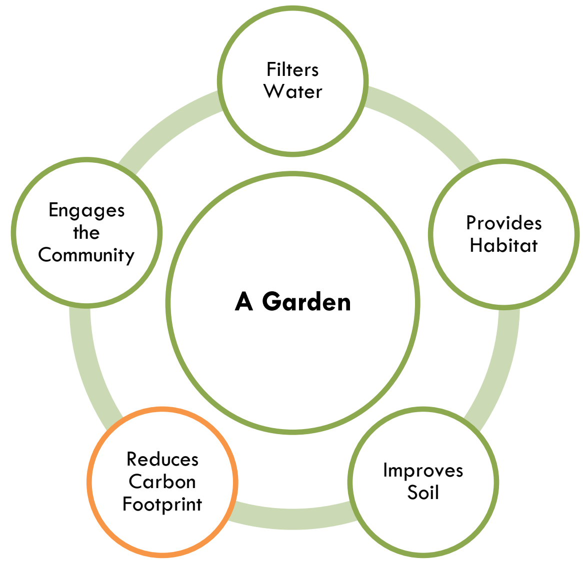
NATURE LAB Educator Resources

GARDEN LESSON PLAN: FOOD AND CARBON

Many elements are interconnected and function together to create the natural and productive living system that is your garden. Look to the end of this activity guide for additional lesson plans, activity guides, and videos that can help you bring together soil, water, habitat, food, and community to explore your dynamic garden ecosystems.



Subject Area: Gardens, General Science

Grade Levels: Geared toward 6th-8th grade, but can be tailored for all grades

Essential Question:

Does eating food grown locally help reduce your carbon footprint?

Purpose and Overview:

In this lesson, students will:

- Learn about the relationship between CO_2 production, climate change, and sourcing food locally. The carbon "foodprint" of vegetables and fruits is complex, involving how the food is produced, how it reaches us, and what we do with it.
- Describe different ways food is produced, transported, and consumed.
- Evaluate how food locally grown food may have a smaller carbon footprint than food found in the grocery store.
- Measure their garden's CO_2 offset by using calculations based on the production, transportation and consumption of their food.
- Measure the amount of food their garden has produced.

Time:

This lesson is part of an extended learning experience that engages students in creating and maintaining a school garden. It is designed to be completed in conjunction with a garden harvest and can be scheduled for time periods when harvests occur. The following are suggested time allotments for each section of the guide.

- **Engage:** one 45-minute class period
- **Explore, Part 1**: one-two 45-minute class periods depending on the size of your garden

- **Explore, Part 2:** two 45-minute class periods
- **Evaluate:** one 45-minute class period
- **Extend:** allow at least one 45-minute for each of the activities suggested in this section of the guide.

Materials and Resources:

Materials for teacher

- Computer with Internet connection
- Set of scales to measure weight (pounds or grams) of garden harvest

Materials for each student or group of students

- Paper, colored markers, pens and pencils
- Clipboards or binders and pencils for each student in group
- Computer with Internet connection
- Baskets or containers for collecting fruits, vegetables, and herbs harvested from the garden
- Camera (optional)
- Handouts listed below (found at the end of this guide)
  a. Life Cycle Assessment
  b. Food and Carbon Case Studies
  c. Food and Carbon Evaluation

Nature Lab videos supporting this activity guide

- The Industrial Tomato https://vimeo.com/138258792
- The Local Tomato https://vimeo.com/148116105
- Nature Works to Make Clean Energy https://vimeo.com/77792708
- Reforestation: Impact on Climate https://vimeo.com/77792711

Gardens How-to Video Series

- Planning Your Garden https://vimeo.com/91446626
- Building a Garden in a Day https://vimeo.com/91445078
- Caring for Your Garden https://vimeo.com/92520693
- Fears https://vimeo.com/92531513

Objectives:

Knowledge

- Describe the carbon cycle.

Comprehension

- Determine non-local food sources and the modes by which food travels into the community.
- Weigh garden harvest and record results.

Application

- Calculate the number of meals the garden provides.

Analysis

- Analyze how both natural processes and human activities have an effect on the accumulation and sequestration of CO_2 in the atmosphere.
- Analyze the relationship between the school garden and its potential to reduce the amount of carbon produced during the life cycle of fruits and vegetables.

Synthesis

- Review school garden CO_2 offset data to develop an opinion on the impact of CO_2 reduction both locally and globally.
- Create a list of ways gardens bring economic and nutritional value to the community.

Evaluation

- Judge the effectiveness of the school garden in helping to reduce carbon dioxide in the atmosphere by providing a local food source.

Next Generation Science Standards:

Disciplinary Core Ideas:

- ESS3.A Natural Resources
- ESS3.C Human Impacts on Earth Systems
- ESS3.D Global Climate Change

Crosscutting Concepts:

- Patterns
- Cause and Effect
- Stability and Change
- Influence of Engineering, Technology, and Science on Society and the Natural World

Science and Engineering Practices:

- Asking Questions and Defining Problems
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence

Performance Expectations:
Middle School

Activities in this lesson can help support achievement of these Performance Expectations:

- ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- ESS3-4. Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's systems.
- ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Common Core Standards:

6th-8th Grade Science and Technical Subjects

- CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.

- CCSS.ELA-Literacy.RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context.
- CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g. in a flowchart, diagram, model, graph, or table).
- CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Vocabulary:

Carbon: A naturally occurring element, often called the building block of life, because it easily bonds to other nonmetallic elements to form a large number of compounds. It comes in three forms: amorphous, or coal (soot, ash); diamond: and graphite.

Carbon cycle: The process in which carbon is exchanged between living organisms, as evidenced particularly through the process of photosynthesis.

Carbon dioxide: A heavy, odorless, colorless gas formed during respiration and by the decomposition of organic substances. A greenhouse gas.

Carbon footprint: The amount of greenhouse gases, especially carbon dioxide, released into the atmosphere as humans burn fossil fuels for energy, such as those used in transportation, manufacturing, and homes. An individual's carbon footprint is the total amount of greenhouse gases your daily activities require, such as driving a car, eating foods that have been transported long distances, coal burned to generate electricity that operates your electrical appliances, etc.

Climate change: The term used to describe the way in which Earth's climate and weather patterns are changing more quickly and dramatically than in the recent past as a result of increased emissions of greenhouse gases into the atmosphere.

Food miles: The distance food travels from where it is grown to where it is purchased by the consumer.

Fossil fuels: Combustible fuels such as coal, oil, or natural gas, formed from natural earth processes such as decomposition of plants and animals.

Greenhouse effect: The natural process that holds gases within Earth's atmosphere to sufficiently warm and support life on the planet.

Life Cycle Assessment: Life Cycle Assessment (LCA) is a systems analysis tool that provides information on the environmental effects of a product from its cradle (acquisition of raw materials) to its grave (waste management). It gathers information on all the inputs and outputs to and from a product system, and assesses the potential environmental impacts associated with those inputs and outputs.

Seasonality: Refers to eating fruits and vegetables when they are in season, e.g. when they are produced according to their planting, growing and harvesting times.

Background:

In this lesson, students will explore the practice of growing one's own food or obtaining food from locally produced sources and its impact on the environment through CO_2 reduction. Additional CO_2 present in the atmosphere caused by human activities, such as the burning of fossil fuels to transport food long distances, is a large factor contributing to global climate change. Food produced locally, in school gardens, backyard gardens, and local farms, can help prevent CO_2 emissions associated with transporting food from distant regions to its destination.

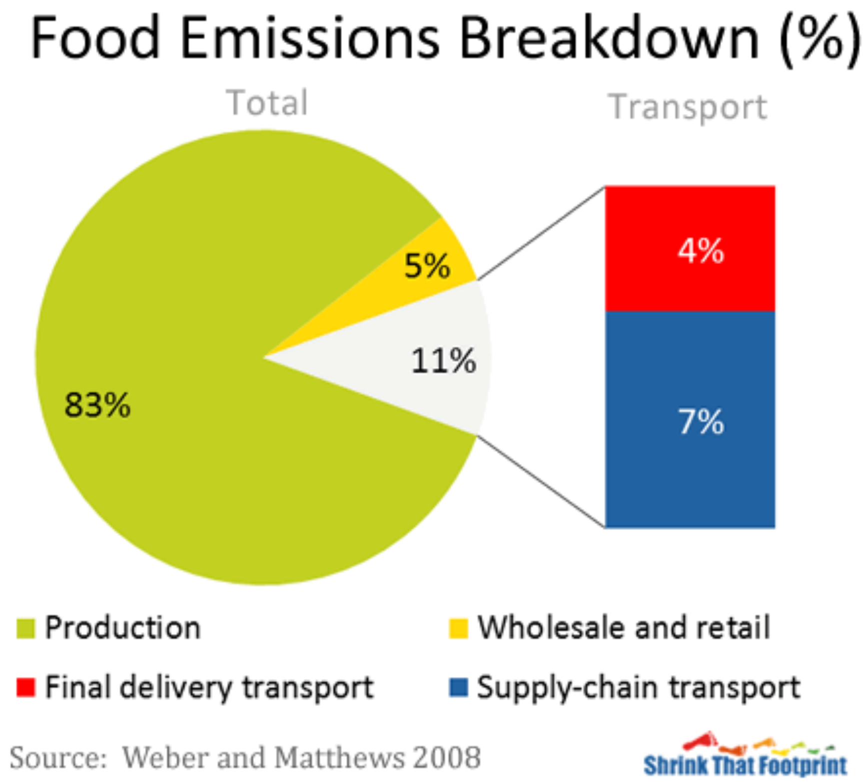
All plants help reduce CO_2 in the atmosphere by absorbing CO_2 in the process of photosynthesis. In addition, food produced locally by nature, in school gardens, backyard gardens, and local farms, can help prevent CO_2 emissions associated with transporting food from distant regions to its destination.

This is a very complex issue; the science of agriculture and climate change is a very active one, filled with hypotheses, exploration, experimentation, data sharing, and debate—all the science activities we want students to engage in. While we may not be able to identify or track every stage of how our food is produced with perfect accuracy, it is possible to understand what the issues are. This is a good opportunity for students to connect science directly to their own lives and to understand how science can help them make decisions. It is also an opportunity for students to jump into all the dynamic, socially contextualized, interpretable, and arguable undercurrents of science.

Students will use their garden produce as an entry into the complex world of food production and try to answer the even more complex question of "Where does our food come from?" And then extend that question further to evaluate the impacts of food systems on our environment. The point is that there are no cut and dry answers when it comes to understanding the dynamic relationship of food and our environment.

One place to begin looking for carbon emissions is *transportation*—how the food arrives at the supermarket or at our door. But transportation represents only one part of the story. Some scientists have found that *production* is the primary culprit in greenhouse gas emissions in the food-to-consumer chain. Production includes the energy used to manage the soil (e.g., farm machinery), irrigate, apply fertilizers or pest controls, harvest, run greenhouses (if they are used), and more. The study of all the steps of how food reaches our homes has been termed Life-Cycle Assessment (LCA).[1]

[1] Life Cycle Assessment (LCA) is a systems analysis tool that provides information on the environmental effects of a product from its cradle (acquisition of raw materials) to its grave (waste management). It gathers information on all the inputs and outputs to and from a product system, and assesses the potential environmental impacts associated with those inputs and outputs.



Another critical component of food's role in energy use and carbon emissions is diet: Eating vegetables and fruits during their local growing seasons and eating all the food we buy (or grow)—that is, not wasting food—can cut down on off-season (high-energy) production and long-distance transportation. Eating a vegetable during its natural production period (for example, eating tomatoes during the part of the season when they are produced) can have a significant impact in the amount of energy used and carbon dioxide emitted.

In the data collection portion of this activity guide, this complex system is simplified to one metric – the amount of CO_2 that is offset as calculated based on the distance food travels to reach your location. This is perhaps an oversimplification of a very complex system. But this metric can be used as an entry point to begin to evaluate our food production system and introduce your students to the dynamic life-cycle of food.

Engage

Part 1 – Life Cycle Assessment

1. Ask students to think of their favorite fruits and vegetables and where these foods might be purchased in their community. Then ask students where do those food items come from? The grocery store? A farm? Your backyard? Ask students to think of all the possible ways food makes it to their plate. Students can complete their life cycle assessment using the Life Cycle handout

2. Explain the definition of Life Cycle Assessment and tell students they are going to explore and diagram the production, transportation and consumption cycle of a **tomato**. Break students into small groups and have them discuss what happens to a tomato from seed to table. Facilitate organization of their ideas into production (anything related to growing the tomato), transportation (at any point along the life of the tomato), and use (related to storing, preparation, eating or waste). Students can also think about the by-products and/or outputs that result from each of the phases. For example, in the production phase, chemical run-off from fertilizer use is a by-product of the growing process.

3. Their lists may look something like the example below:

Production	Transportation	Use
Seeds	Food wholesalers	Refrigeration
Energy	Food companies	Eating
Sunlight	Farmer's markets	Seasonality
Water	CSA[2]	Cooking
Nutrients	Grocery Stores	Preparation
Soil	Restaurants	Storage at home
Chemicals	Homes	Storage at the store
Expertise		
Labor		
Farmers		
Machinery		
By-products or Outputs from the Above Phases		
Chemical run-off Carbon dioxide emissions Changes in soil	Carbon dioxide emissions Waste/Trash	Carbon dioxide emissions Waste/Trash

4. Show students the ***Industrial Tomato*** found at https://vimeo.com/138258792. After they view this video, ask them if there are additional things that can be added to their life cycle tables.

5. Once the groups have brainstormed their lists, have students use the lists to diagram the cycle of the tomato from seed to table. When you start to explore the story of your food, a web of people, processes, and relationships become apparent. Give students time to research how a tomato is produced if they are unclear on how a tomato makes it from farm to table. You can use the graphic at https://www.nourishlife.org/pdf/Nourish_Food_System_Map_11x14.pdf to show students an example of a life-cycle analysis. This diagram explores food systems at the macro-level. Students should do a simpler version of this cycle – they are exploring the cycle of one vegetable, the tomato, and not the entire food system. Encourage students to be creative in how they show the production, transportation, and use of the tomato in their own graphic, making sure to point out the connections, cause and effect relationships, and processes involved in each step.

[2] Community Supported Agriculture, or CSA, refers to a network or association of individuals who have pledged support to one or more local farms, with growers and consumers sharing the risks and benefits of food production. CSA members or subscribers pay at the onset of the growing season for a share of the anticipated harvest; once harvesting begins, they receive weekly shares of produce, usually delivered to them in a box.

6. When groups have completed their life cycle assessment, have the class re-convene and have each group present and explain their diagram. If students are comfortable, allow the class to ask questions and debate about each group's presentation of their diagram.

7. Discuss with the class as a whole. Some discussion questions may include:
   - What issues on these diagrams are the most important to you? Why?
   - What groups of people are affected by this system? How? What are negative ways they are affected? What are positive ways?
   - Who or what has the most power to influence the food we eat? Why?
   - What are the environmental impacts of this food system?
   - What works well in this system? What doesn't work well? Why?
   - What is missing from the diagram that might be important?
   - After creating this life-cycle diagram, what new insights do you have?

Part 2 – Micro to Macro: A comparison of the school garden to commercial farming

From the previous exercise, students learned about the life cycle of a tomato, from seed to table. Now they will compare and contrast how production is different in their garden from commercial production.

1. Break students back into groups (the same groups from part 1, or different groups so students can hear new perspectives) and have them compare their garden, real or virtual/imagined, with a commercial farm that grows tomatoes. What do the 2 have in common? What processes might the farm use that their garden doesn't and vice versa?

2. Show students ***The Local Tomato***, https://vimeo.com/148116105, and have them discuss and add any additional information about local gardening to their notes.

3. In their groups, have students create Venn diagram(s) noting the features they think are unique to the settings and those that are different. Have groups discuss the virtues of home or school gardening vs. commercial farming. What are the pros and cons of each? You can also have students do the same comparison, creating a Venn diagram, for produce grown and sold at a local farm or farmer's market and that grown at a large-scale commercial farm. Again, allow time for students to do further research if needed.

4. After students have completed their diagrams, have them review the case studies below and use additional information in the case studies to revise their life-cycle diagrams and/or Venn diagrams.

Case Study 1 – Immokalee, FL

Florida's climate is less than ideal for growing tomatoes in fields – they have sandy soil, very hot and humid temperatures, and many insects. Farmers add fertilizers to the soil, keep seedlings cool, and apply pesticides frequently. Tomatoes grown in field require the use of field equipment for large-scale production. The tomatoes, once harvested, are usually transported long-distances – approximately 1,300 miles from Immokalee, Florida to Chicago, Illinois for example – and need to be heavily packaged to protect them from damage on their journey.

Case Study 2 – Baja, Mexico

Mexico's warm climate is good for growing tomatoes year round in fields, except for one crucial factor. When tomatoes are produced in Mexico, they are generally coming from a desert area. It doesn't rain much, so water for the tomatoes needs to be piped-in or pumped from elsewhere. It also means the soil needs a lot of fertilizer since desert soils are generally quite sandy and lack many nutrients. Tomatoes grown in fields require the use of farm equipment and as with all long-distance transportation, the tomatoes need to be heavily packaged to protect them from damage on their journey. When traveling by air from Baja, Mexico to Detroit, Michigan, a tomato moves approximately 3,000 miles.

Case Study 3 – The Netherlands

Most tomatoes grown in the Netherlands are grown in greenhouses (also called glass houses). Greenhouses usually require the use of heating systems and lights to produce a tomato in a cold climate. Since this type of tomato is grown in a greenhouse, it does not require field or farming equipment, but does still require the use of fertilizer and heavy packaging if transported a long distance. Shipping from the Netherlands to New York City, this tomato travels approximately 3,500 miles.

Explore – Harvest and Calculating Carbon Offset

Part 1: Harvesting and Recording your harvest

Record and track the harvest of your garden throughout the growing season. Use these steps:

1. Plan a harvest day in the garden. Student groups will use baskets or other containers to collect harvestable fruits, vegetables, and herbs. Each student group might be responsible for harvesting specific garden beds, fruits, or vegetables among all the beds or planters. Make sure students are gentle with the plants as they harvest, being careful not to uproot entire plants or damage a plant while harvesting from it.

2. Use a garden journal to record harvest data (how many pounds of each type of produce).

3. If using a camera, help students photograph the harvest.

4. Use the scales to weigh the total harvest for each vegetable, fruit, or herb, and record the information on the Field Report.

5. Include time for students to share in eating the harvest. A simple salad or one-bite tasting is enough to experience the enjoyment of food in a social context, fostering a sense of community through shared accomplishment. You can also plan full meal and cooking events with your students and the bounty of the garden. Visit the Edible Schoolyard Project's online Resource Library to find recipes for your garden (under the Lesson Planning heading, filter the list on Materials > Recipes): https://edibleschoolyard.org/resource-search.

Part 2: Where your food comes from, transportation and carbon offset calculations

As we learned from the activities above and from the Food Emissions Breakdown in the background information, the production (the growing, cultivating and harvesting) stage in any vegetable's life cycle is the leading cause of carbon dioxide emissions into our atmosphere. Between emissions from heavy, large farm equipment and environmental impacts from pesticide and herbicide use, production clearly bears the environmental load from food production.

However, transportation is also a key ingredient in the make-up of environmental impact, and particularly in the carbon "foodprint" of producing fruits and vegetables. Students will further explore this key stage of the food production life cycle and collect data to assess the carbon offset of their garden. Transportation is a smaller contributor in the food emissions breakdown, but it is a bit easier to quantify. For this reason, students will research where their food comes from and compare these food miles to the production from their garden, calculating an approximate amount of carbon they save by growing and consuming food from their garden.

After a harvest, have students complete these steps to calculate their CO_2 offset:

1. Research and record a Commercial Source or point of origin for each produce item harvested from the garden. Students might gather this information at a local supermarket, where signage and labels usually identify the origin of fruits and vegetables in the produce section. Or they can research online to find out how far a tomato, or any other item, is likely to have traveled to make it to their location.

   If you can't find specific information on how far certain produce items may have traveled to get to you, have students research the major food producing agricultural areas in the country. You can use this information to extrapolate where your food may have come from relative to your location.

   For example, Yuma County Arizona is the winter lettuce capitol of the world – after the summer heat, the temperature drops enough to create the nation's longest growing season and Yuma County supplies **90%** of the nation's leafy vegetables between November and March. You can reasonably assume that the lettuce you find in the grocery store in March has been produced and transported from Yuma, Arizona and use this distance to your location to calculate how much carbon may have been emitted from the transportation.

   Students can follow these suggested steps for researching where their food comes from:

   a. Check the packaging in your local grocery stores to see if any location information about the produce is shared.

b. If this information is not available at the grocery store, check online or in your library to research food production information for the country. Find out what types of food are produced and where at given times of the year. Use this information to estimate where your produce may have come from. (see Yuma, AZ example above)
c. Research where regional food warehouses are in your area – it is likely that the produce landed in a regional distribution center before it was in your grocery store. Check for delivery schedules and locations.
d. Research where your local grocery stores are and how far, or close, they are to a food distribution center in your area.
e. Use the addition of these miles traveled to calculate the amount of CO_2 that may have been emitted during the transportation of the produce. Students can do this for each type of produce from the garden, or focus on 2 or 3 selections.
f. Use an online tool like Google Maps to research food miles represented by each type of produce grown in the school garden had it come from a non-local source and been purchased in local supermarkets
g. Alternatively, you can get fairly general food miles information from this website: http://www.foodmiles.com/.

2. **The calculation**[3]– Use this formula to calculate an estimated amount of carbon that was produced based on the researched travel distance for each type of produce. The letter "n" represents the number of miles traveled by the produce. Then follow the steps below to log this data at as your carbon offset amount. See footnote for formula logic.

$$\text{lbs. of carbon produced} = [\mathbf{n}]\ \text{travel miles} \times \frac{3.7\text{lbs } CO_2}{\text{mile}}$$

3. Help students review the data to discuss the effects of saved CO_2 as shown in the local harvest figures. Have students recall that while transportation is a small part of the carbon emissions for food, when they combine their saved CO_2 with other schools and communities doing the same thing, the effect adds up to have a significant carbon savings around the country. Also think about how much carbon may be saved from your production process of the vegetable, which *is not* accounted for in this formula. Your number and cumulative CO_2 savings may seem small, but combine that with schools, communities, and other cities around the country and your students will see how they are participating in a significant reduction of carbon emissions.

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[3] This formula is based on the average amount of CO_2 produced from the weight of a fully loaded semi-truck at 80,000 lbs. A fully loaded semi-truck at 80,000 lbs. produces 0.0000462 lbs. of CO_2 per pound of cargo for each mile traveled.

$$80{,}000\text{ lbs. of cargo} \times \frac{0.0000462\text{ lbs. of } CO_2}{1\text{ lb. cargo} \times 1\text{ mile}} = 3.696\text{ lbs. of } CO_2 \text{ per mile}$$

Source: http://www.flavoraware.com/carbon-calculator. This formula has been vetted by Nature Conservancy scientists. Recall that the carbon emissions associated with food are a result of a complex system. This formula uses simple mathematics to produce a number that should give your students context for the carbon "foodprint" of their garden produce. It is not a scientifically accurate number, given all of the variables unaccounted for in the formula.

Reflect:

1. Write the vocabulary terms (without definitions) on the board. Have students discuss what they know and understand about these terms.

2. Then have students review the carbon cycle by viewing the video, Reforestation: Impact on Climate, at https://vimeo.com/77792711.

3. Now direct students' attention back to the vocabulary words to discuss the carbon cycle, and connect the ways in which gardens can help reduce CO_2. Point out that this includes not only reducing food miles as evidenced in the data collection, but also in aiding the absorption of CO_2 and the release of oxygen into the environment if you have trees or orchards as part of your garden.

4. Have students reflect on their CO_2 offset data to determine how effective the garden may be in helping reduce carbon build-up in their community. Are there any other ways the garden can be even more effective in this way? Would increasing the garden area, and thus planting more plants, improve it? Would creating another garden in a different campus location make a difference? Why or why not? Have students discuss their questions and ideas in small groups.

5. Depending on whether the harvest was eaten by students in the garden, shared as part of the school's lunch service, sold to the school community, or donated to a food bank, have students share and elaborate on how it felt to participate in the garden harvest. Which part of the experience was the most enjoyable? The growing? The eating? The sharing?

Evaluate

Use the *Food and Carbon Evaluation* student handout to evaluate what your students have learned. See the scoring key, below.

Scoring Key for Evaluation

1. Locally grown foods are both grown and eaten at the source. They do not involve excessive food miles that produce accompanying carbon emissions. Gardens also foster the emission of oxygen into the atmosphere through photosynthesis, part of the carbon cycle.

2. Answers will vary, based on student experiences, however, students may incorporate the data collection process or the food miles research into their responses.

3. When food is grown and harvested at great distances from where it is actually sold to consumers, it must be transported by truck, train, or ship. The greater the food miles, the more carbon emissions are produced in transporting the food. The more food miles required, the higher the carbon emissions. The higher the carbon emissions, the greater the impacts of global climate change.

4. Answers will vary but may include: buy local, organic produce; turn off the lights in your house when you are not in the room; unplug any electronic gadget when you aren't using it; recycle; conserve water by taking shorter showers or not running the tap the whole time you are brushing your teeth, etc.

Extend – Further Investigations

1. Help students learn more about carbon reduction by documenting harvests and calculating CO_2 offset on a continuing basis.

2. Have students research other ways to reduce CO_2 in the atmosphere, such as energy conservation and renewable energy sources. How might carbon reduction benefit other areas, for example, what economic benefits might it encourage? What health benefits? Any others?

3. Have students consider both sides of the story: why is this such a complicated issue? If so much is known about reducing CO_2 in the atmosphere, why is it an ongoing challenge globally?

4. Help students research the concept of a carbon footprint by learning about their own. Students may visit the sites listed below to calculate their carbon footprints. Then help them research ways they may reduce their carbon footprint beyond planting a garden.
   - https://www.nature.org/en-us/get-involved/how-to-help/consider-your-impact/carbon-calculator/
   - https://calc.zerofootprint.net/teachers_guide (requires teachers to sign up for students)
   - https://www3.epa.gov/carbon-footprint-calculator/
   - http://www.parkcitygreen.org/Calculators.aspx (offers specific ways to reduce carbon)

5. Have students gather research to debate the role of healthy eating and sourcing food locally in our society, e.g., students may watch television over a period of evenings and afternoons to record the number of commercials that feature ads for foods. How many commercials feature fresh foods versus processed foods? If processed, are they considered healthy or junk food? Then have students research the location of regional farms where produce is grown locally. Is that produce sold locally as well, or is it part of a large-scale agricultural system where food miles must be factored in? Does the city or county host local farmers' markets, or do local farmers offer ways for the community to purchase their foods through CSAs (Community Supported Agriculture)?

6. Students may delve deeper into the concept of carbon offset through the activities in the *Urban Trees* and *Reforestation* lesson plans. In *Urban Trees*, students learn about the benefits of, and threats to, trees in urban environments. In *Reforestation*, students will go a step further to better understand the effects of deforestation and reforestation on the carbon cycle through the lens of a forest ecosystem.

7. Have students consider how activities they develop and implement using the Community Field Report may impact the community by inspiring more schools, individuals, families, and organizations to plant gardens, thereby increasing CO_2 reduction in the community as a whole.

Additional Resources and Further Reading:

More information on carbon for students to review:

- http://www.sciencekids.co.nz/sciencefacts/chemistry/carbon.html

More on climate change, geared specifically to students:

- https://www3.epa.gov/climatechange//kids/index.html
- https://climatekids.nasa.gov/carbon-gallery/

Life Cycle Assessment: Tomato

A Life Cycle Assessment is a tool that takes into consideration all of the steps that go into the creation of a product including inputs and outputs and assesses the potential environmental impacts associated with those inputs and outputs from cradle (acquisition of raw materials) to its grave (waste management). In this activity you are going to explore and diagram the production, transportation and consumption cycle of a tomato. Think about what happens to a tomato from seed to table.

Describe the steps in the table below where the production column includes anything related to growing the tomato. The transportation column has to do with any point along the life of the tomato. The use column should include anything related to storing, preparation, eating or waste. Make sure to include the by-products and/or outputs that result from each of the phases at the bottom. For example, in the production phase, chemical run-off from fertilizer use is a by-product of the growing process.

Production	**Transportation**	**Use**
By-products or Outputs from the Above Phases		

Case Study 1 – Immokalee, Florida

Florida's climate is less than ideal for growing tomatoes in fields – they have sandy soil, very hot and humid temperatures, and many insects. Farmers add fertilizers to the soil, keep seedlings cool, and apply pesticides frequently. Tomatoes grown in field require the use of field equipment for large-scale production. The tomatoes, once harvested, are usually transported long-distances and need to be heavily packaged to protect them from damage on their journey. **When traveling from Immokalee, Florida to Chicago, Illinois a tomato travels approximately 1,300 miles.**

Case Study 2 – Baja, Mexico

Mexico's warm climate is good for growing tomatoes year round in fields, except for one crucial factor. When tomatoes are produced in Mexico, they are generally coming from a desert area. It doesn't rain much, so water for the tomatoes needs to be piped-in or pumped from elsewhere. It also means the soil needs a lot of fertilizer since desert soils are generally quite sandy and lack many nutrients. Tomatoes grown in fields require the use of farm equipment and as with all long-distance transportation, the tomatoes need to be heavily packaged to protect them from damage on their journey. **When traveling by air from Baja, Mexico to Detroit, Michigan, a tomato moves approximately 3,000 miles.**

Case Study 3 – The Netherlands

Most tomatoes grown in the Netherlands are grown in greenhouses (also called glass houses). Greenhouses usually require the use of heating systems and lights to produce a tomato in a cold climate. Since this type of tomato is grown in a greenhouse, it does not require field or farming equipment, but does still require the use of fertilizer and heavy packaging if transported a long distance. **Shipping from the Netherlands to New York City, this tomato travels approximately 3,500 miles.**

Food and Carbon Evaluation

Answer the following questions. If you need extra space, use additional paper from your notebook.

1. Give an example (with supporting data) of how the production of locally sourced foods such as those grown in the school garden helps reduce CO_2 build-up in the atmosphere.

2. Give an example of how you used technology as part of learning about CO_2 reduction in the garden and how that technology helped you gather data and reach conclusions

3. Describe the cause and effect of food miles on global climate change.

4. Give an example of how to reduce your carbon footprint besides planting a garden.