



Maintaining a Healthy Garden

Lesson eight: How do you water the garden?

“Water in the Garden” and “Watering the Garden” from GARDEN MOSAICS, Cornell University Cooperative Extension Service

Explore the water cycle and figure out how to use the cycle to water your garden. While the plants grow, learn more about garden vegetables by tasting and exploring them one or two at a time.

Content objectives: Describe the steps in the water cycle;
Explain why plant roots need both water and air;
Identify signs of water stress in plants;
Demonstrate when, how, how much a garden should be watered;
Explain how to conserve water in the garden

Life skill objectives: Critical thinking, Decision making, Problem solving, Communication, Citizenship, Leadership

Core and STEM concepts and skills:

Science Earth and space, Life science, Science as inquiry
Math Measurement and data, Operations and algebraic thinking, Mathematical practices
Language Arts: Reading, Vocabulary, Listening, Speaking, Viewing
Social Studies Behavioral; Geography; Economics; People, places and environments

Healthy snack: Try different greens, such as different types of lettuce, kale, chard, collard. Serve with a dipping dressing, such as Ranch™, Thousand Island or homemade dressing. For more ideas, go to <http://idph.iowa.gov/inn/pick-a-better-snack/fact-sheets>

Additional and supporting resources: GARDEN MOSAICS Science Pages, Plants
<http://communitygardennews.org/gardenmosaics/pgs/science/english/mainscience.htm>





BEFORE THE LESSON

1. **Grade 4, Lesson 8:**

This document contains all the curriculum items and resources you need for this lesson. All lesson downloads are located on the www.peoplesgarden.wsu.edu Educational Toolkit.

2. Prepare for tasting: Try different greens, such as different types of lettuce, kale, chard, collard. Serve with a dipping dressing, such as Ranch™, Thousand Island or homemade dressing. For more ideas, go to <http://idph.iowa.gov/inn/pick-a-better-snack/fact-sheets>

THE LESSON

1. **Water in the Garden and Watering the Garden** is a lesson that you develop for your class, based on the Science Pages from Garden Mosaics. It includes an experiment on drainage, and review too little and too much water in the garden.

2. Consider adding information about mulching to retain water in the garden.

<http://communitygardennews.org/gardenmosaics/pgs/science/english/mulch.aspx>

AFTER THE LESSON

Water and weed in the garden. Continue the garden journals or records. Each time you do a lesson or go out in the garden, there is an opportunity to add something new to the Garden Journal.



WATER IN THE GARDEN Teaching Tips



LEARNING OBJECTIVES

Youth will be able to:

- * Describe the steps in the water cycle.
- * Explain why plant roots need both water and air from the soil.
- * Identify signs of water stress in plants.



HOW TO USE THE WATER IN THE GARDEN SCIENCE PAGE

To demonstrate transpiration, place a small plastic bag over the leaf of a house plant or garden plant, and secure the bag around the stem with a twist tie. After about an hour, check the bag. Water from the transpiring leaf will collect on the inside of the bag.

To demonstrate evaporation, condensation, and precipitation, heat some water until it is near the boiling point. Place it in a clear, heat-proof dish. Cover the dish with an upside-down lid or aluminum foil. Put ice on top of the lid or foil. Water will evaporate from the dish, condense on the cool surface, and fall in droplets back into the dish. Tell youth to look for steam rising from warm water (clouds) and drops forming on bottom side of lid (rain). Ask: What happens to the water when it gets heated up? (Answer: It evaporates and becomes water vapor.) What effect does the ice have on the water? (Answer: It causes the water vapor in the air to condense to form water droplets.) How is this demonstration similar to or different from the water cycle that occurs in nature? (Answer: The same processes of evaporation, condensation, and precipitation occur in nature, only on a much larger scale. In nature, other processes such as transpiration are

also important.)

You may wish to review the following scientific terms, and ask youth where they occur in the natural water cycle:

Evaporation is the changing of water from a liquid to a gas.

Condensation is the changing of water from a gas to a liquid.

Precipitation is the process by which water condenses to form drops heavy enough to fall to the Earth's surface.

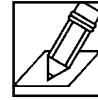
Transpiration is the process by which moisture is carried through plants from roots to leaves, where it changes to vapor, and is released to the atmosphere.

Capillary action is the climbing of liquids in narrow tubes or in tiny openings of porous material, such as soils. (This is due to forces of cohesion and adhesion.)

Surface run-off is the flowing of water over the land from higher to lower ground.

Infiltration is the process of water filling the porous spaces of soil.

Emphasize the fact that plants need a constant supply of water and oxygen. Too little water does not allow the roots to replace water lost by the plant through transpiration. Studies have shown that production is almost doubled if plants have a constant water supply. Also, plants need to take oxygen from the soil pore spaces. Without enough oxygen, plant roots suffocate and die. Plant parts above ground exhibit symptoms of lack of oxygen, including: wilting, yellowing drying foliage, and leaf drop. Constant over-watering kills most plants. These symptoms might be mistaken for the symptoms caused by lack of water. Youth may be interested in setting up a demonstration to compare the symptoms in potted plants when they are given too much or not enough water.



PUZZLE

Answers: RUNOFF; TRANSPIRES; CAPILLARY ACTION; EVAPORATES; CLOUDS; RAIN; PLANTS; SOIL. Final message: WATER CYCLE.



TRY THIS

Youth should discover that sandy soils drain very rapidly, and clay and compacted soils drain very slowly. Sandy loams will accept about 1.25 to 7.5 centimeters of water per hour. A clay-loam may absorb only 0.25 to 1.5 centimeters of water in the same amount of time. A very dry clay-loam soil could therefore take as long as 120 hours to become completely wet to a depth of 30 centimeters, whereas a sandy loam may take as little as 4 hours. Adding organic matter to all soil types will cause them to behave differently. Sandy soils with organic matter added will hold water longer. Adding organic matter to clay or to compacted soils allows water to penetrate more quickly. Challenge youth to set up a demonstration to show how water drainage changes when organic matter is added to different soil types.



SPOTLIGHT ON RESEARCH

The information for this Spotlight is from: Spillman, A. "Salt-Tolerant Forages for Irrigated Areas." ARS News Service Agricultural Research Service, USDA. Washington D.C. 2002. <<http://www.ars.usda.gov/is/pr/2002/020522.htm>>

WATER IN THE GARDEN Science Page

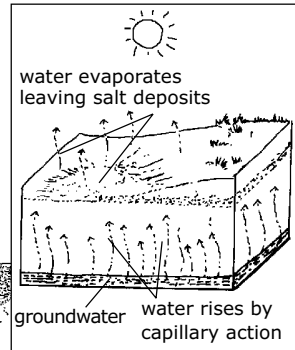
WATER CYCLE IN THE GARDEN

Water falls on the soil when it rains, or when the garden is watered. What happens to this water?

The water in clouds eventually falls to the ground as rain.

Water that is evaporated or transpired eventually forms clouds.

Leaves have thousands of tiny openings through which water vapor comes out of the plant into the air. This process is called transpiration.



Some water flows away over the top of the soil. This is called runoff.

Some water seeps into the soil, filling spaces between soil particles. Water seeps through sandy soils much faster than through clay soils or compacted soils.

Water soaks into the soil down to the roots of plants. Water taken up by roots moves through the stems to the leaves.

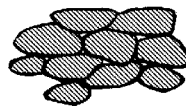
Water may seep through the soil beyond the root zone.

Some water evaporates directly from the soil surface, especially in hot, dry climates. This causes water from lower layers in the soil to be pulled to the surface. As water is pulled up through the soil, it may carry dissolved salts. When the water evaporates, salt deposits are sometimes left on the surface of the soil.

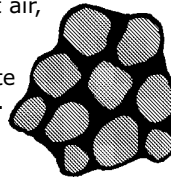
TOO MUCH OR TOO LITTLE WATER

Plants need both water and air in the soil. Ideally, half the volume of soil should be pore spaces. About half of each pore space should be filled with water, and about half with air. When soil does not have the right balance of air and water, plants may suffer from stress.

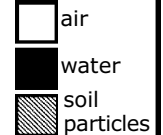
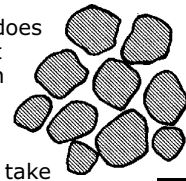
Neither air nor water can enter compacted soil.



Watering the soil too much will fill all the pore spaces with water. Without air, plant roots suffocate and die.

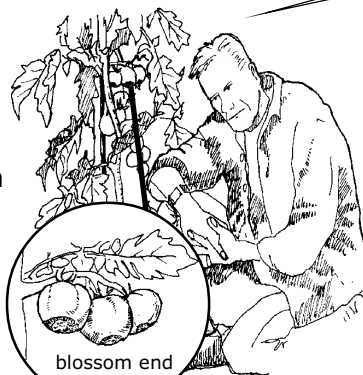


If soil does not get enough water, the roots cannot take up water to replace what is lost through transpiration.

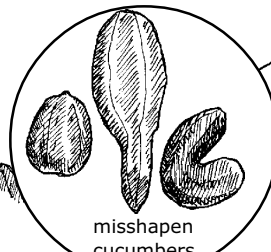


Plants are most affected by water stress right after they are planted or transplanted, and while fruits are forming. Root crops, such as beets and carrots, are vulnerable to water stress while the roots are growing.

These tomatoes have blossom end rot because they did not get enough water when they were forming fruits.



Our garden did not get enough water, so this carrot has a hard core. The lettuce is bitter, and the cucumbers are small and misshapen.





PUZZLE

Unscramble each clue word related to how and where water moves in a garden. Take the letters that appear in boxes, and unscramble these letters to complete a final message that describes what keeps going round and round in the garden.

FOUNRF

SINAPRTRES

PACRYAILL

OTNCAI

TOPEVREAS

CODLUS

RIAN

NALTPS

SILO

message



TRY THIS

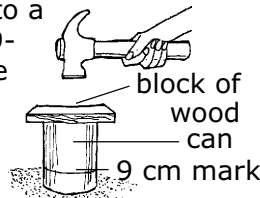
PERC TEST

What you need

- * 4 1-gallon metal cans
- * can opener
- * ruler
- * wood block
- * watch with second hand
- * pencil and paper
- * hammer

What to do

1. Use the can opener to cut the bottoms and tops off 3 of the cans. Mark each can 9 cm from one end.
2. Go to a garden and pick out three sites where you think the water will soak in at different rates.
3. On each of the sites you have selected, set a can on the ground, so that the 9-cm level is near the ground. Place the block over the can and tap with the hammer so the can is pushed into the ground to a depth of 9 cm, and the 9-cm mark is level with the ground (see picture).
4. Make a chart similar to the one shown in the next column.
5. For each site, fill the fourth can with a liter of water, and pour the water into the can in the ground. Record the time when the water was added.
6. Observe the water level every minute for the first 10 minutes, and every 10 minutes or every hour after that, depending on the rate of water flow. Record the time when



	Site 1	Site 2	Site 3
A. Time when water is added			
B. Time when water soaks into ground			
Time it takes for water to soak in (B-A)			

the water has completely soaked into the ground.

7. Figure out the time it took for water to soak into the ground at each site. Where does water soak into the ground the slowest? The fastest? Can you explain your results?



SPOTLIGHT ON RESEARCH

Can plants help solve the salty soil problem of irrigated lands?

Irrigation makes it possible to grow crops in dry regions, where they would otherwise not grow. For example, under irrigation, the San Joaquin Valley in California has become one of the world's most productive agricultural areas, sometimes referred to as "the nation's salad bowl." However, irrigating soil can cause problems in hot, dry places. As irrigation water evaporates from the soil surface, salts in the water are left behind. Salty soil makes it harder for plants to absorb the water they need to grow. As salts from irrigation build up year after year, the soil may gradually become too salty to grow any crops at all. About 30% of the irrigated land in the U.S. and 50% worldwide are salt-affected.

Scientists with the U.S. Department of Agriculture are helping farmers in the San Joaquin Valley to deal with this problem. One way to reduce the amount of salts in soils is to drain off excess irrigation water from the fields, instead of letting it evaporate, which makes the soil saltier. But what can you do with the salty drainage water? The scientists asked, "What if we planted crops that can tolerate salty water to take up excess salt in the drainage water?" In lab trials, they tested crops that produce feed for sheep and cows. They grew a number of different feed crops in tanks, adding salts at different levels to the soil. Overall, alfalfa performed best. Next scientists will conduct field tests on alfalfa, and also test the nutritional value of the feed produced.

Source: Spillman, A. (2002). Salt-tolerant forages for irrigated areas. ARS News Service. Agricultural Research Service, USDA, Washington, D.C. <<http://www.ars.usda.gov/is/pr/2002/020522.htm>>



RIDDLE

Why are mushrooms like little umbrellas?

Answer: Because they come out in rainy weather!

WATERING GARDEN PLANTS Teaching Tips



LEARNING OBJECTIVES

Youth will be able to:

- * Explain when and how much a garden should be watered.
- * Describe several different watering methods that can be used in a garden.
- * Evaluate watering methods to determine which is most suitable for a given situation.
- * Explain how to conserve water in the garden.



HOW TO USE THE WATERING GARDEN PLANTS SCIENCE PAGE

Have youth do a survey of watering techniques being used in the community garden. Find out where the water comes from and how gardeners transport it to their gardens. Observe how and when crops are being watered and compare their vigor. For example, look for different types of drip irrigation systems, including both homemade and store bought devices. Observe how the plants are doing under these watering systems. Are they being watered enough, and in the right way?

Look for plants that appear wilted and stunted because of lack of water. Try to figure out why they are stressed. Are they getting enough water? Is there enough organic matter in the soil? Are plants being mulched?

Look for techniques being used to conserve water. For example, do gardeners collect water in rain barrels? Do they add organic matter and mulch to their soil?

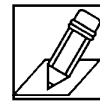
Youth may want to visit several gardens and possibly a farm or university agricultural experiment station to learn about different watering methods. They may also want to do research about watering techniques on the

internet. Go over the general watering tips below with the youth. After youth have learned about watering methods for gardens, have them discuss what recommendations on watering they would give to gardeners. They may wish to draw a poster to illustrate their recommendations, and post it in the garden. Or they may want to make a poster on watering for children and other visitors to the garden.

Here are a few tips that many gardeners could use to improve water use in the garden. Water infrequently, but thoroughly. Frequent shallow watering causes plant roots to concentrate close to the surface, making the plant more susceptible to water stress. How often you must water depends on many factors, including the type of soil you have (sandy soils need watering more frequently than do clay soils), how much organic matter and mulch is present (soil without mulch or organic matter dries out faster), whether or not you have raised beds (raised beds tend to dry out faster), and the weather (obviously, you have to water more often in hot, windy, dry weather, and less often in rainy weather). Generally, unless the weather is very hot and windy, about 2 1/2 centimeters (1 inch) of water per week is adequate for most garden plants. To find out how much rainwater the garden is getting, you can place a straight-sided can in the soil, and then measure how much water is in the can after a rainstorm. If the garden is not getting 2 1/2 centimeters of rain, then you need to make up the difference by watering.

To find out for sure if you need to water, check the soil to the depth of the roots. When the soil is dry to a depth of 15-30 cm, water

thoroughly until the soil is moist to the depth of the roots (at least 60 cm deep for tomatoes, pumpkins, winter squash, sweet potatoes, and watermelon; at least 45-60 cm deep for beans, beets, carrots, cucumbers, peas, peppers, and summer squash; at least 30 cm for cole crops, corn, lettuce, potatoes, radishes, spinach, and berries). 2 1/2 centimeters of water will penetrate to a 38 cm depth in a loam soil.



CROSSWORD PUZZLE

Answers

Across: 1. morning; 4. drip; 7. compaction; 9. trickle; 11. soaker.

Down: 2. organic; 3. sprinklers; 5. rain; 6. barrels; 8. mulch; 10. roots.



TRY THIS

This is a very simple drip irrigation device that works well for widely spaced plants in the garden. Youth should observe that crops irrigated with this device are more vigorous and have higher yields, compared to crops that are not watered during dry spells.



SPOTLIGHT ON RESEARCH

The information for this Spotlight is from: Keller, J. 2002. Contest for Innovative Irrigation Ideas and Technologies for Smallholders. Washington: World Bank. Source: <[Inweb18.worldbank.org/.../\\$FILE/topentrantsI&Dcontest.pdf](http://Inweb18.worldbank.org/.../$FILE/topentrantsI&Dcontest.pdf)>

WATERING GARDEN PLANTS Science Page

TO WATER OR NOT TO WATER?

In most areas, rain alone does not meet all the water needs of garden plants. You need to water the garden.

The soil is dry all the way down to the depth of the plant roots. It's time to water.

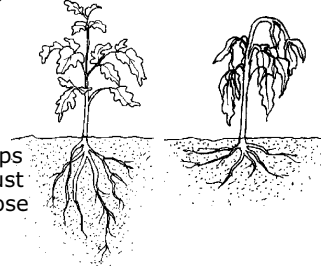


The soil in raised beds dries out faster, so we have to water more often.



At least these beds drain well. If the soil were compacted, the water would not drain and the plant roots would drown.

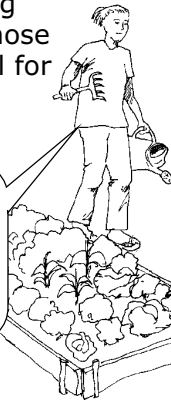
You need to add enough water so that it seeps all the way down to the plant roots. If you just water the soil surface, the roots will grow close to the surface and then the plants will wilt more quickly.



WATERING METHODS

1. A watering can and hose are useful for small gardens.

Direct the water to the base of the plant, not on the leaves.

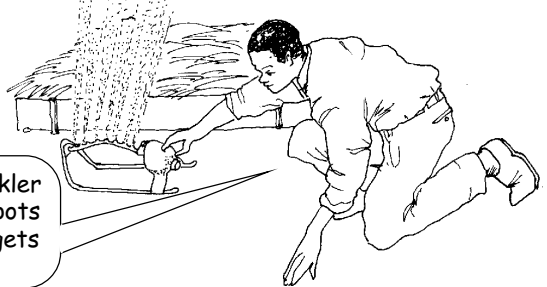


I'm using a gentle rain nozzle so the water can slowly soak into the soil.

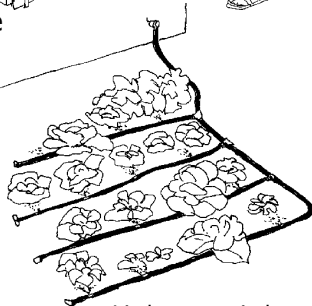


2. Sprinklers are cheap and convenient, but they waste a lot of water to evaporation, especially on hot, windy days.

I'll move the sprinkler around to other spots so all the garden gets enough water.



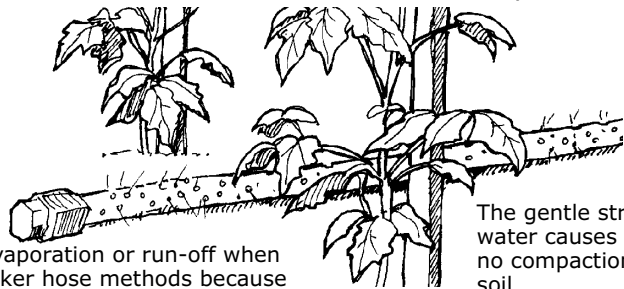
3. A drip or trickle irrigation system applies water directly to the area in the soil where roots are growing.



Many farmers in hot, dry places use drip or trickle irrigation.

Little water is lost to evaporation or run-off when you use the drip or soaker hose methods because the water goes into the ground near the plant.

4. A soaker hose is a plastic or canvas hose with holes all along its length. It is placed along one side of plants or underneath mulch. Water seeps out slowly.

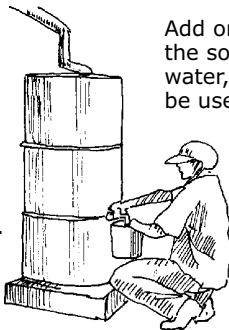


The gentle stream of water causes little or no compaction of the soil.

SAVING WATER IN THE GARDEN

Make the most of available water in the garden.

Collect rain water from roof-tops in rain barrels. Keep the rain barrel covered to prevent mosquitoes from breeding.



Add organic matter to the soil. It holds the water, which then can be used by plants.



Water during early morning. At this time temperatures are cooler and it is less windy, so there is less evaporation.

Cover the soil with mulch, which smothers weeds and allows water to seep slowly into the soil. A mulch cover also reduces evaporation of water from the soil.





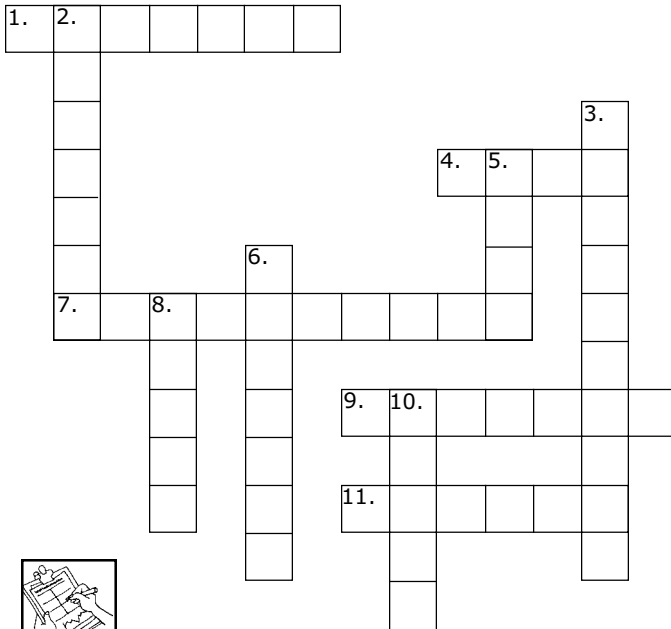
CROSSWORD PUZZLE

Across

- Water in the _____ when it is cooler.
- This type of irrigation system applies water directly to the roots of plants.
- Watering with a gentle stream of water causes little _____.
- Farmers in hot, dry countries use this method of watering.
- A hose with holes all along its length is called a _____ hose.

Down

- Add _____ matter to soil so that the soil will hold more water.
- They waste a lot of water to evaporation.
- Use a gentle _____ nozzle for watering plants.
- Gardeners can collect rain in rain _____.
- _____ will help reduce evaporation from the soil surface.
- When watering add enough water so it seeps all the way down to the _____.



TRY THIS

DRIP IRRIGATION FOR GARDEN PLANTS

What you need

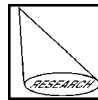
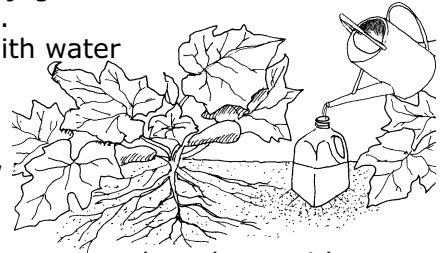
- * plastic one-gallon milk jugs
- * clothespin with spring
- * pin
- * candle
- * matches

What to do

- Light the candle. Use the clothespin to hold the pin. Place the sharp end of the pin in the candle flame until it is hot. Use the hot pin to melt about 8 to 10 small holes in the bottom of the milk jug. CAUTION: Do this only under the supervision of an adult.
- Put some water in the jug to make sure the

water will slowly drip out of it.

- Bury the milk jug between widely spaced plants in the garden, such as tomatoes, peppers, eggplants, or squash. The bottom 15 cm of the jug should be buried (see picture).
- Fill the jug with water every few days during dry spells.
- Observe how well the plants near the jug grow, compared to plants without drip irrigation.



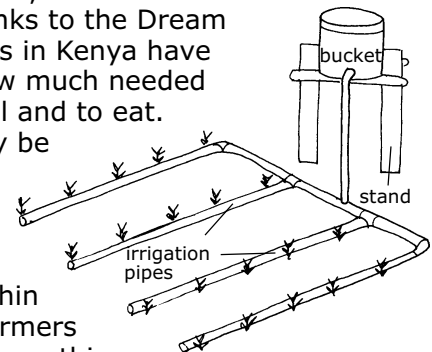
SPOTLIGHT ON RESEARCH

Dream up a watering invention

Can you think of a creative irrigation idea for gardeners and small farmers? Each year the World Bank and the United Nations sponsor a contest to promote irrigation systems for small farmers and gardeners. The irrigation systems must be affordable, creative, easy to operate, and useful in many areas around the world.

One of the contest winners was a "Dream Kit" for drip irrigation, designed by Stephen Ngigi at the University of Nairobi in Kenya. The Dream Kit consists of a bucket mounted on a wooden stand above the ground. The bucket is connected to pipes with tiny holes in them, through which water drips out along a row of crops. In dry areas, the bucket is filled twice a day. Thanks to the Dream Kit, small farmers in Kenya have been able to grow much needed vegetables to sell and to eat.

The kit can easily be put together and repaired by farmers, and costs only U.S. \$15.00. Within three months, farmers can make four times this much by selling crops that would otherwise be difficult to grow. The Dream Kit truly deserves its name!



Source: Keller, J. (2002). *Contest for Innovative Irrigation Ideas and Technologies for Smallholders*. World Bank, Washington D.C.
<<http://www.worldbank.org/.../FILETopenrantsI&Dcontest.pdf>>



RIDDLE

Where do vegetables go to have a drink?

Answer: A salad bar!