



RUTGERS-NEW BRUNSWICK
School of Environmental
and Biological Sciences



Lesson Eight

Food, Water, Land, and Greenhouse Gases





Lesson Overview

Through this point in the curriculum, lessons have looked mainly at one greenhouse gas: carbon dioxide. This lesson turns students' attention to another greenhouse gases whose relationship to food systems and role in the greenhouse effect are important to consider. Food systems are responsible for significant outputs of other greenhouse gases such as methane. Moreover, methane has significantly more heat-trapping power than carbon dioxide. Methane gets produced when ruminant animals like cows, sheep, and goats digest food. Methane also gets produced when the manure of animals raised for food decomposes. In sum, raising animals for food—especially cattle, but also pigs, chickens, and other animals—results in large outputs of powerful greenhouse gases other than carbon dioxide. This is another reason why diets heavy in animal-based foods are associated with more greenhouse gas emissions than diets that emphasize plant-based foods.

Next Generation Science Standards

- 5-LS2-1:** Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.
- 5-ESS3-1:** Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
- 5-ESS2-1:** Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Science and Engineering Practices

- Developing and using models.
- Obtaining, Evaluating, and Communicating Information.

Cross Cutting Concepts

Systems and system models
Cause and effect

Disciplinary Core Ideas

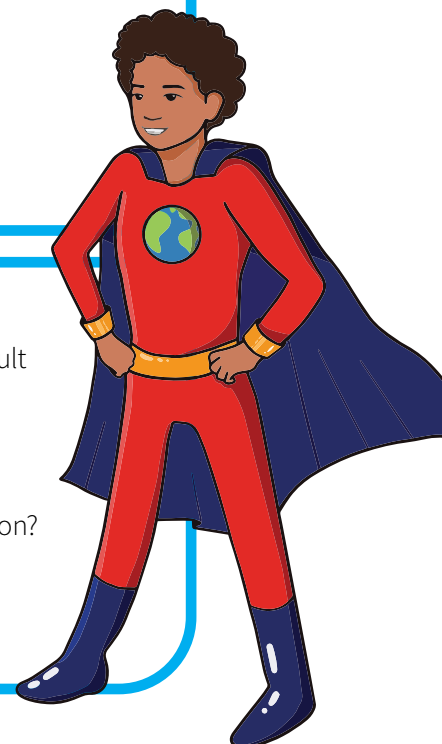
PS1.A: Structure and Properties of Matter
ESS3.D: Global Climate Change

Driving Questions

- How do eating patterns use different amounts of inputs/resources and result in different amounts of outputs?
- How does this impact the climate system?
- How is deforestation connected to greenhouse gas emissions?
- What are the two greenhouse gases that are produced from food production?

Observable phenomena

Deforestation video



Blue italicized words are web links for more information.



Learning Objectives

Students will be able to:

- Explain that increased emissions of other greenhouse gases, not just carbon dioxide, are responsible for global warming.
- Describe what methane is, and how it is produced as an output of food systems.
- Connect eating patterns heavy in animal-based food products to increased emissions of methane and thus to a stronger greenhouse effect.
- Explain what deforestation is and how this is connected to greenhouse gas emissions.

Behavior Change Objectives

Students will be able to:

- Identify how growing foods for different eating patterns impact the environment differently.
- Recognize how farm animal contribute to methane emissions.

Keywords

**methane | ruminant animals | manure | deforestation | land use | water use
greenhouse gas emissions**

Sources used in the development of this lesson

- Aleksandrowicz, et al. 2016. “The impacts of dietary change on greenhouse gas emissions, land use, water use, and health: A systematic review.” PLOS One 11(11): e0165797.
- Environmental Protection Agency. 2022 “Overview of Greenhouse Gases.” [epa.gov/ghgemissions/overview-greenhouse-gases](https://www.epa.gov/ghgemissions/overview-greenhouse-gases)
- Moss, Angela. 2000. “Methane production by ruminants: Its contribution to global warming.” Annales de zootechnie, INRA/EDP Sciences 49(3): 231-253.
- Tian, Hanqin, et al. 2020. “A comprehensive quantification of global nitrous oxide sources and sinks.” Nature 586: 248-271.

Before you Begin

- Prepare to show slides to class.
- Make enough copies of handouts.
- Review eLearning game.

Blue italicized words are web links for more information.



Materials

- Presentation Slides and Worksheets
- Computer/Chromebook/Technology
- Video: [youtube.com/watch?v=nt6JX_CDQAA&list=PLKx8NLAujm_nCPmzHM3eUKi-aqMvaH55Zw&index=3](https://www.youtube.com/watch?v=nt6JX_CDQAA&list=PLKx8NLAujm_nCPmzHM3eUKi-aqMvaH55Zw&index=3)
- Exit Ticket

Lesson

1st Recap & Lesson Introduction

1. Review what was discussed last class:
 - A. the different types of eating patterns and what resources or inputs are needed to produce those different foods.
 - B. land use, water use, and greenhouse gas emissions and how they relate to the eating patterns.
2. Introduce today's lesson: HOW eating patterns use different amounts of land and water, and result is different greenhouse gas emissions and how that impacts the climate system.

2nd Observable Phenomena

1. Show deforestation video and have students complete the notice and wonder worksheet that corresponds with it. Show the video enough times that students are able to write down one thing they notice and one thing they wonder about the video.

3rd Lesson

1. Land Use Discussion:
 - A. Lead a discussion on deforestation based on observable phenomena. Explain to students that this is done by burning or cutting down trees and one reason this action occurs is when more land is needed to create farms.
 - B. Have students give examples of why they think this is bad for the climate system.
 - C. Utilize slides to explain the role carbon dioxide plays in deforestation.
 - D. Use football field example on slides to explain to students how much land is used and why more land is needed for animal-based eating patterns compared to plant-based eating patterns.
2. Water Use Discussion:
 - A. Utilize slides to explain how much water is needed to produce animal-based foods. Using the hamburger example.
 - B. Use the Olympic swimming pool example on slides to explain to students how much water is used for animal-based foods compared to plant-based foods. Allows students time to think about why this is.



3. Greenhouse Gas Discussion:

- A. Show the video for students and emphasize that one harmful output of raising animals is methane gas. Have students complete the video recap handout.
- B. Do a quick recap on what carbon dioxide and methane are and how they are created/where they can be found. Discuss with students the connection between deforestation and greenhouse gas production.
- C. Use the car example on slides to explain to students how much greenhouse gas emissions are produced from animal-based foods compared to plant-based.
- D. Spend some time on the recap slide to ensure students understand the connection between deforestation and greenhouse gas emissions, as well as the connection between animals and methane emissions.

4th eLearning Game: Food, Water, Land, and Greenhouse Gas Emissions

- 1. On the class board/smart board, the teacher demonstrates eLearning game: Food, Water, Land and Greenhouse Gas Emissions. Time permitted, allow students to play the game in pairs, in groups, or individually. Remind students that they can play the games at home as well.
- 2. Remind students that they can earn points toward the Climate Change Hero Challenge for playing the games. You can also ask how they are doing with the other activities on the Challenge sheet that was introduced in Lesson 3.

Exit Ticket

Learning Reflection

- 1. Teacher passes out Exit Ticket.
- 2. The teacher collects exit tickets and reviews student answers. Make minor adjustments to the next lesson based on data received.

