CALIFORNIA'S CLIMATE-SMART FARMS

SWEET CORN, WATER, AND CLIMATE CHANGE

OVERVIEW

In these three activities, students explore the connection between climate change, precipitation, and agriculture by focusing on corn grown in California. Each activity in the set is designed to stand alone. The activities may also be combined to make a more complex learning progression.

GRADE LEVEL: 6–8

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CALIFORNIA FOOD FOR CALIFORNIA KIDS® downloadable resource

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CALIFORNIA FOOD
FOR CALIFORNIA KIDS®

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CORN, WATER, AND CLIMATE CHANGE

Summary of Activities

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ACTIVITY	TIME	MATERIALS
How Do Water Shortages Affect Corn and Other Crops? Students analyze infographics showing how a water deficit can stress corn plants and alter the development of corn cobs.	• One 50-minute period	• Copies of student pages • Access to internet (optional)
Is There Evidence of Drought in California? Students plan and conduct an investigation of drought conditions in California over time using an online mapping tool.	• One 50-minute period to set up, plus time to observe and analyze results	• Copies of student pages • Access to internet
What Can Farmers and Others Do to Conserve Water? Students read a profile of Three Sisters Gardens, which uses water conservation methods to grow corn and other crops, and identify steps individuals can take to conserve water.	• One 50-minute period	• Copies of student pages • Access to internet (optional)

Background

In summer, many Californians enjoy eating sweet corn on the cob. California is one of the top growers of sweet corn, just behind Florida, producing 17 percent of the nation's crop. Most sweet corn is sown in spring, harvested in summer, and eaten fresh.

Some people don't realize that there are three main types of corn: flint or dent corn, field corn, and sweet corn. Flint corn, which is the oldest type, has a hard seed coat and often different colors, and is used to make cornmeal and hominy. Popcorn is a specific type of flint corn. Field corn is grown for livestock fodder, cereal, processed foods, and ethanol, and is kept in the field until the ears are almost dry. Sweet corn—the kind we eat fresh, frozen, or canned—is a genetic mutation of field corn that was discovered in the 1700s. It stores more sugar in its kernels than field corn and is harvested before it is fully mature.

Field corn, flint corn, and sweet corn plants can become stressed if they don't get enough water during their growth cycle. The pollination period is especially sensitive to a water deficit, and reduced water can cause fewer kernels to form.

In California, the sweet corn crop as well as the entire agriculture industry are closely tied to the availability of water. California receives 75 percent of its rain and snow in the watersheds north of Sacramento, while 80 percent of the water demand comes from the southern two-thirds of the state. A complex system of dams, reservoirs, pumping stations, and canals moves water to where it is needed, and is largely responsible for the magnitude of the state's economy, population, and agricultural production.

Climate change is already impacting the amount of water available in California. With warmer temperatures, snowpack in the mountains is decreasing, causing snow to melt faster and earlier, making it more difficult to store and use the water. At the same time, the demand for water is increasing with hotter summer months and longer growing seasons. And as precipitation varies, the potential for drought is always a concern.

Because 40 percent of water from the state's water system is used for agriculture, farmers will play a crucial role in conserving California's water resources, especially in the face of climate change. With sweet corn production, for example, transitioning from furrow-irrigated to drip-irrigated fields and using drought-tolerant varieties can save a significant amount of water per year and help to prevent drought.

Resources

- **Climate Change Basics.** California Department of Water Resources. This webpage provides an overview of how climate change is affecting California's water resources. https://water.ca.gov/Water-Basics/Climate-Change-Basics#:~:text=Sea%20level%20rise%20in%20California%20could%20lead%20to%20flooding%20of,into%20the%20Bay%2DDelta%20system
- **Water, Climate Changes, and California Agriculture.** Giannini Foundation of Agricultural Economics, University of California. This article describes potential effects of climate change on the availability of water for agriculture and offers hope for continued growth. https://s.giannini.ucop.edu/uploads/giannini_public/2a/d1/2ad1d16c-75f9-42b3-a0dd-6fc2e15e37af/v18n1_3.pdf
- **Water Use in California.** Public Policy Institute of California. Facts and graphs showing California's state and regional water use by sector: urban, agriculture, and environment. https://www.ppic.org/publication/water-use-in-california/
- **Climate Change, Corn Bushels, and Your Wallet.** Center for Climate and Energy Solutions. A study from the U.S. Department of Agriculture warns that climate change could lead to more frequent extreme weather and threaten future corn, soybean, and wheat crops. https://www.c2es.org/2019/07/climate-change-corn-bushels-and-your-wallet/
- **Alfred Melbourne and Three Sisters Gardens.** Vanguard Court Watch. This compelling 37-minute interview tells the story behind Three Sisters Gardens, which was born from a commitment by farmer Alfred Melbourne to give back to the community and help at-risk youth after spending nearly two decades in prison. https://soundcloud.com/davisvanguard/vanguard-court-watch-podcast-episode-5-alfred-melbourne
- **Growing Maize Plants.** Cold Spring Harbor Laboratory. This 2:47-minute time-lapse video shows corn plants growing, from germination to maturation. https://www.youtube.com/watch?v=B35qxXjC5yw

Extension Ideas

- Explore with your students the topic of drought and its effects on humans through a set of labs developed by NASA. Lessons include "Normal Climate Patterns," "Droughts of the Past," and "Is Your Region Ready for Drought?" See **EarthLabs: Drought** for details. https://gpm.nasa.gov/education/lesson-plans/earthlabs-drought
- Challenge students to plan an investigation that compares soil moisture in a "Three Sisters garden" versus other planting schemes. See the **Three Sisters Garden** interactive in Understanding Food and **Climate Change** and **How to Grow a Three Sisters Garden** for more information. https://foodandclimate.ecoliteracy.org/interactive-guide/page_0004.xhtml https://www.nativeseeds.org/blogs/blog-news/how-to-grow-a-three-sisters-garden

- Encourage students to research the history of corn, including the role of Indigenous people in its cultivation. Invite students to share their personal and cultural stories about corn. They may also want to explore other stories, customs, celebrations, and ceremonies that center around corn. See the 18-minute video **Popped Secret: The Mysterious Origin of Corn**, which explores the history of corn, and the 2-minute video **Glass Gem Corn: An Artful Heirloom**, which describes how Carl L. Barnes cultivated this variety as a way to sustain his Indigenous heritage. See the website **Native American Maize (Corn) Mythology** for some Indigenous stories around corn.
  https://www.youtube.com/watch?v=mBuYUb_mFXA
  http://www.native-languages.org/legends-corn.htm
- Encourage students to research the history of corn, including the role of Indigenous people in its cultivation. Invite students to share their personal and cultural stores about corn. They may also want to explore other stories, customs, celebrations, and ceremonies that center around corn.
- Use corn to explore plant development with students. See **"Experiments with Corn to Demonstrate Plant Growth and Development"** from Biology Teacher for suggestions. Then challenge students to a Corn Competition to grow the tallest corn stalks they can using what they learned about plant development and water conservation strategies.
  https://online.ucpress.edu/abt/article/62/4/297/16243/Experiments-with-Corn-to-Demonstrate-Plant-Growth
  https://plantingscience.org/resources/85/download/CornCompetition_StudentPacket.pdf

Note: Complete activity sets for all the *California's Climate-Smart Farms* lessons are available at: https://www.ecoliteracy.org/download/climate-smart-lessons

ACTIVITY 1

How Do Water Shortages Affect Corn and Other Crops?

Students analyze infographics showing how a water deficit can stress corn plants and alter the development of corn cobs.

How Do Water Shortages Affect Corn and Other Crops?

Evidence

Did you know that snow is an important source of water in California? The winter snow that accumulates in California's high mountain ranges stores precious water for the dry summer months. When this snowpack melts, it helps to keep streams flowing during the warmer months of the year and replenishes reservoirs and groundwater stores. One-third of the water used by California farmland and cities comes from melted snowpack.

Climate change is increasing the average temperatures in California. Warmer winters mean that less precipitation falls as snow and more falls as rain. With less snowpack, water flowing to reservoirs could slow to a trickle between spring and fall. And that will mean less water available to farmers and the rest of us.

Sweet corn is an important crop in California. This is the kind of corn that people eat fresh or frozen and is different from field corn, which is used for livestock, cereal, and processed foods. California produces 17 percent of the nation's sweet corn, second only to Florida.

One big question with climate change is how lower water levels will affect the ability to grow sweet corn and other crops. The infographics on the following pages show some effects of water deficits on corn plants.

How Low Water Levels Affect Corn Plants

Plants produce fewer carbohydrates, so they are less able to fill ears with kernels.

The growth of silk is delayed, resulting in unsuccessful pollination and fewer kernels.

Leaves can wilt and curl, disrupting photosynthesis and plant growth.

Cell growth is less virgorous, resulting in shorter plants and smaller ears.

Roots are less robust, making plants less able to uptake nutrients from the soil.

How Corn Develops

Corn is a member of the grass family and can grow up to 15 feet tall. When the plant reaches about two-thirds its full height, tassels appear near the top. These are the male flowers containing pollen. About three days later, threadlike silks grow from the young ears of corn. Each silk is a female flower connected to a single ovule, which can grow into a kernel if fertilized. Pollen from the tassels is carried by the wind to the silks, which flutter to catch the drifting pollen. Each kernel must be fertilized to fully develop.

Water and Kernel Development

GLOSSARY TERMS

Carbohydrate (noun) A molecule made up of carbon, hydrogen, and oxygen that can be broken down by organisms to release energy.

Deficit (noun) A shortage of something

Fertilization (noun) The fusing of a male reproductive cell (pollen) with a female reproductive cell (ovum or egg) to form a new plant.

Photosynthesis (noun) The chemical process by which plants make their food using energy from the sun to turn water and carbon dioxide into carbohydrates.

Pollen (noun) The male reproductive cell of flowering plants.

Reservoir (noun) A storage area for large quantities of water.

Silk (noun) The long, threadlike part of an ear of corn through which pollen travels to the ovum.

Snowpack (noun) The slow-melting packed snow accumulated over the course of a winter.

Tassel (noun) The topmost part of a corn plant, which produces pollen.

Guiding Question: How Do Water Shortages Affect Corn and Other Crops?

POSSIBLE ANSWERS

Look at the evidence from the previous page. **What possible answers to the question are presented?**

DIGGING DEEPER

Research to find out more about how water deficits due to a changing climate may affect crops. Places to start:

- Watch the 1-minute video **How Will Climate Change Affect Drought?** that explains how warming temperatures will change the amount of water available in California. https://www.youtube.com/watch?v=oQEXxw3_KA4
- View the poster **Climate Change and the Future of California's Water** to learn about some of the effects of warmer temperatures on California's agriculture. https://water.ca.gov/What-We-Do/Education/Climate-Change-Poster
- Read the Scientific American article **"Rising Temperatures Could Cut Corn Production"** to uncover other ways climate change could impact the corn crop. https://www.scientificamerican.com/article/rising-temperatures-could-cut-corn-production/

Summarize what you learned:

WHAT DO YOU THINK?

Using the evidence from the previous pages and your additional research, explain your answer or solution to the question.

Claim: Write a sentence stating your answer.

EVIDENCE

Data: Include data that supports your claim.

REASONING

Explanation: Share how your evidence supports your claim.

ACTIVITY 2

Is There Evidence of Drought in California?

Students plan and conduct an investigation of drought conditions in California over time using an online mapping tool.

Is There Evidence of Drought in California?

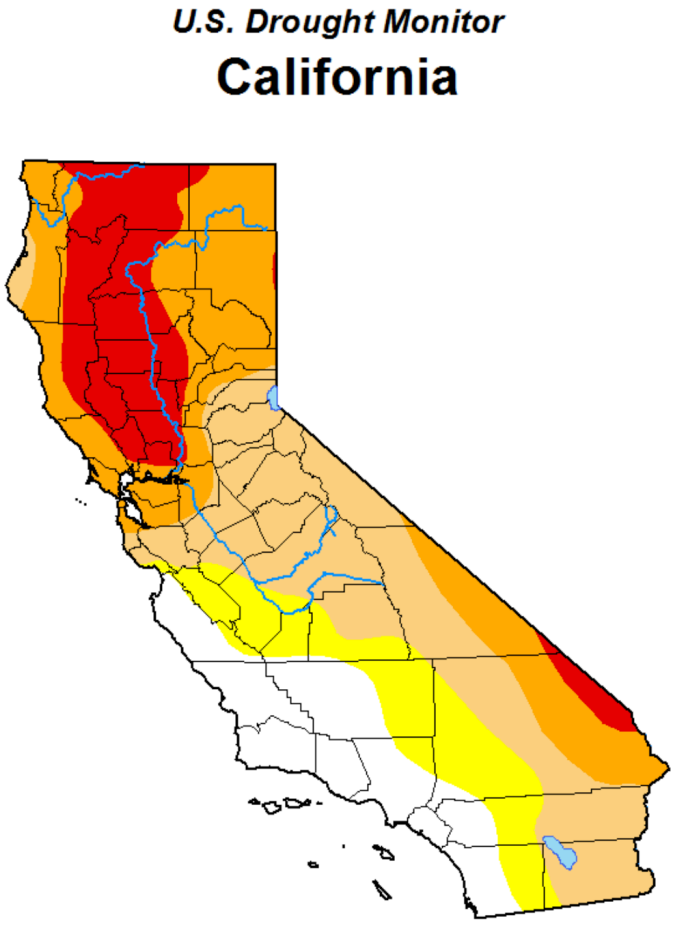
Evidence

California's famous sunshine also means a seasonally dry climate. In some areas California sees very little precipitation between spring and fall. Even in wet years, some parts of the state experience an extended dry spell in the winter. And, since 1895, the state has experienced several multi-year droughts.

A drought is a shortage of water over an extended period of time. When precipitation is less than normal for months or years, streams and rivers decline and water levels in lakes, reservoirs, and wells drop. If dry weather continues and water becomes more scarce, the dry period can become a drought.

While droughts are a normal part of California's climate cycle, scientists predict that they will become more frequent—and more severe—with climate change. At the same time, they also predict that California's rainy season may become wetter as well.

The **U.S. Drought Monitor** tracks potential drought conditions throughout the country. Use this website to plan and conduct an investigation, such as the example on the next page, of whether there is currently a drought in California.
https://droughtmonitor.unl.edu/CurrentMap.aspx



EXAMPLE INVESTIGATION

1. On the U.S. Drought Monitor website, find a map of current drought conditions for California by going to Map Archive. Under Date, select “Current”; under Area Type, select “State”; and under Area, select “California.”

2. Note what colors are showing in different areas of California and what those colors mean. In your own words, describe what you observe. (For example, “It is abnormally dry in the Central Valley, but no drought conditions are showing on the Central and Southern Coast.”

3. Look at the chart to the right of the map and note the current percentages of each area of each drought condition.

4. Compare conditions for today’s date with conditions one year ago, five years and 10 years ago. Do this by changing the date listed under Date. How do the maps compare? How do the percentages of each area of the different drought conditions compare?

5. Select a year and compare conditions in February and August of that year.

6. Describe any patterns you observe from your investigation.

GLOSSARY TERMS

Drought (noun) A prolonged period of abnormally low rainfall causing a shortage of water.

Scarce (adjective) Not enough to satisfy the need.

Guiding Question: Is there Evidence of Drought in California?

POSSIBLE ANSWERS

Look at the evidence from the previous page. **What possible answers to the question are presented?**

DIGGING DEEPER

Research to find out more about drought in California and beyond. Places to start:

- Read the webpage **Drought: Things to Know** to learn when droughts begin, whether a lack of rain means there will be a drought, and other information about droughts. https://www.usgs.gov/special-topic/water-science-school/science/droughts-things-know?qt-science_center_objects=0#qt-science_center_objects
- Watch the 1-minute video **Using NASA Data to Monitor Drought and Food Insecurity** to see how mapping data can be used to predict and plan for drought. https://youtu.be/JEX54EHBUHo
- Read the article **Drought and Climate Change** to learn about the causes and impacts of increased drought worldwide. https://www.c2es.org/content/drought-and-climate-change/

Summarize what you learned:

WHAT DO YOU THINK?

Using the evidence from the previous page and your additional research, explain your answer or solution to the question.

Claim: Write a sentence stating your answer.

EVIDENCE

Data: Include data that supports your claim.

REASONING

Explanation: Share how your evidence supports your claim.

ACTIVITY 3

What Can Farmers and Others Do to Conserve Water?

Students read a profile of Three Sisters Gardens, which uses water conservation methods to grow corn and other crops, and identify steps individuals can take to conserve water.

Three Sisters Gardens in Yolo County

What Can Farmers and Others Do to Conserve Water?

Evidence

At Three Sisters Gardens in West Sacramento, farmer Alfred Melbourne's motto is, "It's more than just lettuce!" By that, he means that Three Sisters Gardens is not simply a farm: it's a nonprofit organization that brings community members together to grow both food and lives. Its mission is "to teach youth in this urban community how to grow, harvest, and distribute organic vegetables right where they live."

Melbourne, who identifies as Hunkpapa Lakota, explains that both the farm and its name are "based on Traditional Native teachings of protecting our Mother Earth and respecting ALL living things." According to tradition, the "three sisters"—corn, beans, and squash—are grown together as companion plants to support each other. Corn stalks offer bean plants a structure for climbing; beans enrich the soil with nitrogen from the air; and large squash leaves shade the soil, keeping it moist for the others. "Like the Three Sisters legend of companionship planting," says Melbourne, "Three Sisters Gardens believes that our communities can begin to heal and thrive when all components, the youth, adults, and elders, are working together as one."

As a farmer in California, Melbourne is deeply aware of the changing climate and how it affects the availability of water. About 40% of California's water is used in agriculture, and he feels that farmers have an important role in protecting this precious resource.

The farm uses many strategies to conserve water while growing corn, beans, squash, and a wide variety of other vegetables and herbs. A methodically planned-out drip irrigation system delivers water close to the roots, reducing evaporation. Automatic timers schedule watering for the cooler times of day, further reducing water loss. The farmers also compost plant waste and apply it to the soil, improving the soil structure and increasing its capacity to hold water. And they plant cover crops instead of keeping fields bare, which keeps the soil loose rather than compacted so that it can soak up water.

Saving water is just one of the many ways Three Sisters Gardens is working to engage the community in creating a more resilient food system that is good for people—and the environment.

Three Sisters Gardens:
https://www.3sistersgardens.com/

GLOSSARY TERMS

Companion planting (noun) Growing crops together that enhance each other's growth or protect each other from pests.

Conservation (noun) The protection of natural resources, including caring for them and not wasting them.

Cover crop (noun) Plants grown to protect and enrich the soil.

Irrigation system (noun) A set of pipes, drip emitters, valves, sprinklers, ditches, or other components used to water plants.

Resilient (adjective) Able to withstand or recover quickly from difficult circumstances.

Guiding Question: What Can Farmers and Others Do to Conserve Water?

Possible Answers

Look at the evidence from the previous page. **What possible answers to the question are presented?**

DIGGING DEEPER

Research to find out more about what farmers and individuals can do. Places to start:

- Read **Water Conservation Tips for Farmers** to learn about additional ways farmers can save water.
  https://norcalagservice.com/water-conservation-tips-for-farmers/
- Watch a 7-minute video, **Oneida Elder Speaks About the Three Sisters Garden,** to learn how this planting method conserves natural resources and has helped to sustain Indigenous communities.
  https://youtu.be/lSwGxJe4bVs
- Use a **Water Footprint Calculator** to determine how much water your activities take. The calculator includes water you use from the tap and the "virtual water" needed to produce your food, electricity, and home goods.
  https://www.watercalculator.org/
- Read the webpage **Save Water at School** to identify ways you and other students can conserve water at school.
  https://coolcalifornia.arb.ca.gov/tip/save-water-schools

Summarize what you learned:

WHAT DO YOU THINK?

Using the evidence from the previous page and your additional research, explain your answer or solution to the question.

Claim: Write a sentence stating your answer.

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Explanation: Share how your evidence supports your claim.

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ABOUT THE CENTER FOR ECOLITERACY

The Center for Ecoliteracy is an internationally recognized leader in education for the sustainability of people and the planet. Since 1995, the Center has engaged with thousands of educators from across the United States and six continents. The Center offers publications, seminars, coaching for teaching and learning, in-depth curriculum development, keynote presentations, and technical assistance. Our California Food for California Kids® initiative connects public school districts as they advance their work in providing students with fresh, locally-grown food and reinforcing connections between the classroom, cafeteria, and garden. With a network of over 100 public school districts across the state, California Food for California Kids helps districts share the knowledge, experience, and caring of its participants to advance practical solutions that transform school food systems and how students learn about the food they eat.

CREDITS

Author Leslie Comnes

Designer Karen Brown

PHOTOS

Three Sisters Gardens Photos courtesy Three Sisters Gardens

Student activities Karen Brown

Stock photos corn on cob: iStock.com/timsa; corn kernels: iStock.com/xamtiw; corn stalk: iStock.com/WesAbrams; corn: iStock.com/real444; disstressed corn: iStock.com/J Gouin; cornwith rust: iStock.com/User9236883_407; corn plant: iStock.com/JJ Gouin; corn roots: iStock.com/JJ Gouin

Our deepest gratitude to Three Sisters Gardens who shared their stories, knowledge, and photos in the development of this lesson. Their generosity and wisdom will help students understand and adapt to the challenges they may face in the future of agriculture.