Agriculture *and the Environment*

4th Edition

Food and Agriculture
Center for Science Education

Educator's Guide

Teacher Guide: Risks and Rewards

Desired Results

National Learning Standards

NGSS.MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

CCSS.ELA-LITERACY.SL.6-8.1.C: Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text or issue under discussion.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

Understandings

Students will understand that:

- Most things in life have both risks and rewards.
- Risk assessment helps us understand potential risks and anticipated benefits.

Essential Questions

- What are some common risks we take?
- What are the rewards of those risks?
- What makes a risk worth taking?
- What risks are you willing to take?

Students will know:

- Risks cannot be eliminated.
- Agricultural risks are carefully considered by government and research institutions.

Students will be able to:

- Identify the risks and rewards associated with a common product (motor vehicle).

Assessment Evidence

Performance Tasks

- Students will identify the risks and rewards associated with a common product.

Other Evidence

- Students will respond to specific questions with detail.
- Students will make comments that contribute to the topic, text or issue under discussion.

Learning Plan

Learning Activities

- Students will read an informational text about risks and rewards.
- Students will answer questions about the text.
- Students will read the risks associated with the automobile. They will discuss whether the item should be banned.
- Students will research and identify the risks and rewards associated with a common product. They will record their findings and share with the class.
- Students will reflect on their findings.

Background: Risks and Rewards

Risk is part of our lives. We get on our bikes or ride in our cars knowing there is a risk that we might be in an accident. We watch toddlers take their first steps knowing they risk falling. We invest money knowing the stock market could decline at any moment.

We can do certain things to minimize risks. We can wear safety helmets and seat belts. We can move toddlers away from furniture with sharp edges. We can invest money in markets that have proven track records. But, even with these measures, we realize that uncertainty is an essential part of life.

A certain level of risk in our lives is necessary to achieve certain benefits. A high school freshman doing a science project asked 50 people if they would sign a petition demanding strict control or total removal of the chemical "dihydrogen monoxide" because it:

1. Can cause excessive sweating and vomiting
2. Is a major component of acid rain
3. Can cause severe burns in its gaseous state
4. Can kill if aspirated
5. Contributes to erosion
6. Has been found in tumors of terminal cancer patients

Of the 50 people surveyed, 43 (86 percent) said they would sign the petition, 6 were undecided and 1 said no. Yet, if the student asking the question had presented the benefits of dihydrogen monoxide, commonly known as water, the results would have been a unanimous no. Being able to compare the risks of a product to its potential benefits is critical to making the right decision.

In agriculture, risk assessment helps determine acceptable levels of risk. Government and research institutions cannot approve products and methods in which the risks are judged unreasonable in relation to the predicted benefits. For instance, professionals who manage pesticides think about a chemical's effectiveness in controlling target pests as well as the possible benefits and risks to society and the environment.

Policy questions are often posed as though we can guarantee safety when, in fact, nothing we do is risk free. As you consider the issues that face your generation, it's critical to understand how to assess risks and rewards.

Questions for discussion:

1. What is risk, in your own words?
2. What are some of the benefits of "dihydrogen monoxide"?
3. Why must we know how to assess risks and rewards?

Engagement: Risk and Rewards Engagement

Name Date Class

Materials:
Research materials (which may include internet access), paper and pencil

Procedure:

1. Read the background information on risks and rewards. Answer the questions at the bottom of the page.

2. Read the description below to identify a common, but risky, product.
   Contains a chemical that causes cancer in laboratory animals
   Causes serious injury to millions of people
   Kills 40,000 people each year in the United States
   Kills millions of animals a year
   Causes fires when ignited
   Requires tremendous resources for production
   Causes major air pollution problems
   Produces toxic gases
   Causes billions of dollars in property damage every year
   Destroys millions of acres of land for roads to facilitate it

3. Should this product be banned? Why or why not? _____

4. What is this product? _____

5. What are the benefits of this product? _____

6. Choose a commonly used product, and identify the product's potential risks. These may include financial, environmental, health and safety, legal or moral risks. Make a T-chart. Label one side risks, and the other side rewards. Research and record at least five risks and three rewards associated with the product.

7. Share your findings with your class. Read the risks first, and see if the students can identify the product. After revealing the product, ask for additional contributions and record them on your T-chart.

8. Reflect on these questions; your teacher may ask you to write or discuss:
   a. How does your chosen product impact the Earth and its systems?
   b. How would the risks or the rewards increase as human population also increases?
   c. Are there any products that contain no risks? If so, what are they?

Teacher Guide: Biodiversity

Desired Results

National Learning Standards

NGSS: MS-LS2-1: Analyze and interpret data to provide evidence for effects of resource availability on organisms and populations of organisms in an ecosystem.

NGSS: MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

Understandings

Students will understand that:

- Wetlands harbor a remarkable diversity of life.
- Wetlands benefit farmers.
- Farmers can improve wetland habitat.

Essential Questions

- How do wetlands contribute to biodiversity?
- Why do farmers care about wetland preservation?
- How are wetlands preserved by farmers?

Students will know:

- A variety of abundant food sources promotes biodiversity.
- Farmers are enrolled in the Conservation Reserve Program.

Students will be able to:

- Define biodiversity.
- Identify positive and negative agricultural practices that impact biodiversity.

Assessment Evidence

Performance Tasks

- Students will participate in a wetland feeding simulation and analyze how agricultural practices impact resource availability.

Other Evidence

- Students will respond to specific questions with detail.
- Students will identify ways to minimize human impact on wetland habitats.

Learning Plan

Learning Activities

- Students will read an informational text about biodiversity.
- Students will answer questions about the text.
- Students will participate in a wetland simulation, where pennies, marbles, rubber bands and paper clips are spread over an area to represent food resources.
- Students will collect as many food resources as possible, given a specific tool and time limit.
- Students will reflect on their experience and analyze agricultural practices that impact resource availability.

Background: Biodiversity

The meaning of *biodiversity* can be found by studying the word itself: bio, meaning life, and *diversity*, meaning variety. Biodiversity refers to the variety of life on Earth at all levels — from genes to ecosystems. Wetlands are among the most productive ecosystems in the world, comparable to rainforests and coral reefs.

Wetlands are transitional zones between aquatic environments and terrestrial environments. Swamps, bogs, coastal and inland marshes and fens are all types of wetlands. Wetlands occur in both freshwater and saltwater systems on every continent, except Antarctica. They occur in every climate from the tropics to the tundra.

Wetlands have been called "biological super systems" because they produce quantities of food that support countless species. With shallow water and high levels of nutrients, a wetland is ideal for the development of organisms that form the foundation of the food web. More than one-third of the threatened and endangered species in the United States live only in wetlands and nearly half use wetlands during their lifespan.

Not only do wetlands harbor a remarkable diversity of life, but they are also often the delivery system for water to a farm. They benefit farmers by regulating water and creating cleaner water through their natural filtration system.

Farmers with wetland habitats on their property are adopting practices that attract wildlife and improve biodiversity. Some of these practices include:

1. Integrated Pest Management: Using non-chemical pest control strategies including cultural, mechanical and biological controls as well as good sanitary practices.
2. Pesticides: Correctly applying pesticides and installing pesticide exclusion strips approximately 30- to 60-feet wide at the edges of fields.
3. Food Plots: Leaving 10–12 rows of unharvested, standing crop along the entire length of field edges (especially sides next to wetland areas) to provide overwinter food for animal species.

As of September 2017, farmers had enrolled more than 23 million acres of their land in the Conservation Reserve Program, a voluntary program that aims to reduce soil erosion, improve water quality and maintain fish and wildlife habitat. By working together, farmers are finding a balance between growing and producing food, as well as responsibly preserving water and land, without threatening wildlife habitat or agriculture.

Questions for discussion:

1. What is biodiversity, in your own words?
2. What ecological benefits do farmers receive from wetland preservation?
3. How can farmers contribute to the preservation of wetlands?

Engagement: Biodiversity Engagement

Name Date Class

Materials:

- 1 package of large, thick rubber bands
- 1 large box of paper clips
- 1 package of marbles
- 100 pennies
- 5 oz. paper cups (1 per person)
- Plastic spoons
- Clothespins
- 1 sheet, blanket or tablecloth
- 1 pad of small sticky notes
- 1 large piece of chart paper or poster board

Procedure:

1. Read the background information about wetland biodiversity. Answer the questions at the bottom of the page.
2. In this wetland simulation, you will be a wetland-dwelling bird species. The items on the floor represent food resources. The paper cup represents your stomach.
3. The tool you receive represents your bill or beak. Your bill or beak is uniquely designed to gather specific food needed to survive. Participants with clothespins may only eat rubber bands. Participants with spoons may eat any of the items.
4. At the signal, you will gather as many food resources as possible into your stomach. The feeding time will last 30 seconds.
5. Participants must follow these rules: 1) Only one food resource at a time may be picked up and only with your bill or beak. 2) Food must be brought to the stomach; the stomach cannot be used to help pick up food. 3) Only one hand can be used to pick up food resources. 4) Participants must return to the edge of the feeding ground for the start and end of each round.
6. Once time has been called, count the number of resources you have in your cup. For each set of five items you collected, take one sticky note (round up to the nearest five).
7. On a large sheet of chart paper, use the sticky notes to make a bar graph to record how well each species did. The x-axis should be labeled "bill or beak type" and the y-axis should be labeled "amount of food collected."
8. Each species needs 10 food resources to survive and reproduce; participants who did not collect 10 are considered dead and must sit out the remaining rounds.
9. Repeat the procedure until either one species is extinct or all food resources have been depleted.
10. Which species did the best overall?
11. Which food resource was collected the least?
12. As the rubber bands were depleted as a food resource, what happened to the clothespin-beaked bird species?
13. Reflect on these questions; your teacher may ask you to write or discuss:
    a. What happened to the biodiversity of this wetland habitat?
    b. What agricultural practices might negatively impact resource availability?
    c. What agricultural practices might positively impact resource availability?

Teacher Guide: Air Quality

Desired Results

National Learning Standards

NGSS.MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

NGSS. MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

CCSS.ELA-LITERACY.SL.6-8.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume and clear pronunciation.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

Understandings

Students will understand that:

- Farms are one source of fugitive dust.
- Particulate matter is both a nuisance **and** a health concern.
- Farmers use techniques to control dust and reduce air pollution.

Essential Questions

- Why should we care about air quality?
- What sources negatively impact air quality?
- What are farmers doing to reduce agricultural pollutants?

Students will know:

- Human impacts affect air quality.
- Methods for monitoring and minimizing fugitive dust.

Students will be able to:

- Students will respond to specific questions with detail.
- Students will present their findings to the class with pertinent descriptions, facts, details and examples.

Assessment Evidence

Performance Tasks

- Students will monitor and minimize fugitive dust in test areas.

Other Evidence

- Students will respond to specific questions with detail.
- Students will identify ways to minimize human impact on wetland habitats.

Learning Plan

Learning Activities

- Students will read an informational text about air quality.
- Students will answer questions about the text.
- Students will identify high fugitive dust areas around their campus.
- Students will monitor fugitive dust by collecting particulate matter in test areas.
- Students will develop a plan to minimize fugitive dust in test areas.
- Students will reflect on and present their findings.

Background: Air Quality

Air pollution is a major problem of recent decades, which has had a serious impact on human health and the environment. There are hundreds of pollutants in the air that we breathe. Some come from natural sources, but most come from human activity. Air pollutants are found outdoors and indoors. They can contain fibers, mists, molds, bacteria and gases.

Particle pollution, also called particulate matter, is made up of particles (tiny pieces) of solids or liquids that are in the air. Some particles are big enough or dark enough to see — for example, you can often see smoke in the air. Others are so small that you can't see them in the air.

Fugitive dust is particulate matter suspended in the air by wind and human activities. It has not come out of a single source, like an industrial vent, and is usually not a by-product of burning. Fugitive dust particles typically contain soil minerals, but can also contain sea salt, pollen, spores, tire particles and other debris.

Fugitive dust can be hazardous to your health. When inhaled, larger particles settle in the upper airway, while smaller particles can travel to the deep parts of the lungs causing respiratory illness, lung damage and even death. Extreme fugitive dust can result in dust storms like those of the Dust Bowl in the 1930s. Dust storms reduce visibility and can lead to traffic accidents.

Common sources of fugitive dust:

- paved and unpaved roads
- agricultural tilling operations
- leaf blowers
- off-road vehicles
- mining and mineral processing
- sand and gravel plants
- building construction and demolition

There are many ways fugitive dust can be controlled to reduce air pollution. Some farmers plant trees and install raised landforms to reduce wind speed. They pave roads and storage areas accessed by heavy vehicles, like tractors, or use gravel to reduce dust. Additionally, many farmers cover piles of fertilizer, compost and animal feed with a physical cover or dust suppressant spray. Watering roads, the most common and typically least expensive method, only temporarily controls dust.

We all have a part to play in reducing human impact on air quality. American farmers are no different. Many are adopting sustainable practices that protect the environment without sacrificing farm productivity.

Questions for discussion:

1. Why is fugitive dust a major problem?
2. What are farmers doing to reduce fugitive dust?
3. How have you personally experienced fugitive dust?

Engagement: Air Quality

Name Date Class

Materials:
Index card, pencil, quarter, scissors, hole punch, string, clear packing tape, permanent marker, hand lens or microscope, various materials for controlling fugitive dust

Procedure:

1. Read the background information on air quality. Answer the questions at the bottom of the page.
2. Place a quarter in the center of an index card. Use a pencil to trace around the quarter. Repeat this process on both the left and right side of the center circle to create three circles spaced equally apart. Use scissors to cut out each circle without damaging the card.
3. Use a punch to put a small hole in one end of the index card. Tie a string through the hole. The string will be used to hang the card at a selected monitoring site.
4. Put a long piece of clear packing tape over the quarter-holes on one side of the index card. Be sure to completely cover all three holes. The sticky side of the tape will be used to collect fugitive dust. Do not touch the exposed sticky surface.
5. Before hanging the index card at a selected site, use a permanent marker to write your name, date and site location at the top of the strip.
6. Brainstorm with your class to identify different monitoring locations in your environment, both inside and outside. Use a piece of tape to secure the index card by its string to a stable surface at your chosen site. The index card should be able to move freely without contacting other objects and not easily reached by others.
7. After one week, collect your index card. Use a hand lens to observe particles and record observations in your science journal. You may be able to identify different particles such as dust, ash or pollen.
8. Collaborate with your colleagues to place the index cards in ascending order, from the least fugitive dust to the most fugitive dust. Identify the locations with the greatest prevalence of fugitive dust.
9. Work in small groups to create a strategy to reduce the fugitive dust in a specific area. Gather necessary materials and implement your strategy. After one week, collect your index card. Use a hand lens to observe particles and record observations in your science journal.
10. Share your findings with your class. Identify the area, control techniques and pre- and post-intervention results. Explain how you could apply your strategy to a different setting or scale.
11. Reflect on these questions; your teacher may ask you to write or discuss:
    a. What human practices increase fugitive dust on our campus and in our community?
    b. What natural causes increase fugitive dust on our campus and in our community?
    c. Which control techniques were most successful in decreasing fugitive dust?

Teacher Guide: Soil Quality

Desired Results

National Learning Standards

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

CCSS.MATH.CONTENT.8.G.C.9: Know the formulas for the volumes of cones, cylinders and spheres and use them to solve real-world and mathematical problems.

CCSS.MATH.CONTENT.6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems (e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams or equations).

CCSS.ELA-LITERACY.RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements or performing technical tasks.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

Understandings

Students will understand that:

- Healthy soil is well structured.
- Evaluating bulk density is one way to assess soil structure.
- Farmers can implement techniques to improve soil structure.

Essential Questions

- What qualities increase soil function?
- How can soil quality be measured?
- What can farmers do to improve soil quality?
- Why do farmers care about soil quality?

Students will know:

- Compaction describes bulk density that is too high.
- Compaction causes problems both on the farm and in the environment.

Students will be able to:

- Take a core sample and determine the bulk density.
- Identify human activities that affect bulk density.
- Identify techniques that improve soil structure.

Assessment Evidence

Performance Tasks

- Students will evaluate bulk density and assess soil structure.

Other Evidence

- Students will respond to specific questions with detail.
- Students will use geometric and ratio formulas to solve real-world mathematical problems.

Learning Plan

Learning Activities

- Students will read an informational text about soil quality.
- Students will answer questions about the text.
- Students will take a core sample and determine the bulk density.
- Students will analyze the meaning of their results.
- Students will plot their results on a map and pinpoint areas of high compaction.
- Students will identify practical ways that compaction could be minimized within the sampling area.

Background: Soil Quality

Soft and crumbly — like cottage cheese.
Loose and full of holes — like a sponge.

These are descriptions of a soil that has proper structure. Soil structure is the arrangement of the solid parts of the soil and the space between them. When the solid parts — sand, silt and clay particles — cling together as coarse, granular aggregates, the soil has a good balance of solid parts and pore space.

Healthy soil is well-structured. One way we measure the structure of soil is by evaluating bulk density. Bulk density is calculated as the dry weight of soil divided by its volume. This volume includes the volume of soil particles and the volume of pores among soil particles. Bulk density is typically expressed in $g/cm^{3.}$

Bulk density is important. Compaction is a term that describes bulk density that is too high. Compaction can restrict root growth and cause poor plant growth reducing crop yield. Compaction causes poor movement of air and water through the soil. It can lead to increased runoff and erosion on sloping land or waterlogged soils in flatter areas.

There are practices farmers can avoid to reduce the likelihood of compaction:

- Minimize soil disturbance and production activities when soils are wet
- Use designated field roads or rows for equipment traffic
- Reduce the number of trips across an area

Long-term solutions to bulk density and soil compaction problems revolve around decreasing soil disturbance and increasing soil organic matter. Farmers can use techniques such as cover crops (plants grown for the enrichment of the soil) and reduced tillage (limiting how much the ground is broken up at the beginning of a planting season). Using these techniques results in increased soil organic matter, less disturbance and reduced bulk density.

Soil structure is critical to how soil functions. As world population and food production demands rise, keeping our soil healthy and productive is of paramount importance. As a result of using techniques that promote proper soil structure, farmers are preventing unnecessary erosion, increasing water infiltration and improving microbial populations — all while harvesting better profits and often better yields.

Questions for discussion:

1. Why is measuring bulk density important?
2. What practices promote well-structured soil?
3. Why should a farmer care about soil quality?

Engagement: Soil Quality

Name Date Class

Materials:
Empty tin can with height of approximately 2–3 inches, can opener, cm ruler, wood block, mallet, garden trowel, butter knife, paper food tray, microwave oven, scientific scale

Procedure:

1. Read the background information on soil quality. Answer the questions at the bottom of the page.
2. Remove the bottom of the tin can to create a metal ring. To complete this exploration, you will need to know the soil volume, which will be the same as the volume of the ring. Complete the table to calculate the volume of the soil.

Height of ring (in cm to the nearest mm)	Diameter of ring (in cm to the nearest mm)	Radius of ring (half the diameter)

Soil volume (cm^3) = 3.14 x r^2 x ring height
Soil volume (cm^3) = _____

3. Determine a suitable location to take a soil sample to measure bulk density. Avoid areas that are rocky, sandy, extremely dry or muddy.
4. After arriving at your location, place the ring on the soil surface. Place the wood block over the can and tap the wood with a mallet. Continue until the top of the can is even with the soil's surface.
5. Dig around the ring, and with the trowel underneath it, carefully lift the ring out to prevent any loss of soil.
6. Remove excess soil from the top and bottom of the sample with a butter knife. The top and bottom of the sample should be flat and even with the edges of the ring.
7. Calculate the dry weight of the soil by removing all moisture. Use the butter knife to gently knock the soil out of the metal ring and into a paper food tray. Use the butter knife to break the soil into small clumps.
8. Place the paper tray containing the soil in a microwave and dry for four-minute cycles at full power. To determine if the soil is dry, weigh the sample and record its weight after each cycle. When its weight does not change after a drying cycle, then it is dry. Open the microwave door for one minute between cycles to allow venting.
9. Weigh the dry soil on its paper tray. Weigh an empty paper tray. Determine the weight of the dry soil by finding the difference.

Weight of dry soil and tray	Weight of empty tray	Weight of dry soil

Complete this equation to calculate bulk density:
Bulk density (g/cm^3) = Weight of dry soil (g) / Soil volume (cm^3)
Bulk density (g/cm^3) = _____

11. Bulk density greater than 1.6 g/cm^3 tends to restrict root growth. Healthy soils rich in organic matter can have densities of less than 0.5 g/cm^3. Write a sentence to summarize the bulk density of your soil sample:
_____
12. Compare your results with the class. Using a map of the sample area, identify locations with the highest compaction (greatest bulk density) and the areas with the lowest bulk density. Discuss practical ways that compaction could be minimized within the sampling area.
13. Reflect on these questions; your teacher may ask you to write or discuss:
    a. Give two examples of human activity that affect bulk density within your sampling area.
    b. What practices could be implemented to improve bulk density within your sampling area?
    c. Apply what you've learned to an agricultural setting.
    d. How would the bulk density of your soil sample affect plant growth?
    e. As a farmer, how would the sampling results influence your agricultural practices?

Teacher Guide: Water Quality

Desired Results

National Learning Standards

NGSS.MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

NGSS.MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

CCSS.ELA-LITERACY.SL.6-8.4: Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume and clear pronunciation.

Understandings

Students will understand that:

- Water pollution comes from many different sources.
- Water monitoring identifies the presence of pollutants.
- Water treatment improves the quality of water.

Essential Questions

- What sources negatively impact water quality?
- How can water quality be measured?
- What can farmers do to improve water quality?

Students will know:

- Point- and nonpoint-sources of pollution.
- Water filtration is an effective water treatment option.

Students will be able to:

- Assess the quality of water before and after water treatment.
- Determine an effective method to filter polluted water.

Assessment Evidence

Performance Tasks

- Students will filter water using different materials.
- Students will identify the most effective materials for filtration.

Other Evidence

- Students will respond to specific questions with detail.
- Students will present their claims and findings with facts, details and examples.

Learning Plan

Learning Activities

- Students will read an informational text about water quality.
- Students will answer questions about the text.
- Students will filter impure water using provided materials and consider the effectiveness of each.
- Students will design their own water filtration method using a combination of materials.
- Students will present their findings in a one-minute PSA.
- Students will reflect on their experience.

Background: Water Quality

Two-thirds of the Earth's surface is covered by water. The human body is 75 percent water. Water is one of the most vital resources for life on Earth. We use water for many uses, from sanitation to recreation and farming to urban landscaping.

Sources of water pollution can be grouped into two major categories: point-source pollution and nonpoint-source pollution. Point-source pollution is any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch or factory smokestack. Factories and sewage treatment plants are two common types of point sources. Most nonpoint-source pollution is a result of runoff. When rain and melted snow move over the ground, they pick up and carry away pollutants, depositing them into our waterways. There are many different causes of nonpoint-source pollution, including agriculture, urban areas, roadways and construction sites.

Water quality tests attempt to determine the presence of heavy metals, nutrients, pesticides, industrial chemicals and various toxins. Water quality can be evaluated using many different indicators. Here are a few important ones:

pH: This is a measurement of how acidic or how basic the water is. pH can be influenced by human factors, such as acid rain, increased carbon dioxide and point-source pollution.

Bacteria: Fecal Coliform bacteria indicate the presence of sewage contamination of a waterway and the possible presence of disease producing pathogens.

Nutrients: Too much nitrogen and phosphorus can cause algae to grow faster than ecosystems can handle. The presence of algae blooms increases bacterial growth that can make people sick and decreases oxygen that aquatic animals need to survive.

Filtration is the use of a physical barrier, chemical and/or biological process to remove impurities from the water. Many consumers filter their drinking water at home. Municipal water treatment plants use filters to remove dissolved particles, such as dust, parasites, bacteria, viruses and chemicals. Farmers use filters to remove pathogens that cause viruses and sediment that could damage irrigation systems.

Fresh water is so abundant in the United States that people sometimes take its availability for granted. Monitoring water quality and investing in water treatment systems, such as filtration, are essential practices to preserving the quality of our water supply.

Questions for discussion:

1. Make a list of all the ways you use water daily.
2. Give a specific example of both point-source and nonpoint-source pollution. Where does the pollution come from, how does it move and where does it go?
3. Why do farmers care about water quality?

Engagement: Water Quality

Name Date Class

Materials:
Clear disposable plastic cups (three per group), food coloring, almond extract, pin, clean (sterile) sand, aquarium charcoal, clean gravel, a coffee filter, water and litter.

Procedure:

1. Read the background information on water quality. Answer the questions at the bottom of the page.
2. In this scientific simulation, you oversee water quality for your community's water system. Residents have complained that the water looks and smells "funny." Using the materials provided, supply the community with quality drinking water and assure them it is safe to drink.
3. Use a pin to poke six small holes in the bottom of one plastic cup. This cup will hold your filtration system.
4. Fill the second plastic cup with water. This cup will act as the water source. Add a few drops of food coloring and almond extract, which represent the pollutants. Set this cup aside.
5. Fill the cup with holes on the bottom with a filtration material (sand, litter, gravel, coffee filter, charcoal) to test how well it cleans the water sample.
6. The third cup will be used to collect the clean water sample after filtration.
7. When you are ready, hold the filtration system cup over the collection cup. Carefully pour water from the source into the filtration system. Evaluate the water collected and record your observations in the table provided.
8. Repeat this process (steps 4–7) using each filtration material. Finally, create a unique combination of filtration materials to maximize effectiveness. Record observations.

Filter Material	Visual Observations	Odor Observations
Sand		
Charcoal		
Gravel		
Coffee filter		
My unique combination		

9. Present your claims and findings in a one-minute public service announcement (PSA) that assures citizens their water is safe to drink. Speak clearly and include facts and details. Make a recording to share with the class or present a live version.
10. Reflect on these questions; your teacher may ask you to write or discuss:
    a. How did you decide if the water was or was not clean?
    b. What other tests might be necessary to assure water quality and safety?
    c. How do communities use filtration methods to preserve water quality?
    d. How do farmers use filtration methods to preserve water quality?

Teacher Guide: Introduction to Sustainability

Desired Results

National Learning Standards

NGSS.MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

NGSS.MS.ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

CCSS.ELA-LITERACY.RI.6-8.1: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

CCSS.ELA-LITERACT.SL.6-8.5: Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

CCSS.ELA-LITERACT.SL.6-8.6: Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

Understandings

Students will understand that:

- Sustainability involves balancing the needs of people, profit and the planet.
- Farmers are adopting practices to better balance these needs.

Essential Questions

- Research a chosen topic about environmental sustainability.
- Establish how increases in human population affect the environment.
- Identify farming practices that minimize human impact on the environment.

Students will know:

- A sustainable farm should be a profitable business.
- A sustainable farm deals with people fairly and supports the community.
- A sustainable farm practices environmental stewardship.

Students will be able to:

- Assess the quality of water before and after water treatment.
- Determine an effective method to filter polluted water.

Assessment Evidence

Performance Tasks

- Students will create a multimedia presentation about environmental sustainability.

Other Evidence

- Students will respond to an article with evidence and inferences.

Learning Plan

Learning Activities

- Students will read an informational text about sustainability.
- Students will answer questions about the text.
- Students will work in groups to research a chosen topic.
- Students will create a presentation using appropriate software.
- Students will present their research to the class.

Background: Intro to Sustainability

In agriculture, sustainability means meeting today's food and textile needs now and in the future. Sustainability requires balancing the needs of people, profit and the planet — something farmers know is essential to the long-term success of their operations.

People

As much as agriculture has mechanized, people are still central to food and fiber production. Today, family farms employ 2.6 million people, and many farmers work hard to provide socially just and safe employment opportunities. That means providing adequate wages, working conditions and opportunities for advancing. You can often find farmers engaging with people in their communities by providing farm tours, hosting educational events and supporting youth organizations.

Profit

In recent years, slightly more than half of farm households have had negative farm income each year. That means most farmers are not making a profit. A sustainable farming operation should be a profitable business that contributes to a robust economy. Farmers can increase profitability through diversification (varying what they do or produce), creative marketing and policies that help secure fair farm prices.

The Planet

Environmental sustainability in agriculture means good stewardship of the natural systems and resources that farms rely on. Among other things, this involves:

- Building and maintaining healthy soil
- Minimizing air and water pollution
- Promoting biodiversity

Human activity impacts the environment. Farming by its very nature alters natural ecosystems to produce food, fiber and fuel for humans. Agriculturists work hard to ensure they are working to implement sustainable practices.

When farmers do better, we all do better. The opposite is also true. Today's farmers and ranchers are not only responsible for what they produce, but also how they produce it. Thanks to research and technology, farmers are adopting practices that satisfy human food and fiber needs, enhance environmental quality, use resources more efficiently, sustain economic viability and benefit society.

Questions for discussion:

1. What is sustainability, in your own words?
2. What management practices can farmers employ to positively impact:
    a. People?
    b. Profit?
    c. The Planet?
3. Consider the statement, "When farmers do better, we all do better. The opposite is also true." Is this a fact or an opinion? Explain your reasoning.

Engagement: Introduction to Sustainability

Name Date Class

Materials:
Access to a computer lab or laptops/tablets (one per group), presentation software

Procedure:

1. Read the background information on sustainability. Answer the questions at the bottom of the page.

   Environmental sustainability in agriculture means good stewardship of the natural systems and resources that farms rely on. Among other things, this involves:
   - Building and maintaining healthy soil
   - Minimizing air pollution
   - Minimizing water pollution
   - Promoting biodiversity

   Choose one of the topics above for further research. Your group will have 45 minutes to research this topic and answer the questions below. Then you will present your findings using presentation software (PowerPoint, Keynote, Canva, Google Slides, etc.). The presentation should be no longer than 5 minutes and consist of approximately 10 slides.

2. Answer the following questions to prepare for your presentation:
   - Topic:
   - Why is your topic important?
   - How is your topic negatively affected by human activity?
   - What practices are farmers adopting to address your topic?

3. Be sure to include pictures and a slide with your sources. Carefully evaluate sources for credibility. Educational institutions (.edu) and government organizations (.gov) will provide research-based information.

4. Reflect on these questions; your teacher may ask you to write or discuss:
   a. How would you summarize the role farmers play in environmental sustainability?
   b. How does technology and research guide farmers toward sustainable practices?
   c. How can consumers support farmers in their efforts?

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Welcome Educators!

Welcome to the fourth edition of '*Agriculture and the Environment*.' This resource was designed to engage middle school students in discovery and exploration of topics related to agriculture and natural resources. Inside you'll find six engaging lessons; each made up of a teacher's guide, background information for the student and student engagement sheets. The teacher's guide follows the Understanding by Design® (Wiggins and McTighe) method of instruction. To extend learning with older students, we encourage you to check out the high school Sustainable Agriculture lessons in the Free Resources section on AgFoundation.org. We hope this resource provides you with a starting place for exploration about agriculture and the environment.

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