

SEEDS AND CLIMATE RESILIENCE



OVERVIEW

In these three activities, students explore the relationship between seed production and climate change, and consider the role that seeds play in climate resilience. 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





CENTER FOR
ECOLITERACY

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Published by Learning in the Real World

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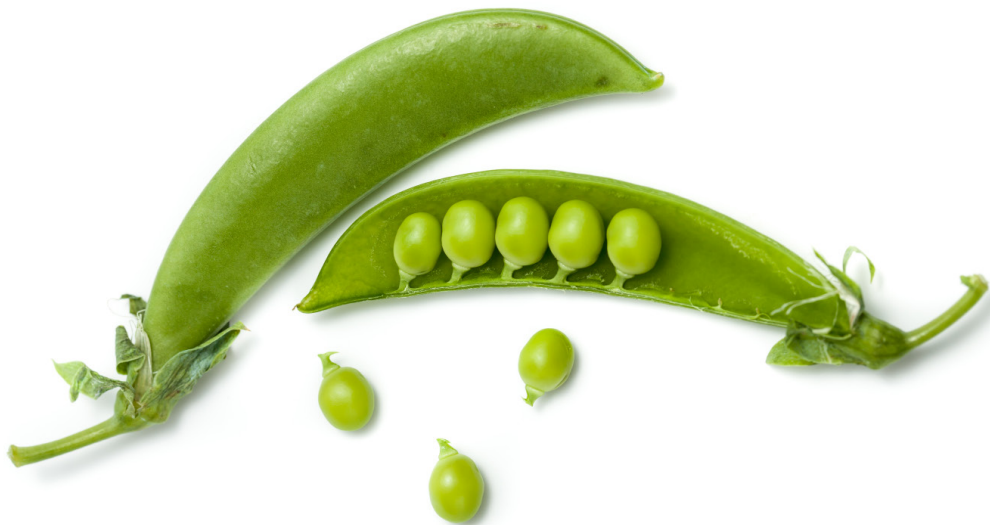
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SEEDS AND CLIMATE RESILIENCE

Summary of Activities

| ACTIVITY | TIME | MATERIALS |
|---|--|---|
| <p>How Are Seeds and Climate Change Connected?</p> <p>Students learn about the importance of seeds as a crop and analyze ways that climate change can affect seed growth and development.</p> | <ul style="list-style-type: none"> • One 50-minute period | <ul style="list-style-type: none"> • Copies of student pages • Access to internet (optional) |
| <p>How Do Temperature and Moisture Affect Seed Germination?</p> <p>Students plan and conduct an investigation to see how variances in temperature and moisture affect seed germination.</p> | <ul style="list-style-type: none"> • One 50-minute period to set up, plus time to analyze results | <ul style="list-style-type: none"> • Copies of student pages • Access to internet (optional) • Materials for Investigation: beans or other seeds, cups, paper towels, covered boxes, heating pad or other heat source, and access to refrigerator, or materials for student-designed investigation |
| <p>What Can We Do to Build Climate Resilience?</p> <p>Students read a profile of San Diego Seed Company, which is working to address climate change by supplying locally cultivated seeds suited to the area's microclimate. They also identify steps individuals can take to increase climate resilience through seeds and gardening.</p> | <ul style="list-style-type: none"> • One 50-minute period | <ul style="list-style-type: none"> • Copies of student pages • Access to internet (optional) |

Background

Most people don't think of seeds as a separate crop that is grown in California. But seed production is an important part of the state's agriculture economy, generating more than \$2 billion in global seed sales each year. California's diverse climate and soils enable seed farmers to provide seeds for a wide variety of specialty crops.

Changes in climate—particularly higher temperatures and lower rainfall—have a tremendous impact on agriculture. Climate change affects plant growth cycles, the levels of pests and disease, the timing of when plants flower, the presence of pollinators, how well the crop matures, and ultimately, crop yield and quality.

One thing that can help farmers cope with climate changes is access to a diversity of crop varieties. This crop diversity ensures that farmers are able to find crops adapted to the microclimate in their specific locale. Local seed production leads to plants that are better able to withstand the climate conditions found there.

Climate resilience is the ability to prepare for and respond to disturbances related to climate. Building climate resilience involves identifying problems that climate change may create and taking steps to better cope with them. Local seed production is one strategy for increasing climate resilience. Another is establishing seed banks at the local, regional, national, or international level, which is a means of storing seeds for future use.



Resources

- **What Does a Seed Farmer Do?** Modern Farmer. This easy-to-understand article describe the process of producing seeds.
<https://modernfarmer.com/2018/05/what-does-a-seed-farmer-do/>
- **Understanding Food and Climate Change: An Interactive Guide.** Center for Ecoliteracy. This guide uses text, photography, and video to help students and educators learn how food and climate systems interact and how personal choices can make a difference.
<https://foodandclimate.ecoliteracy.org/interactive-guide/cover.xhtml>

- **The California Seed Industry: A Measure of Economic Activity & Contribution to California Agriculture.** This pamphlet provides an overview of California’s seed production industry. https://www.seedcentral.org/market/CA_seedindustry_2009.pdf
- **Climate change is hurting farmers – even seeds are under threat.** Richard Ellis. Phys.org. December 18, 2019. This article describes some of the effects of climate change on seed production. <https://phys.org/news/2019-12-climate-farmers-seeds-threat.html#:~:text=Our%20research%20has%20also%20shown,respond%20to%20the%20changing%20climate>
- **Seed: The Untold Story.** Collective Eye Films. This 1.5-hour documentary shines a light on farmers, scientists, lawyers, and Indigenous seed keepers working to protect humankind’s seed stores and seed diversity. See also the companion educational discussion guide. <https://www.seedthemovie.com/>
- **Reseeding the Food System.** In this in-depth interview, Mohawk woman Rowen White shares how seeds have shown her that resilience is rooted in diversity, and that all of us carry encoded memories of how to plant and care for seeds. <https://emergencemagazine.org/story/reseeding-the-food-system/>

Extension Ideas

- Invite students to explore how their diet would be different if they could only eat foods that grow in their region. To start the conversation, use Center for Ecoliteracy’s 1.5-minute video **What is a Food System?** that describes the various ingredients of ketchup and where they come from. https://foodandclimate.ecoliteracy.org/interactive-guide/page_0002.xhtml
- Plant hardiness maps provide information about microclimate conditions in different areas. Invite students to explore their own microclimate and how it compares to others nearby by examining the **USDA Plant Hardiness Zone Map**. Find out how plant hardiness zones and other climate factors are shifting with climate change. <https://planthardiness.ars.usda.gov/PHZMWeb/>
- Encourage students to save seeds from the school garden to use next year or to share with community members. See the **“Save Your Seeds” activity** at KidsGardening for details. Discuss how seed-saving helps communities increase their resilience to climate change. <https://kidsgardening.org/garden-activities-save-your-seeds/>
- Start a discussion about career options for addressing climate change by sharing **A Day in the Life of the California Seed Industry**, a 5-minute video by the California Seed Association that describes different careers in the seed industry. <https://www.youtube.com/watch?v=zxUbpZISr2s>
- Invite students to share their personal and cultural stories about seeds or resilience. Encourage them to draw on these stories to identify ways they could help make their community more resilient. For inspiration, see **Truelove Seeds** or **Baker Creek Heirloom Seeds**. <https://trueloveseeds.com/>
<https://www.rareseeds.com/>

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

SEEDS AND CLIMATE RESILIENCE

ACTIVITY 1

How Are Seeds and Climate Change Connected?

Students learn about the importance of seeds as a crop and analyze ways that climate change can affect seed growth and development.

How Are Seeds and Climate Change Connected?

Evidence

Have you ever wondered where the seeds in seed packets come from? It may surprise you to learn that while many farmers grow food, some grow the seeds that others plant.

To produce seeds, seed farmers first grow plants. Then, instead of harvesting the crop, they let it remain on the plant until the seeds mature. For the best seeds, farmers collect from the healthiest-looking plants with the tastiest produce.

The seed industry in California is a major provider of seeds worldwide. It produces more than \$2 billion worth of seeds each year, which is almost 8 percent of the global seed market and 13 percent of the U.S. seed market.

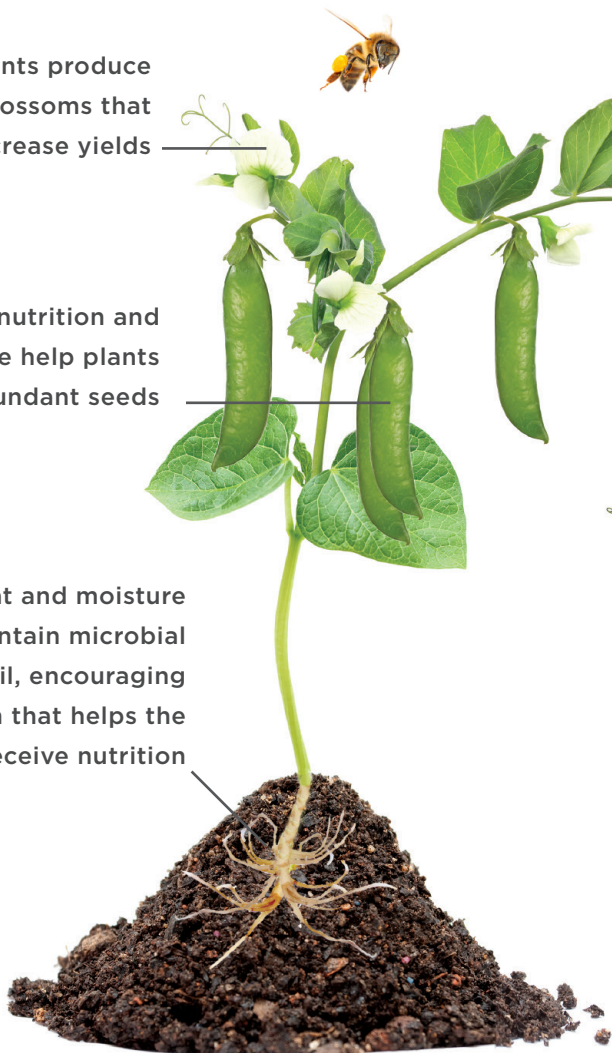
A changing climate can have a big impact on plants as well as on seed production. The following charts show different ways that changes in temperature and moisture can affect seeds.

Stable Climate Conditions

Healthy plants produce many blossoms that increase yields

Good nutrition and moisture help plants produce abundant seeds

Reliable heat and moisture help maintain microbial life in soil, encouraging root growth that helps the plant receive nutrition

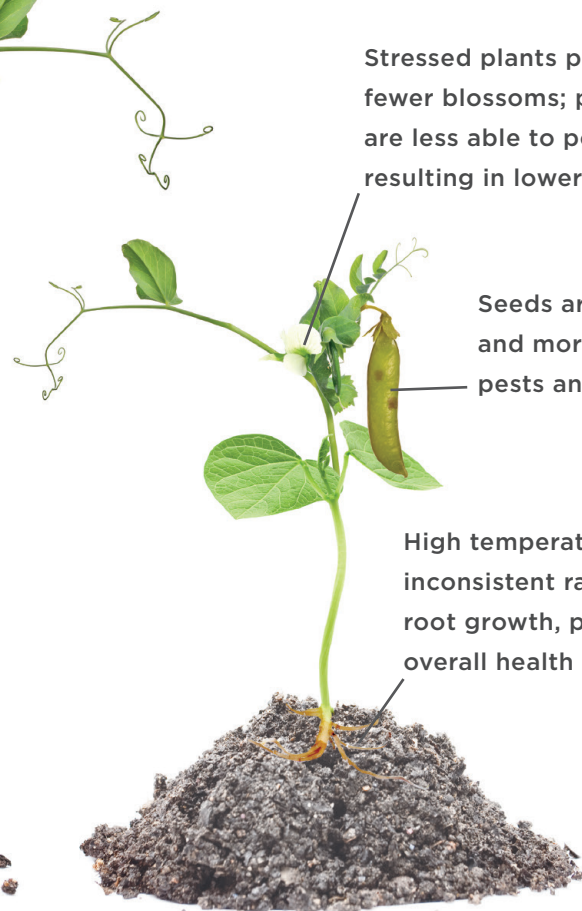


Extreme Heat, Flood, or Drought

Stressed plants produce fewer blossoms; pollinators are less able to pollinate, resulting in lower yields

Seeds are fewer, smaller and more susceptible to pests and disease

High temperatures and inconsistent rainfall inhibit root growth, putting plants' overall health at risk



HOW HIGHER TEMPERATURE AND MOISTURE CHANGES CAN AFFECT SEEDS

| SEED PRODUCTION | SEED GERMINATION | OVERALL EFFECTS |
|---|---|--|
| <ul style="list-style-type: none"> • Fewer flowers per plant • Bees and other pollinators less able to pollinate flowers • Shorter seed development time, so smaller seeds | <ul style="list-style-type: none"> • Seeds germinate at an unsuitable time • Fewer seeds germinate • Fewer seedlings survive • Seedlings grow more slowly | <ul style="list-style-type: none"> • Smaller and fewer seeds and plants • Changes to areas where crop can grow • Decreased variety of crops |

GLOSSARY TERMS

Seed development (noun) The process by which plants form seeds.

Seedling (noun) A young plant, especially one raised from seed.

Germination (noun) The sprouting of a seedling from a seed.

Pollinate (verb) Transferring pollen from a flower's male part (the stamen) to the female part (the pistil) of the same flower or another flower.

Guiding Question: How Are Seeds and Climate Change Connected?

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 the connections between seeds and climate change. Places to start:

- Watch a 3.5-minute video, **Seeding Climate Resilience**, in which a farmer talks about how seed selection helps create crops that can withstand changes in climate.
<https://climateatlas.ca/video/seeding-climate-resilience>
- Read how higher temperatures and increased precipitation (rain and snow) harms seeds in the ground: **Seeds in Tibet Face Impacts from Climate Change**.
<https://www.sciencedaily.com/releases/2020/02/200225171755.htm#:~:text=With%20warmer%20temperatures%2C%20seeds%20may,but%20ultimately%20make%20them%20fail.>
- Find out how to save seeds and share them with friends and neighbors by looking at **Seed Sharing in the Age of Climate Change**.
<https://sustainableamerica.org/blog/seed-sharing-in-the-age-of-climate-change/>

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

How Do Temperature and Moisture Affect Seed Germination?

Students plan and conduct an investigation to see how variances in temperature and moisture affect seed germination.

How Do Temperature and Moisture Affect Seed Germination?

Evidence

A seed is a plant embryo enclosed in a covering called a seed coat, usually with some stored food. The process of germination occurs when seeds come out of dormancy and begin to grow. This is triggered by factors such as moisture, temperature, and light. Because climate change affects the amount of moisture and the temperature in a region, it can also affect seed germination.

Plan and carry out an investigation, such as the following, to learn how climate factors affect seed germination. You may use beans, peas, or other seeds for your investigation. **EXAMPLE INVESTIGATION**

1. Decide whether you will investigate the effects of temperature or moisture on seed germination. For each test, cut two layers of paper towels or filter paper to fit inside the bottom of three glasses, cups, or paper cups. In each cup, place 10 seeds between the layers. Use the same kind of seeds in all three cups.
2. Set up the cups as described below.

| MOISTURE TEST | TEMPERATURE TEST |
|---|---|
| <p>For:</p> <ul style="list-style-type: none"> • Cup #1—Dry: Add no water to paper towels. • Cup #2—Moist: Moisten paper towel with a little bit of water and squeeze the paper towel to remove excess water. • Cup #3—Wet: Put water in the cup so that the seed and paper towel are completely covered in water. <p>Place all three cups in a sunny location. Check daily and replenish moisture as needed in Cups #2 and #3</p> | <p>Moisten paper towels and then:</p> <ul style="list-style-type: none"> • Cup #1—Cool: Place cup in the refrigerator. • Cup #2—Room temperature: Keep cup at room temperature. Put it in a closed box to keep out light. • Cup #3—Warm: Place cup in a warm place (for example, on a heating pad set on low, or on top of the refrigerator). Put it in a closed box to keep out light. <p>Check the paper towels daily and moisten as needed.</p> |



Example of setup with cups, seeds, and paper towels

3. Every day for the next 10 days, record the number of seeds in each cup that have germinated. When they germinate, a root or stem will emerge.
4. Calculate the percentage of seeds that germinate each day under each condition. Design a way to show your data on a graph. What do your results tell you about the effect of climate change on seeds?

GLOSSARY TERMS

Dormancy (noun) The state of being alive, but not growing.

Embryo (noun) A plant or animal in its earliest stage of development.

Germination (noun) The sprouting of a seed.

Seed coat (noun) The outer covering of a seed.

Guiding Question: How Do Temperature and Moisture Affect Seed Germination?

POSSIBLE ANSWERS

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

DIGGING DEEPER

Learn more about temperature and moisture and how they may affect seed germination. Places to start:

- Watch a 4-minute film about factors that can affect seed germination, **Seeds and Germination Explained**.
<https://www.youtube.com/watch?v=taaiH3XdSxw>
- Read **What Climate Change Means for California** to find out some of the ways climate change may affect California, such as less water and shifts in growing regions.
<https://www.epa.gov/sites/production/files/2016-09/documents/climate-change-ca.pdf>

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 We Do to Build Climate Resilience?

Students read a profile of San Diego Seed Company, which is working to address climate change by supplying locally cultivated seeds suited to the area's microclimate. They also identify steps individuals can take to increase climate resilience through seeds and gardening.



What Can We Do to Build Climate Resilience?

Evidence

Climate resilience is the ability to prepare for and respond to disturbances related to climate. Building climate resilience involves identifying problems that climate change may create and taking steps to better cope with them.

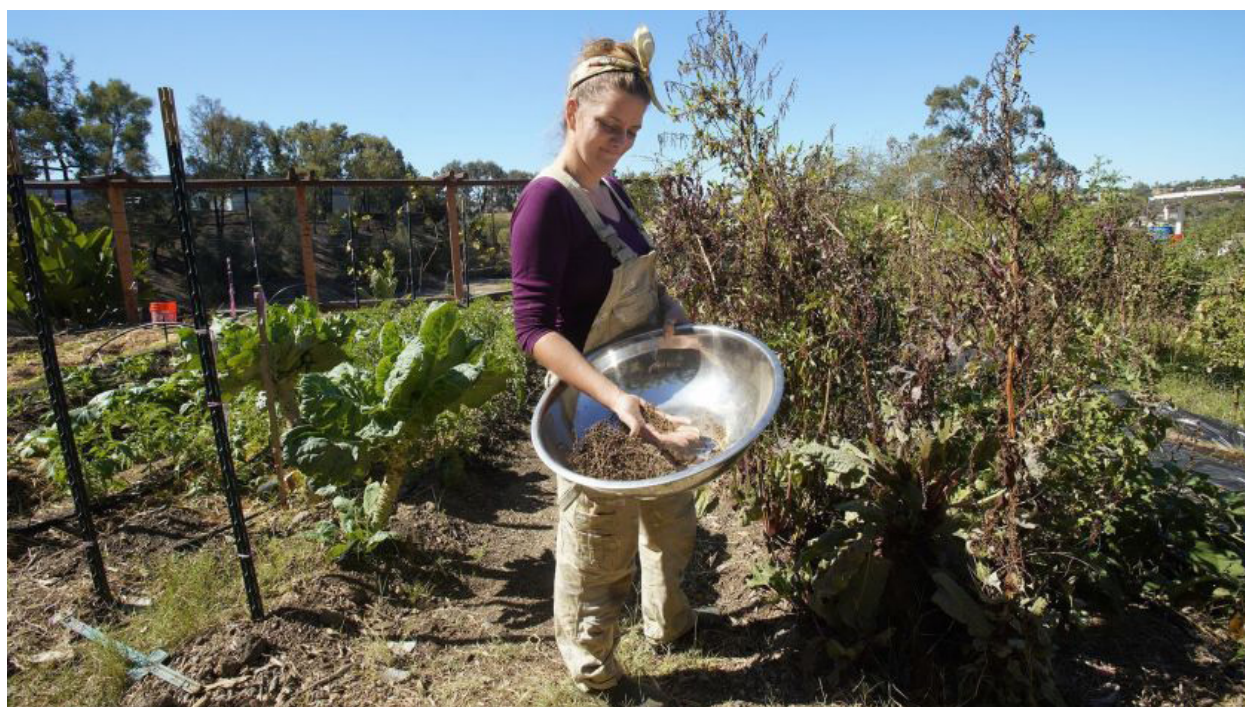
Local seed production is one strategy for increasing climate resilience. In 2010, farmer Brijette Peña came to the realization that few companies were producing seeds adapted to Southern California climates. So, she started the San Diego Seed Company, which produces organic heirloom varieties of vegetables and other plants. Providing well-adapted seeds for Southern California growers adds one more layer of support to the regional food system.

The idea is simple. By producing local seeds—seeds that are produced in the very place that they are intended to be grown—the food crops can adapt to local growing conditions. This makes these crops more resistant to local plant diseases and pests, and better adapted to the local climate.

Local seed production is one strategy for increasing climate resilience. In Southern California, that means producing seeds that can withstand the area’s increasingly dry conditions, with the droughts that are apparent with climate change.

San Diego Seed Company:

<https://sandiegoseedcompany.com/>



Brijette Peña, founder of San Diego Seed Company



GLOSSARY TERMS

Adapt (verb) To change in response to a new or changed environment.

Climate resilience (noun) The ability to prepare for and respond to events or trends related to a changing climate.

Local seeds (noun) Seeds produced by small-scale farmers for plants that have characteristics specific for the location.

Variety (noun) A group of plants within a species that have one or more distinguishing characteristics.

Guiding Question: What Can We Do to Build Climate Resilience?

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:

- Watch the 3-minute video **Civil Eats TV: Saving Seeds with Kristyn Leach** to find out why and how to be a seed saver.
<https://vimeo.com/409938981>
- See if there's a seed library near you, which may offer free seeds in exchange for a reciprocal harvest: **West Coast Seed Libraries**.
<https://www.pacifichorticulture.org/articles/seed-libraries/>
- Check out the interactive map at **U.S. Climate Resilience Toolkit Case Studies** to find out what people near you are doing to build resilience in their community.
<https://toolkit.climate.gov/#case-studies>
- Get ideas for actions gardeners can take to build climate resilience from **National Wildlife Federation's Gardening for Climate Change**.
<https://www.nwf.org/Our-Work/Climate/Climate-Change/Greenhouse-Gases/Gardening-for-Climate-Change>

Summarize what you learned. What positive and negative effects could these actions have?

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.



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

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PHOTOS

San Diego Seed Company Photos courtesy San Diego Seed Company

Student activities Karen Brown

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Our deepest gratitude to San Diego Seed Company, 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.