

SESSION FIVE

WATER, WATER EVERYWHERE

PURPOSE

- To understand the importance of water to agriculture and plant life
- To understand how water moves into, through and out of plants
- To understand the source of water for agriculture
- To explore the relationship of irrigation practices to food production

BACKGROUND INFORMATION

Throughout history, water has played an important part in agriculture. The supply of water has determined where irrigation and grazing were possible to sustain agriculture and develop civilizations. When agriculture was able to flourish so did farms, cities and communities.

The growth cycle of a plant consists of seed, sprout, seedling and mature plant. Without water, crops cannot germinate and grow. Soil, light, water, and air are where plants get the nutrients and energy they need to continue to grow and make food. Often plant growing failures can be traced to bad water management. Too much water in the soil drives out air and shuts off the oxygen supply causing root damage or death. So, farmers water deeply, but as infrequently as possible to allow air to enter the soil between irrigations. Also, farmers speed up drainage by adding organic matter to heavy soils such as clay. Successful farmers know when and how much water is needed for their crops.

Most irrigation in the United States occurs in the West, where summer precipitation is low. One of the problems with irrigation is maintaining an adequate water supply during the growing season. In many areas, the annual rainfall pattern is such that the water for irrigation falls during the non-growing season and must be stored for summer use. Water storage sources are surface stream, rivers and lakes from rainfall and melting of the mountain snow pack, and ground water pumped from the aquifers. Surface and ground water both originate from moisture in the earth's atmosphere.



The term “irrigation” is the process of putting water into the soil to make plants grow. There are three basic ways to irrigate - surface, micro-irrigation, and sprinkler. Surface irrigation includes methods such as border-strip and furrow where water flows on top of the soil. Micro-irrigation techniques such as drip, bubbler, and spray deliver a measured amount of water through an emitter located near each plant. Micro-irrigation techniques can be located above or below the ground. Sprinkler irrigation includes the use of a mechanical device which sprinkles water over the crops to simulate rain.

The method of irrigation used depends on many factors including geographical location, crop, soil, climate and economics. Farmers and ranchers are continually testing new technologies to maximize their production and economic return. Farm management practices to increase water application efficiency includes improved plant varieties, laser leveling to make their fields level or sloped, selection of irrigation systems to ensure optimum efficiency for specific crops, and water recycling programs.

Irrigation water is measured in acre-feet. An acre-foot of water is enough water cover an acre of land one foot deep and is equivalent to 326,000 gallons. Most crops are irrigated with two to four acre-feet of water per acre per year. Coincidentally, suburban land covered with houses and landscaping uses about the same amount of water per acre.

Here is a sampling of the amount of water it takes to produce certain crops in a deep, permeable, well-drained soil under average conditions+. Do you know the water requirements for the major crops in your area?

CROP	WATER REQUIREMENTS (in inches annually)
Alfalfa	49
Beans	20
Field Corn	23-27
Pasture	49
Rice	37
Small grains	16-29
Tomatoes	22-28

+Estimated water requirements for crops in the Sacramento Valley Region, California. The range reflects the variable planting dates and growing season for the individual crops.

ACTIVITY A: How Does Water Move in Plants?

OBJECTIVE: Participants will predict and observe how plants react to water and how water travels in plants.

MATERIALS YOU WILL NEED

Activity A-1:

Wilted plant, especially good are tomato or marigold plants – 1 plant
or wilted cut flowers i.e. daisy or marigold
6-8 inch bowl or saucer – 1
Water – 1 pint
Pitcher – 1

Activity A-2:

Celery stalk with leaves and/or white flower i.e. carnation, daisy, 1-2
flowers or stalks
8 ounce glass jar or container – 2
Food coloring – 1 box of four colors
Warm water – 1 pint
Pitcher - 1

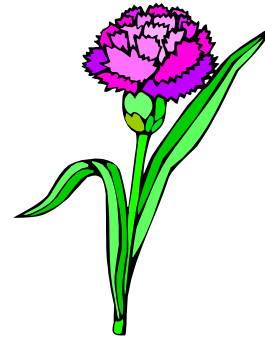
GETTING READY

- Obtain all necessary materials.
- Activity A-1: A week to ten days before the meeting, withhold water from a plant and allow it to wilt. Tomato and marigolds work well for this observation. OR select a cut flower that will wilt and easily recover i.e. daisy, marigolds. Caution: Do not allow the plant to dry out so much that it dies.
- Activity A-2: For better and faster observation, place the celery and/or flower in colored water at least 3 days before the meeting.



SUGGESTED GROUPING

Small or large group; opportunity for participants to observe.



ACTION (Observing, Communicating, and Inferring)

Activity A-1:

1. Show the participants the wilted plant or cut specimen. Ask them to predict what will happen if water is added.
2. Place the plant in a bowl and water heavily OR place the cut specimen in a container of water.
3. Place all in a location where participants can observe it during the meeting and/or over a period of time.

Activity A-2:

1. Place the freshly cut celery stalk and/or flower in a container of warm, colored water.
2. Place in a location where participants can observe it during the meeting and/or over a period of time.

TIP: For best results, be sure to freshly cut the stem of the specimen before placing it in water.

SCIENCING

Observing and Communicating

Activity A-1:

- Describe what happened to the wilted plant or cut specimen when the water was added. Did you predict the result?

Activity A-2:

- Describe what happened to the celery and/or flower. Cut the stem of the celery crosswise to observe. Describe what it looks like? Did the color of the flower change?

Inferring and relating

Activity A-1:

- Why do plants become dehydrated?
- Where does the moisture go?
- What do you think happens to food crops during a drought?
- What do farmers have to do if it does not rain for a long time?
- When does the farmer know when it is time to water his crop?

Activity A-2:

- Why do plants need water?
- How do you think the food coloring got inside the celery and/or carnation?

MORE FACTS: Water travels to all parts of a plant through tubes called xylem vessels. It is lost from holes in the leaves called stomata and evaporates. This helps to pull more water up through the plant. The flow of water through a plant is transpiration. The food coloring shows how water flows inside the tubes of the celery and/or flower.)

ACTIVITY B:

Is There Water Underground?

OBJECTIVE: Participants will explore ground water and learn that not all water is visible on the surface. Terminology is water table, ground water, aquifer, artesian well, and spring.

MATERIALS YOU WILL NEED

Clear glass jar or liter bottle (top cup off) – 1 per groups
Three types of soil i.e. sand, clay, and potting soil
Water – 1 quart
Food coloring, blue
Medicine Dropper or/and straw – 1 per group
Pencil – 1 per participant

GETTING READY

Obtain all necessary materials. If in small groups, you will need a set of the materials for each group.



SUGGESTED GROUPING

The demonstration could be set up for group observation or with small groups, of 2-3, to separately explore ground water.

ACTION (Observing, Communicating, and Inferring)

1. As a demonstration or in small groups, fill a glass jar with two inches of each of the three different soil types as a first layer of sand, then a layer of clay, and then two inches of potting soil.

TIP:
The water may run around the edges of the jar at the layer of clay.

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2. Slowly pour water into the jar. Have the participants observe how the water moves through the three materials.
3. Continue to add water until half of the sand layer is saturated. This represents ground water.
4. Give the participants the challenge of getting water out of the jar without tipping the jar. Only a pencil and a medicine dropper or straw may be used.
5. Have participants draw what occurred in the jar and label the different layers including water level. Introduce the terms: ground water, water table, and aquifer.

(The water in the soil is the ground water. The top of the ground water is called the water table. The sand containing the water is the aquifer.)

SCIENCING

Observing and communicating:

- What happened when the water was added to the jar?
- Which layer absorbed the water?
- Are all layers saturated with water?
- Did the water pour through or run off the layers?

Applying and inferring:

- What does the pencil and medicine dropper represent?
- How does a farmer capture ground water for irrigation?
- What are other ways that water comes out of the ground?
- How could someone demonstrate an artesian well and/or spring?

MORE FACTS: An *artesian* well flows naturally because of the water pressure exerted on the water in the aquifer. Pressure exerted by the inflowing water causes the aquifer to rise in the well without pumping.

Springs are different because there is no pressure involved. The water flows out of an aquifer where the aquifer touches the surface of the ground.

ACTIVITY C:

How Does the Water Flow?

OBJECTIVE: Participants will observe and compare different methods of irrigation.

MATERIALS YOU WILL NEED

Aluminum pans, approximately 7"x7" size- 3
Aluminum pans, approximately 9"x12" size – 3
Soil, any type, one inch deep in each pan
Water, 2 gallons
Liquid measuring cup – 1
Spray bottle – 1
Paper cups, 8 ounces - 1
Nail or ice pick
Small blocks of wood to raise the end of each pan - 3

GETTING READY

- Obtain all the necessary materials. You will need a complete set of the above materials for each group if each group will be doing all types of irrigation. If they are divided into three groups with each group doing a different irrigation method, only one set of supplies will be needed.
- If the participants are young, you may want to use the nail or ice pick to poke small holes at one end of the smaller aluminum pans for drainage.
- This activity can be messy therefore an outside place would be easier to manage and clean up.
- The types of irrigations systems illustrated are as follows:
 - ❖ Spray bottle represents a “sprinkler”
 - ❖ Paper cups with one or more small holes at bottom represent a “micro-irrigation” system, and
 - ❖ “Surface” irrigation has water only being delivered at one side of the pan with the use of furrows, and cross-checks.



SUGGESTED GROUPING

Groups of 3-4 participants or divide group into three groups and have each group do a different irrigation system.

ACTION (Observing, Communicating and Comparing)

1. The object of this activity is to let the participants explore how to irrigate soil with a limited amount of water. They will predict and determine which method is best for the soil type.
2. Poke holes in the end of the smaller pans for drainage. Place one inch of soil in each of the smaller pans. The pans can be slightly elevated or flat but should be all the same. The larger pans are used to set the smaller pans inside to capture the water that drains through the holes.
3. Instruct the participants to “design” an irrigation system . . . surface, micro-irrigation, and/or sprinkler using the supplies available.
4. Have participants predict which irrigation method will be the most effective with this type of soil.
5. Each pan can only use a maximum of 1 pint of water (2 cups) to irrigate the soil. The soil needs to be wet but not soggy with very little run off or water through the drain holes of the pan.
6. Have the participants record the amount of water applied to each irrigation system or pan. STOP when the water appears through the drain holes.

SCIENCING

Observing and communicating:

- What is the type of soil?
- Does it easily absorb water? Or does the water run off?
- How much water was used for each irrigation system at the time of the water passing through the drain holes?
- Did the soil move in the pan? (*This is called erosion.*)



Comparing:

- Which irrigation system did the best job in wetting the soil? Why?
- What are the differences in amount of water for each irrigation system?
- Were there different designs for the surface and micro-irrigation systems? If yes, how were they different?

Applying, inferring and relating:

- Would the results be the same with a sandy soil? Clay soil? Compost soil?
- What happens to runoff water at the farm?
- What factors determine the type of irrigation system to use?
- Why do farmers need to be concerned about how much water they use to irrigate?
- Is erosion is good thing? Why? Should the farmer try to avoid erosion?

Relating:

- Participants could continue to experiment by using the variables such as the pans level or slightly elevated, different soil types, furrow design, amounts of water, or length of time. A farmer needs to consider these variables when selecting an irrigation system.



ACTIVITY D: How Do Radishes Grow?

OBJECTIVE: Participants will become “farmers” and grow radishes and determine how much water is needed.

MATERIALS YOU WILL NEED

Radish seeds – 3-4 seeds per person
Potting soil – same type for all containers
Container - 16 oz plastic cups, 6” tall milk cartons, or liter/gallon soda bottles with tops cut off - 1 per person
Water - 1-2 gallons
Liquid measuring cup – 3 or 4 to share
Trowel - 3 or 4 to share
Bucket – 1 - 3 gallon for group
Pencils - 1 per person
Activity D: “How Do Your Radishes Grow?” Worksheet

GETTING READY

Obtain all necessary materials. Important: Potting soil should be pre-mixed with water to be the same wetness.



SUGGESTED GROUPING

Each participant should have their own radish seeds to plant.

ACTION (observing, communicating and comparing)

1. Wet potting soil to be wet but not soggy or dripping.
2. Fill container 3/4 full of potting soil; all containers should be the same size with the same depth of soil.

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3. Place 2-3 seeds in center of container; 1/4 inch deep; cover with soil.
4. Record where the container is kept i.e. light exposure and temperature.
5. Water, as needed. Measure and record amount water each time; date.
6. Observe when seeds sprout; record date.
7. Thin radishes, two inches apart, in each container.
8. Observe growth of leafy foliage. Record daily growth on chart.
9. Ready to harvest in 3-6 weeks depending upon variety.

TIP: Best crops occur with soil temperatures of 50-60 F degrees; rich, loose soil with constant moisture for non-stop growth; a sunny location and planted outside in early Spring or late Fall. Radishes can also be grown inside by a sunny window.

SCIENCING

Observing, communicating and comparing:

- Was it easy to grow the radishes?
- How many days until the radishes sprouted?
- How did you know it was time to water?
- How much water and how often was it watered?
- How big were the radishes?
- Which radish had the most leafy foliage?
- What was the difference in temperature and light and the need for water?
- Whose radish was ready to harvest first?

Applying and Inferring:

- How did you know your radish needed to be watered?
- What would happen if you didn't water enough or over watered your radish?
- When did you know it was time to harvest your radish?
- Can a radish over mature?
- What are signs of over maturity?
- If you repeated growing a radish, would you do it differently the next time?

Relating:

- What does a farmer need to consider when he grows his crop?

ACTIVITY D: How Do Radishes Grow? Worksheet

Location of plant: _____ Date planted: _____

Sun? Yes No How many hours of sun per day? _____

Temperature? Hot Cool Cold

Watering Table: Record date and amount of water given to plant. Measure the water by $\frac{1}{4}$ cup, $\frac{1}{2}$ cup, $\frac{3}{4}$ cup, or 1 cup.

Date	How much water?	Date	How much water?	Date	How much water?
TOTAL		TOTAL		TOTAL	

Plant Growth Chart: Draw a picture of your radish plant as it grows. Record day seed germinated or sprouted above the soil. Record height of plant, number of leaves and color.

GERMINATION Day: _____	Day: _____	Day: _____	Day: _____	Day: _____	Day: _____
Day: _____	Day: _____	Day: _____	Day: _____	Day: _____	Day: _____