Kansas Corn: Water Conservation

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Kansas Corn: Water Conservation
Grade Level: Middle School

Overview
Water usage and conservation is an important issue. Only 1 percent of the total water supply on Earth is available for humans. Of that, 42 percent is used in agriculture. Not all freshwater resources are evenly distributed. In Kansas, water usage and water rights are very important topics. As a state, how do we balance the need for water in agriculture, manufacturing, and our daily lives? It is important that everybody does their part to conserve the invaluable natural resource.

Kansas College and Career Ready Standards
Science
- **MS-ESS3-1.** Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
- **MS-ESS3-3.** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Learning Objectives
- Students will learn the importance of water conservation.
- Students will learn the proportion of fresh water available for human use.
- Students will learn two different methods for calculating flow rate.

Materials
- Water Conservation PowerPoint (available at www.kansascornstem.com)
- Water in the Heartland Notes Worksheet (S1-3 or available at www.kansascornstem.com)
- Calculating Water Flow Worksheet (S4-5 or available at www.kansascornstem.com)
- 1,000-mL graduated cylinder
- 100-mL graduated cylinder
- 5 50-mL beakers
- Pipet
- Water
- Food coloring
- 6 empty gallon milk jug-style containers
- Timer
- 6 large bowls or large beakers (500-600 mL)
- 6 260-mL beakers or small plastic cups

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Procedures for Instruction
Length of Time for Preparation: 20 minutes
Length of Time for Classroom Teaching: 1-2 class periods

Preparation Procedure
Demonstration
Prepare a 1,000 mL of water in large container and add several drops of food coloring to the water to make it easier to see. Gather a 100-mL graduated cylinder, four 50-mL beakers and a pipet.

Lab
Gather six empty gallon milk jugs. Puncture a small hole in the bottom of each jug. Vary the size of each hole so the water will flow out at different rates. Flows should range from slow drips to a steady stream. Cover the holes with tape. Fill the jugs about half full of water. Mark a line on the jug so that it can be refilled to the same point each time.

Background Information
Water covers three-quarters of the Earth's surface. Over 97 percent of the earth's water is found in the oceans as salt water. Only 3 percent of Earth's water is freshwater. Of that, 3 percent, only a limited amount of usable freshwater is available for human use. About 2 percent of the Earth's water freshwater is stored in glaciers, ice caps, and snowy mountain ranges. This leaves only 1 percent of the Earth's water for our water supply needs. Freshwater supplies are found in the atmosphere, beneath the ground, or on the surfaces of lakes, rivers, and streams.

We use freshwater for a variety of purposes. According to the U.S. Environmental Protection Agency, agriculture represents the largest consumer use of fresh water, about 42 percent. Approximately 39 percent of our freshwater is used for the production of electricity. About 11 percent of available freshwater is used in homes and businesses. The remaining 8 percent is used in manufacturing and mining.

The total amount of water on the planet does not change. Water moves around on the planet and changes form, but we will never have any more water than we have right now. With our growing population and ever increasing demand on our freshwater supply, it is more important than ever that we learn to conserver the limited freshwater supplies.

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Classroom Discussion

Let students discuss their ideas, and guide the discussion without telling them if they are right or wrong.

- What are some things we use water for?
- How much of the Earth is covered in water?
- How much of that water is available for human needs?

Procedure for Lab

Demonstration of the amount of fresh water on Earth

1. Measure 1,000 mL of water into a 1,000-mL graduated cylinder or large container. Add a couple drops of food coloring so the water will be easier for students to see.
2. Tell students that this represents all the water on planet Earth. Review with the students some of the things stated earlier that humans use water for (drinking, washing, growing crops, etc.). Tell the students that you are going to find out how much of Earth's water is available for those things.
3. Measure out 28 mL into a separate 100-mL graduated cylinder. Hold up the container holding the remaining 972 mL of water. Tell the students that this is the amount of water found in our oceans. Ask the students if we can use ocean water for the activities listed earlier (drinking, washing, growing crops, etc.). Students should state that the water in the oceans contains salt, making it unusable for humans. This might be a good time to point out that removing salt from water is an expensive process and uses a lot of energy.
4. Hold up the 100-mL graduated cylinder that you measured the 28 mL of water into. Tell the students that this represents fresh water on the planet. Ask the students if all of this water is available for human use. Discuss the students' responses.
5. From your 28-mL freshwater supply, pour out 23 mL into a 50-mL beaker. Tell the students that this amount represents the amount for fresh water that is frozen in the ice caps, glaciers, and mountain tops. This water is unavailable for human use.
6. From the 5 mL of water that is left of your freshwater supply, measure out 4 mL and pour it into a separate 50-mL beaker. This represents the amount of fresh water that is found underground. Most of this is unavailable for human use.
7. From the 1 mL of water left that is left of your freshwater supply, use a pipette to extract 1 drop (1/3 of a mL) and squeeze it into a separate 50-mL beaker. This represents the amount of fresh water in the atmosphere. This is also unavailable for human use. The remaining 2 drops of water represent the Earth's surface water. This is the amount of water that is found in our lakes, rivers and streams. From the remaining freshwater, use a pipette to extract 1 drop and squeeze into a separate 50-mL beaker. This represents the amount of fresh water that is too polluted for human use. Pour the remaining fresh water into the last 50-mL beaker. This last drop is the surface water that is available for human use. From that last drop, 42 percent is used for agriculture, 39 percent is used to produce electricity, 8 percent is used in manufacturing and mining and 11 percent is used in homes and businesses.

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Class Discussion

- Explain to students that the total amount of water on the planet is not going to change. Even though water moves around on the planet and changes form, we will never have more than we have right now.
- Were you surprised at how little water is available for human use?
- Would you call water a scarce or abundant resource? Why?
- What is the main cause of the increased demand for fresh water?
- The number of people who need to use Earth's fresh water keeps increasing. If the amount of fresh water cannot change, but there are more people who need it, what does that mean? What might happen?

Calculating Flow Rate

Tell students that we are going to try to come up with an estimate for how much water we use during the day. In order to do this, we need to practice calculating flow rate. Hand out calculating Water Flow Rate Worksheet to help students with the activity.

Have students go to one of the six lab stations around the room. Each lab station should have a prepared milk jug with a hole in the bottom covered with tape, a timer, a bowl or large beaker, and a graduated cylinder.

1. Students should hold the gallon jug above the bowl or large beaker. Have them remove the tape and start the timer.
2. After 1 minute, have the students place their finger over the hole on the bottom of the jug to stop the water. Hold the jug over the sink. Tilt the jug to the side so the tape can be replaced. Refill the jugs to the line marked on the side of the container.
3. Use a graduated cylinder to measure the water that was collected. The amount of water collected is labeled mL/min. This can be converted to L/min. by dividing by 1,000.
4. You can measure the flow rate of you classroom sinks by timing how long it takes for a 500 mL beaker to fill. Divide 500 by your time. The answer will be in mL/sec. This can be converted to mL/min. by dividing the answer by 60. And converted to L/min. by further dividing it by 1,000.
5. This method can used to find the flow rate of drinking fountains, or any other water source in the building. Use smaller beakers or cups as needed.
6. Next, we will try to find the flow rate for your shower and bath at home. Students can cut the top off of a milk jug. Fill the milk jug with 1 L of water and mark the line of the outside. They can then time how long it takes to fill up 1 L of water.
   - One toilet flush uses 5 gal. of water.
   - A 10-minute shower uses 100 gal. of water.
   - To fill half a full bathtub takes 50 gal. of water.
   - Brushing teeth takes 2 gal. of water.
   - The dishwasher uses 10 gal. of water.
   - The clothes washer uses 50 gal. of water

7. On average, each of us uses about 70 gal. of water everyday. Using the above information, students can calculate their daily water use. They can use their own data collected to figure out how much their shower uses. They can look up their dishwasher and/or washing machine to see how much water they use. Students can also use the above estimates if they cannot find the information they need. Fun fact: In pioneer days, it is estimated that people used only 5 gal. of water per day.
8. Have students look for places in their day where they can reduce their water use. Examples might include shorter showers, making sure the dishwasher if full before running it, turning off the water while brushing their teeth, etc.

How do Farmers Save Water?

Agriculture uses 42 percent of our available fresh water. Farmers are also trying to do their part to conserve water. Divide the class into groups. Assign each group a portion of the article to read. Have each group present their section to the class.

Water in the Heartland

Water is important for everyone, which includes farmers. Water is essential for growing the crops we eat every day. With agriculture using 42 percent of our available freshwater resources, farmers are doing their part to conserve water. Farmers are using the latest technologies available to make sure there are enough water resources for everyone and future generations.

1. *Irrigation Scheduling*
   Smart water management is not just about how water is delivered but also when, how often, and how much water is applied. To avoid under or over watering their crops, farmers carefully monitor the weather forecast. Some farmers use weather monitoring stations in their fields that can send weather information from the field to their smartphones. Soil probes and plant-based sensors can be placed in the fields to help monitor the soil and plant moisture. Farmers can adapt their irrigation schedule to the current conditions. Watering at night can help slow down evaporation, allowing water to seep down into the soil and replenish the water table. Farmers are also using technology that allows them to control their irrigations systems from their smart devices.
2. *Drought-Tolerant Crops*
   Farmers are able to utilize the latest advancements in biotechnology, which allow crops to grow in regions that they were not able to be grown in the past. Scientists genetically engineer the seeds to produce plants that can withstand drier conditions. With the use of genetic modification, we can now grow corn in parts of the country where we have not been able to grow them before because of limited access to water. In some areas of the country, farms don't irrigate. These farmers rely on drought-tolerant crops, soil moisture and special tilling practices to produce their crops during the dry season.

3. *Cover Crops*
   Farmers plant cover crops after their main crop is harvested to protect soil that would otherwise go bare. Cover crops reduce weeds, increase soil fertility, and provide organic matter which in turn helps help prevent soil erosion and compaction. This allows water to penetrate the soil more easily and improves the soil's water-holding capacity. Farmers use perennial grasses and clover in their fields for building healthy soil. Farmers that have fields planted with cover crops can be more productive than conventional fields during years of drought.   The ability for a farm to use cover crops is dependent on where the farm is located. Farmers have to decide if cover crops are appropriate for their region because cover crops do use some of the moisture stored in the soil and may not be as effective in drier climates.
4. *Soil Management and Conservation Tillage*
   The Dust Bowl of the 1930s was created by a perfect storm of deep plowing and loss of perennial grasses followed by extreme drought and wind erosion. Modern farmers use soil mapping and no-till practices to help maintain the health of the soil and conserve water. Soil mapping is very important for the correct implementation of sustainable land use management. Soil mapping provides significant information about the characteristics and condition of the land. This mapping describes the condition of the soils and is key in guiding landowners on how to wisely manage their land. Conservation tillage uses specialized plows or other implements that partially till the soil but leave at least 30 percent of vegetative crop residue on the surface. Like the use of cover crops, these practices help increase water absorption and reduce evaporation, erosion, and compaction.
5. *Irrigation Segmentation*
   Not every part of a farmer's field needs the same amount of water. Farmers rely on soil testing to let them know which amounts of water to apply where. Some farmers are able to divide their watering in their fields into fractional parts. As the center pivot irrigation system goes around in a circle in each section, which looks like a slice of pie, fields can have different amounts of water applied to it. All of this is controlled by a computer and changed as needed. For even more control, some irrigation systems can vary the flow of water from each individual spray nozzle. These nozzles are specially designed to apply just the right amount of water to the right spot as the center pivot irrigation system goes around the field.

   Not every region has the same amount of water resources available, so farmers are developing ways to make sure not a drop of water is wasted when watering their crops. Continued monitoring of our groundwater reservoirs with index wells is essential for maintaining our aquifers. With good conservation practices and the latest technology, we can make sure that our water natural resources are well preserved into our future.

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Teacher Tips
Have an estimated water use chart available for students who are unable to do the at-home portion of the lab.

Lab Analysis
Find out the average daily water use of your class. Students can also calculate how much water is used for the entire class and all the students in the school. How much water could be saved if each student in the school reduced their shower time by one minute?

Assessments
Students may do additional research on a water conservation practice and can write a report on their given topic, connecting it to a Kansas farmer and what they are doing on their land.

Science and Agriculture Careers
To learn more about agriculture careers, visit www.agexplorer.com. You can also find career profiles at www.kansascornstem.com.

Sources

- https://water.usgs.gov/edu/earthwherewater.html
- https://water.usgs.gov/edu/earthhowmuch.html
- https://cuesa.org/article/10-ways-farmers-are-saving-water
- https://www.epa.gov/sites/production/files/2015-08/documents/mgwc-ww-intro.pdf
- http://cmase.pbworks.com/w/file/fetch/65195601/Water%20Distribution%20Demonstration.pdf

Any educator electing to perform demonstrations is expected to follow *NSTA Minimum Safety Practices and Regulations for Demonstrations, Experiments, and Workshops*, which are available at http://static.nsta.org/pdfs/MinimumSafetyPracticesAndRegulations.pdf, as well as all school policies and rules and all state and federal laws, regulations, codes and professional standards. Educators are under a duty of care to make laboratories and demonstrations in and out of the classroom as safe as possible. If in doubt, do not perform the demonstrations.

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3. **Cover Crops**
   Farmers plant cover crops after their main crop is harvested to protect soil that would otherwise go bare. Cover crops reduce weeds, increase soil fertility, and provide organic matter which in turn helps help prevent soil erosion and compaction. This allows water to penetrate the soil more easily and improves the soil's water-holding capacity. Farmers use perennial grasses in their fields for building healthy soil. The ability for a farm to use cover crops is dependent on where the farm is located. Farmers have to decide if cover crops are appropriate for their region because cover crops do use some of the moisture stored in the soil and may not be as effective in drier climates.

4. Soil Management and Conservation Tillage

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5. Irrigation Segmentation

Not every part of a farmer's field needs the same amount of water. Farmers rely on soil testing to let them know which amounts of water to apply where. Some farmers are able to divide their watering in their fields into fractional parts. As the center pivot irrigation system goes around in a circle in each section, which looks like a slice of pie, fields can have different amounts of water applied to it. All of this is controlled by a computer and changed as needed. For even more control, some irrigation systems can vary the flow of water from each individual spray nozzle. These nozzles are specially designed to apply just the right amount of water to the right spot as the center pivot irrigation system goes around the field.

Not every region has the same amount of water resources available, so farmers are developing ways to make sure not a drop of water is wasted when watering their crops. Continued monitoring of our groundwater reservoirs with index wells is essential for maintaining our aquifers. With good conservation practices and the latest technology, we can make sure that our water natural resources are well preserved into our future.

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Water in the Heartland

Key for marking the text:
☐ Highlight the information you already know in the text. This is information to build on.
☐ Highlight information that is new to you and that you know is important.
? Think of a question? Mark the text with a question mark, then write your questions in the section on the right.
_ Underline your vocabulary and any other keywords that are important.

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Questions and Notes
After you make a question mark in the text, write your question out in this column next to it. Take any notes that helps you remember a concept next to the text.

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Calculating Water Flow Rate

Objective: Try to come up with an estimate for how much water we use during the day. To do this, we need to practice calculating flow rate. Go to one of the six lab stations around the room. Each lab station should have a prepared milk jug/2L bottle with a hole in the bottom covered with tape, a timer, a bowl or large beaker, and a graduated cylinder.

1. Hold the gallon jug above the bowl or large beaker. Remove the tape and start the timer.

2. After 1 minute, place your finger over the hole on the bottom of the jug to stop the water. Hold the jug over the sink. Tilt the jug to the side so the tape can be replaced. Refill the jugs to the line marked on the side of the container.

3. Use a graduated cylinder to measure the water that was collected. The amount of water collected is labeled mL/min. This can be converted to L/min. by dividing by 1,000.

   ________________mL/min or ________________L/min

4. You can measure the flow rate of the classroom sinks by timing how long it takes for a 500 mL beaker to fill. Divide 500 by your time. The answer will be in mL/sec. This can be converted to mL/min. by multiplying the answer by 60. And converted to L/min. by further dividing it by 1,000.

   ___________mL/sec or ___________mL/min or ___________ L/min

5. This method can be used to find the flow rate of drinking fountains, or any other water source in the building. Use smaller beakers or cups as needed.

6. Next, try to find the flow rate for your shower and bath at home. Cut the top off of a milk jug. Fill the milk jug with 1 L of water and mark the line of the outside. Time how long it takes to fill up 1 L of water.

- One toilet flush uses 5 gal. of water.
- A 10-minute shower uses 100 gal. of water.
- To fill half a full bathtub takes 50 gal. of water.
- Brushing teeth takes 2 gal. of water.
- The dishwasher uses 10 gal. of water.
- A clothes washer uses 50 gal. of water.

7. On average, each of us uses about 70 gal. of water every day. Using the above information, calculate your daily water use. Use your own data collected to figure out how much your shower uses.

Fun Fact: In pioneer days, it is estimated that people used only 5 gal. of water per day.

8. Look for places in your day where you can reduce water use.