gather the whole group together. Review any student questions and have students share and discuss their responses to questions 3 and 4.

Extensions

- The EPA has an informative site about climate change, "Agriculture and Food Supply Impacts and Adaptations," at http://www.epa.gov/climatechange/impacts-adaptation/agriculture.html.

Standards

National Science Education Standards
Grades 9-12

Life Science
Interdependence of Organisms 4.4, 4.5
Earth and Space Science
Global climate 1.4
Science in Personal and Social Perspectives
Population Growth 2.2, 2.3
Environmental Quality 4.1, 4.3
Natural and human-induced hazards 5.4
Science and Technology in local, national, and global challenges 6.2

National Geography Standards

2. Knows the location of places, geographic features, and patterns of the environment
9. Understands the nature, distribution and migration of human populations on Earth's surface
14. Understands how human actions modify the physical environment
18. Understands global development and environmental issues

Common Core State Standards for Literacy in History / Social Studies, Science and Technical Subjects 6-12

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

3. People, Places, and Environments
5. Individuals, Groups, and Institutions
6. Power, Authority, and Governance
7. Production, Distribution, and Consumption
9. Global Connections

Resources

- Scientific American article, "Farmed Out: How Will Climate Change Impact World Food Supplies?" at http://www.scientificamerican.com/article.cfm?id=how-will-climate-change-impact-world-food-supplies

Acknowledgements

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Name: TEACHER ANSWER KEY

Date: _____ Class:_____

Farming In a New Climate Reality

How will climate change impact food production? The answer is complex, but let's take a look at one small country, Bangladesh, that is already feeling the impact of climate change. Rice is the main crop impacted. Before we go to Bangladesh, let's reacquaint ourselves with plants.

Part 1: Limiting Factors

According to the **principle of limiting factors**, the maximum rate of photosynthesis a plant can achieve is limited by whichever basic resource of plant growth is least available.

1. What are the limiting factors to plant growth? What does a plant need in order to grow? List as many factors as you can.
   Factors include: pH level, light (intensity, color and photoperiod or length of day), carbon dioxide, nutrients or soluble minerals in the soil, temperature of both the air and the root zone (also, the variation between the high and low temperature), soil particle size (the size affects the rate of drainage as well as aeration or oxygen content at the root zone, water).

As you remember, carbon dioxide, or CO_2 is one of the primary reactants in photosynthesis.

2. What do you think will happen to rates of photosynthesis if CO_2 levels increase?
   Student answers will vary. Make sure they are well reasoned. Since CO_2 is a reactant, increasing its supply could logically lead to higher rates of photosynthesis. However that photosynthetic increase could be easily offset by lack of water or changed temperatures.

3. Do you think increased CO_2 levels will be good or bad for food crops?
   Student answers will vary. Make sure they are well reasoned. If students have argued that increased CO2 will lead to increased photosynthesis, this is the place to discuss other factors like temperature, water or nutrient availability.

Now let's explore the complexity of increasing CO_2 levels and its impact on plants. Read the article at http://www.newscientist.com/article/dn11655-climate-myths-higher-co2-levels-will-boost-plant-growth-and-food-production.html and answer the questions below.

4. Scientists have done experiments in which plots of land are subjected to increased CO_2 levels. What are the longer-term impacts of increased CO_2 levels on plant growth?
   Experiments imply increased yields of about 13 percent for crops other than maize (corn), sugarcane, millet and sorghum (all C4 crops). Experiments on natural ecosystems show that within a few years initially elevated plant growth rates tend to level off, usually due to another limiting factor such as water or nutrient availability.

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5. Describe some other limiting factors that could be impacted by climate change and how changes in those factors can affect plant growth.
   In cooler regions, higher temperatures will likely increase plant growth. However, in the tropics, increased temperature may actually reduce growth. A recent long-term (20-year) study of Panamanian and Malaysian rainforest plots showed tree growth reduced by 50% in association with increased local temperatures of more than 1ºC. (Another example: recent studies project declines in corn yields in Africa with increased temperature. Lobell et al. 2011 Nature Climate Change 1:42-45.)

   Due to air pollution, plant-damaging ground-level ozone is expected to rise and could offset benefits from higher CO_2. Levels.

   Increased CO_2 levels will bring regional climate changes that will change regional water supplies. In some places, rainfall may increase; in other places it may decrease. The timing, frequency and intensity of rainfall are also expected to change in many places.

   Based upon their prior knowledge, students might provide other reasonable answers.

6. According to the article, is it possible to predict the world's changes in food production due to elevated CO_2 levels? Explain why or why not.
   Predicting the world's net changes in food production due to increased CO_2 is difficult, if not impossible. Essentially, world food production is predicted to increase until local average temperatures rise by more than 3°C. At that point, production is predicted to decrease. Smaller temperature increases (1 to 2°C) in tropical and dry regions are expected to reduce food production. In water-constrained environments like the western US and much of the developing world, losses due to lack of water may greatly exceed the small gains from elevated CO_2.

   The world's food crops depend on specific combinations of soil, climate, water and weather, plus the market and economic systems for food delivery, storage and production. Shifting crops will likely be difficult for the worlds' poorest farmers.

Part 2: The Impact of a Changing Climate on Food Production in Bangladesh

Listen to the story, "Bangladesh farmers confront new climate reality," at http://cironline.org/projects/food-for-9-billion and answer the questions below.

1. The narrator says that many changes predicted by climate change have arrived already in coastal Bangladesh. What are the changes?
   Stronger and more frequent storms. Erratic rainfall. Salty soils that make it impossible to grow crops.

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2. For Bangladesh, what is the biggest threat from climate change? Why?
   Rising sea level is the biggest threat from climate change because it could wipe out one sixth of the county and 15 million people may have to leave the southern regions.
3. The government minister says that the global community is responsible for climate change and thus must pay for efforts to deal with the situation in Bangladesh. Do you agree or not? Explain.
   Student answers will vary. Accept all answers that are well reasoned and logical.

The government is trying to raise money to fight against the damage in their country, but experts from other countries say that the answers lie in different solutions. Fill in the chart below.

	Minister of the Environment	U.S. AID	Agriculture specialist at Cornell University
Ideas for combating the impacts of climate change on food production in Bangladesh	*The government of Bangladesh says it needs $10 billion right away to pay for things like shoring up seawalls and building cyclone shelters.*	*•Some disaster relief support.* *• Support research into rice varieties that can tolerate flooding or salt.* *•Promote fish farming, as well as horticulture.* *•Diversification will mean more resiliency to climatic shocks.*	*• Adding lime to soils in northern Bangladesh, where most of the country's food comes from, can increase crop yields by more than a third.* *• Shift to crops that use less water. The environment can be highly productive for agriculture with some changes.* *• Change farming methods and diversify: plant vegetable gardens on rafts that float when there's a flood; convert rice fields into ponds for fish or shrimp.*

4. Bangladeshi farmers are trying to cope with changing climatic conditions and still feed the country's large population. If you were in a position to support a mitigation or adaptation project with a large sum of money, which would you choose and why? Explain your answer in one or more complete paragraphs.
   Student answers will vary. Accept all answers that are well reasoned and logical. Note that countries with high CO2 emissions tend to focus on mitigation, while countries with low CO2 emissions tend to focus on preparing for the new reality.

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