NATIONAL GEOGRAPHIC
Activity*apply*

Best Practices

What can we do to ensure future agricultural production?

Overview

Students explore the reasons for increased agricultural production and make predictions about future agricultural production. They examine data and investigate field research that is attempting to increase plants' yields without chemical or biological interventions. Students propose land management strategies for different fields.

For the complete activity with media resources, visit:
http://education.nationalgeographic.org/activity/best-practices/

Directions

1. Engage students' interest in learning about agricultural production.

Show the **Yields of Cereal Grains from 1961 to 2012** graph image. (Download the image from the media carousel above by clicking on the down arrow in the lower right corner of the carousel window.) Tell students that agricultural yields have increased over the past 50 years. Ask:

- *Which area has the highest agricultural production of cereal grains?* (North America has the highest yields of cereal grains.)
- *Why do you think there are occasional dips in crop yields?* (Answers will vary. Yields could drop because the weather was not cooperative or because there were pest infestations.)

Tell students they will explore the factors that led to increased crop yields and be asked to predict whether these increases can continue in the future.

2. Discuss the role of uncertainty in the scientific process.

Tell students that science is a process of learning how the world works and that scientists do not know the "right" answers when they start to investigate a question. Tell students that they can see examples of scientists' uncertainty in forecasting crop yields. Show the **Projection of Maize Crop Yields in France** graphs. (Download the image by clicking on the down arrow in the lower right corner of the media carousel window.) Tell students that these graphs show the average daily precipitation, number of hot days, and yield of maize. The gray line shows the predictions for crop yield based on technological improvements. The pink shading shows the expected yield based on temperature and precipitation influences. The red lines outside the pink shading show the total

uncertainty. Ask:

- *Does the technology trend (gray line) accurately predict crop yields?* (No, the technology trend does not adequately predict crop yields. This is because crop yields are dependent on temperature and precipitation as well as technological improvements.)
- *Why do you think the crop models still have uncertainty even after accounting for precipitation and temperature differences year to year?* (Student answers will vary. The crop yield could be affected by a pest infestation.)

Tell students they will be asked questions about the certainty of their predictions. Let students know that they should think about what scientific data is available as they assess their certainty with their answers. Encourage them to discuss the scientific evidence with each other to better assess their level of certainty with their predictions.

3. Introduce the concept of stocks and flows in a system.

Tell students that materials flow into and out of systems. The flow of the materials over time can change and can be influenced by many different factors and interacting parts.

Scientists think about how one part of the system can affect other parts of the system. Give students a simple example of a stock and flow in a system, as described in the scenario below.

There is a bathtub with water flowing in from the faucet and water leaving through the drain. Ask:

- *When the drain is plugged, what happens to the level of water in the bathtub?* (The water level will increase because the outflow of water is stopped, but water keeps coming in from the faucet.)
- *When the faucet is turned off, what happens to the level of water in the bathtub?* (The water level will decrease because the inflow of water is stopped, but the water keeps leaving through the drain.)
- *How can the level of water in the bathtub be kept at the same level?* (The water in the bathtub can be kept at the same level by making the inflow equal to the outflow. Then the water that comes in through the faucet will be offset by the water that leaves through the drain.)

Tell students they will be following the flow of materials, in this case the amount of topsoil and nutrients, through a system. Let students know they will be exploring some environmental and human factors that contribute to changes in the quality of soil in the modeled system.

4. Have students launch the Best Practices interactive.

Provide students with the link to the Best Practices interactive. Divide students into groups of two or three, with two being the ideal grouping to allow groups to share a computer workstation. Tell students they will be working through a series of pages of questions related to the data in the interactive. Ask students to work through the interactive in their groups, discussing and responding to questions as they go.

Tell students this is Activity 5 of the **Can We Feed the Growing Population?** lesson.

5. Discuss the issues.

After students have completed the activity, bring the groups back together and lead a discussion focusing on these questions:

- *What techniques have been used to increase crop yields around the world?* (Different ways of planting crops have increased the yield of rice, as in the System of Rice Intensification project. Scientists have been able to crossbreed crops to create better-yielding crops, and genetic modifications have allowed some crops to be grown without using pesticides. Scientists have developed fertilizers that can help crops grow to their full potential. Farmers use irrigation during dry years to provide enough moisture to their crops.)
- *What is the relationship between monocropping and pesticide usage?* (When crops are monocropped [a single crop being grown year after year in the same fields] pesticide usage can be high. This is because the pests have a lot of access to a single crop. When the crops are rotated or smaller fields are planted with different crops, the amount of food available to a specific pest is limited. With large fields of the same crop, pests have a feast. To limit the damage caused by pests, pesticides might need to be applied more than they would be in smaller fields with different types of crops.)
- *Do you think agricultural production will continue to increase?* (Answers will vary. There are many challenges facing agriculture today. Much of the increased yield is due to modern technology, but there may be limits to how much technology can continue to increase crop yields. The technology used in North America might not be applicable to agricultural areas of other regions of the world.)
- *Why won't a land management plan from one field be just as good for another field?* (Land management plans should differ for different fields because they should be suited to the land, not a one-size-fits-all solution. A field on a hill will need to be planted differently than a flat field. Fields in a very rainy or windy climate will need to be treated differently than fields in drier, less windy climates. The land management plan should focus on preserving the soil and increasing its quality. This means the first focus should be on preventing erosion. The next focus should be

on putting more organic material into the soil so it can hold more moisture and be more nutrient-rich. This can be done with different tillage strategies and crop rotation.)

Tip

If you would like to save student data for grading online, register your class for free at the High-Adventure Science portal page.

Tip

This activity is part of a sequence of activities in the Can We Feed the Growing Population? lesson. The activities work best if used in sequence.

Modification

This activity may be used individually or in groups of two or three students. It may also be modified for a whole-class format. If using as a whole-class activity, use an LCD projector or interactive whiteboard to project the activity. Turn embedded questions into class discussions. Uncertainty items allow for classroom debates over the evidence.

Informal Assessment

1. Check students' comprehension by asking them the following questions:

- How does monocropping lead to increased fertilizer and pesticide usage?
- Compare and contrast different methods of pest control.

2. Use the answer key to check students' answers on embedded assessments.

Objectives

Subjects & Disciplines

Science

- Earth science
- General science

Learning Objectives

Students will:

- describe how genetic modifications can increase crop yields
- describe how monocropping can lead to increased fertilizer and pesticide use
- explain why different landscapes require different land management plans
- propose a land management strategy for a field, given information on the topography of the field and climate of the area

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Multimedia instruction
- Self-paced learning
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Evaluating
  - Understanding

National Standards, Principles, and Practices

National Science Education Standards

• (5-8) Standard A-1:
Abilities necessary to do scientific inquiry
• (5-8) Standard D-1:
Structure of the earth system
• (5-8) Standard F-1:
Personal health
• (5-8) Standard F-4:
Risks and benefits
• (9-12) Standard A-1:
Abilities necessary to do scientific inquiry
• (9-12) Standard A-2:
Understandings about scientific inquiry
• (9-12) Standard C-5:
Matter, energy, and organization in living systems
• (9-12) Standard F-1:
Personal and community health
• (9-12) Standard F-2:

Population growth
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

Common Core State Standards for English Language Arts & Literacy

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.11-12.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.9-10.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.6-8.4

ISTE Standards for Students (ISTE Standards*S)

• **Standard 3:**
Research and Information Fluency
• **Standard 4:**
Critical Thinking, Problem Solving, and Decision Making

Next Generation Science Standards

• **Crosscutting Concept 1:**
Patterns
• **Crosscutting Concept 2:**
Cause and effect: Mechanism and prediction
• **Crosscutting Concept 3:**
Scale, proportion, and quantity
• **Crosscutting Concept 7:**
Stability and change
• **Science and Engineering Practice 1:**

Asking questions and defining problems
• **Science and Engineering Practice 4:**
Analyzing and interpreting data
• **Science and Engineering Practice 5:**
Using mathematics and computational thinking
• **Science and Engineering Practice 6:**
Constructing explanations and designing solutions
• **Science and Engineering Practice 7:**
Engaging in argument from evidence
• **Science and Engineering Practice 8:**
Obtaining, evaluating, and communicating information

Preparation

What You'll Need

Required Technology

- Internet Access: Required
- Tech Setup: 1 computer per learner, 1 computer per small group, Interactive whiteboard, Projector

Physical Space

- Classroom
- Computer lab
- Media Center/Library

Grouping

- Heterogeneous grouping
- Homogeneous grouping
- Large-group instruction
- Small-group instruction

Resources Provided: Handouts & Worksheets

- Answer Key - Best Practices

Resources Provided: Interactives

- Best Practices interactive

Resources Provided: Images

- Yields of Cereal Grains 1961-2012
- Projection of Maize Crop Yields in France

Background & Vocabulary

Background Information

Agricultural productivity has increased greatly over the past 50 years with more mechanization and specialization of crops. Biological innovations in pest control, such as genetic engineering, have

allowed farmers to use fewer pesticides. Biological innovations have also led to more nutritious foods. Scientific studies have resulted in increased yields. It is still a question as to whether these innovations can continue to produce sufficient food from a decreased area of agricultural land.

Prior Knowledge

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Recommended Prior Activities

- Climate and Crop Growth
- Preserving Soils
- Soil Quality
- Using the Land

Vocabulary

Term	Part of Speech	Definition
crop rotation	*noun*	the system of changing the type of crop in a field over time, mainly to preserve the productivity of the soil.
fertilizer	*noun*	nutrient-rich chemical substance (natural or manmade) applied to soil to encourage plant growth.
genetic modification	*noun*	process of altering the genes of an organism.
model, computational	*noun*	a mathematical model that requires extensive computational resources to study the behavior of a complex system by computer simulation.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.

For Further Exploration

Reference

- National Geographic Encyclopedic Entry: rural area
- National Geographic Encyclopedic Entry: urban area
- National Geographic Encyclopedic Entry: agriculture
- National Geographic Encyclopedic Entry: fertility
- National Geographic Encyclopedic Entry: humus

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Partner