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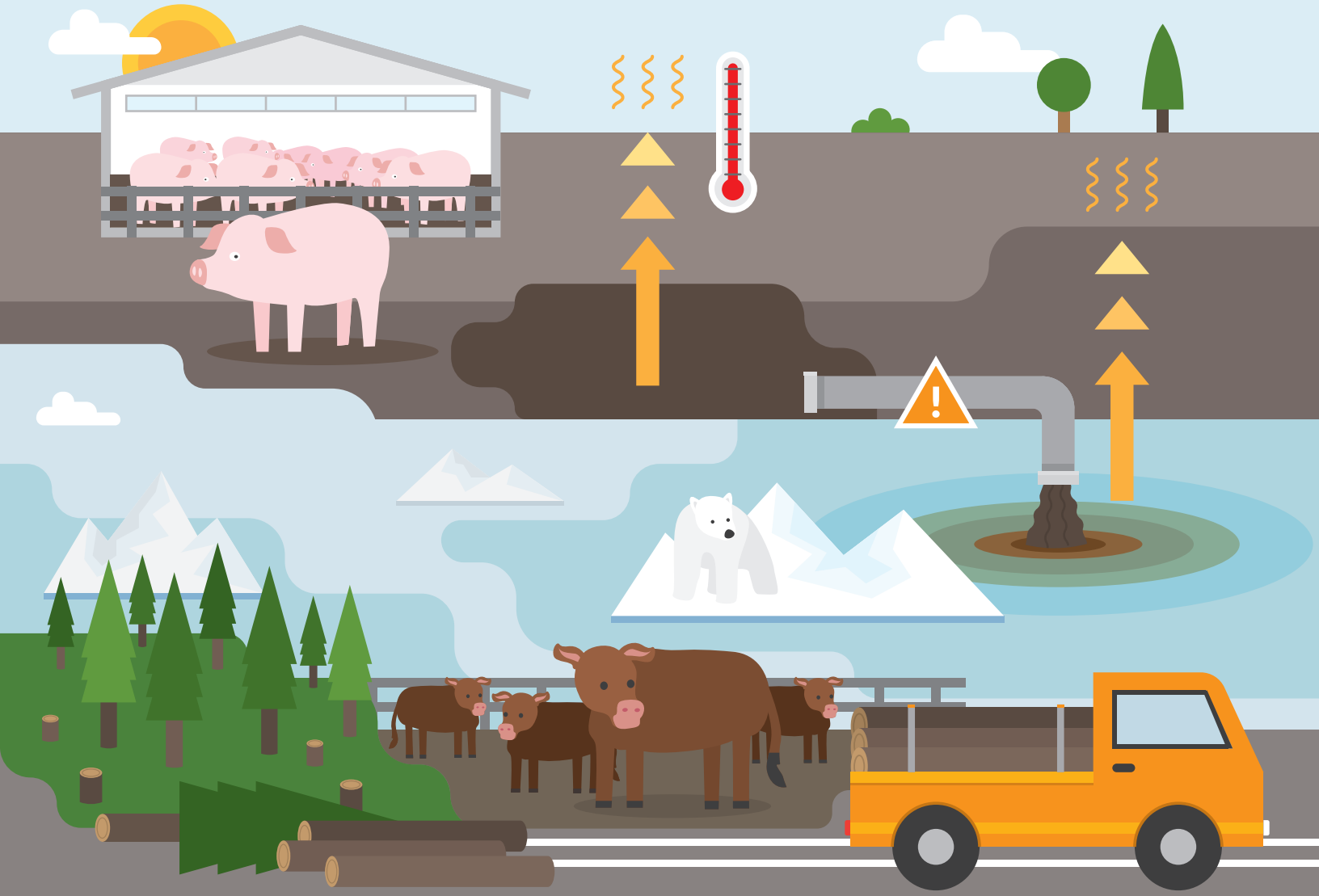
MS Earth Science Lesson 2 - Section 1

# Environmental Impacts & Our Food System: Exploring the Evidence

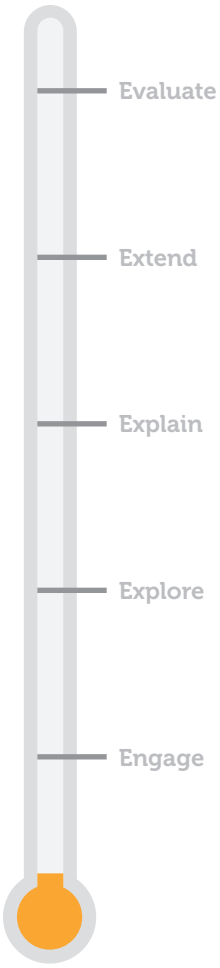
> *"The most important thing is to actually think about what you do. To become aware and actually think about the effect of what you do on the environment and on society."*
> **— Jane Goodall, Primatologist and Conservationist**



## Overview

Modern animal agriculture has a pronounced impact on natural resources like land, water, and fossil fuel. Industrialized agriculture or factory farms, along with small farms, produce significant amounts of waste and are inextricably connected to the scale at which humans are able to raise billions of animals each year for food. The sheer number of animals raised for food has sparked concerns about animal agriculture, including the magnitude to which it is polluting our land, air, and water as well as contributing to global climate change.

- For this activity, students will learn how the volume and scale of modern animal agriculture is connected to pollution, depletion, and degradation of natural resources and global climate change.
- Students in small groups will construct an argument supported by evidence that explores a phenomenon related to animal agriculture and the environment.




## Essential Question:

- What are the effects that animal agriculture has on the environment?

## Lesson Time:

Section 1 = 60-75 minutes
Section 2 = 60-75 minutes

## Student Learning Objectives:

Students will be able to...

- Understand the volume and scale of modern animal agriculture
- Define industrialized agriculture or factory farming
- Explore the environmental impacts of animal agriculture
- Construct an argument supported by evidence

## Resources:

- **Student Handout:** Claim Matrix Rubric
- **Student Handout:** Developing a Claim Supported by Evidence
- **Student Handout:** Phenomenon: Methane on the Rise (plus Teacher Key)
- **Student Handout:** Phenomenon: Hydrogen Sulfide in the Air (plus Teacher Key)
- **Student Handout:** Terms and Definitions

## Materials:

- Poster paper (at least 3' by 3') for each group of 3-4 students
- Different colored markers or pens

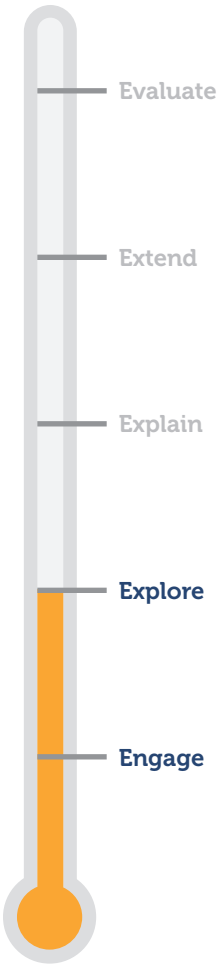
## Next Generation Science Standards

**MS-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.

**Clarification Statement:** Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

**MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

**Clarification Statement:** Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.




# Activities: Section 1

## Engage: What is causing the rise in methane? What is causing the rise in hydrogen sulfide in the air? (10 minutes)

For the "explore" activity, students will work in groups to investigate a phenomenon related to animal agriculture and global warming. There are two phenomena that students can explore:

- **Phenomenon: Methane on the Rise**
- **Phenomenon: Hydrogen Sulfide in the Air**

Before students begin the "explore" activity, engage students using the phenomena handouts. Read the introduction and exploratory question for **Phenomenon: Methane on the Rise**. Now, ask students to brainstorm possible answers to the exploratory question. Don't identify which answers are right or wrong. Next, read the introduction and exploratory question for **Phenomenon: Hydrogen Sulfide in the Air**. Once again, ask students to brainstorm possible answers to the exploratory question. Don't identify which answers are right or wrong.

## Explore: Construct an Argument from Evidence (30 minutes)

Distribute a copy of the student handout, **Terms & Definitions**, to each student. As students proceed through both sections of this lesson, they should reference this document whenever they come across unfamiliar terms. Now, divide the two phenomena up among groups of students (3-4 students per group). Each student will need a copy of the handout for the phenomenon that their group is exploring. This handout contains all of the information that the students will need to investigate their assigned phenomenon.

Within the handout, students will be presented with a phenomenon related to animal agriculture. Students are asked to consider an exploratory question relating to that phenomenon. At this point, students should come up with some additional questions. What information do they need to know to answer the exploratory question?

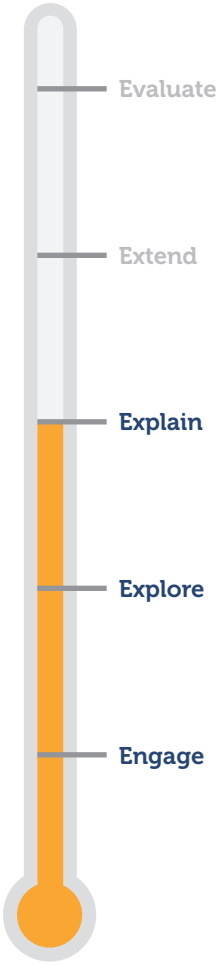
Using data and information provided in the handout, each group will make a claim that attempts to answer their phenomenon's exploratory question. Students should provide three pieces of evidence that support this claim along with their sources, which are located on the final page of the handout. Each member of the group will need to justify why their evidence helps to support their claim.

Finally, students should brainstorm additional research that could be done to answer the exploratory question.

Using their handouts, students will complete a "Supporting a Claim" matrix, which includes the following components:

- The phenomenon
- The exploratory question being asked
- Your claim (which attempts to answer the question)
- Evidence (at least three pieces of evidence, including some numerical data)
- Justification of evidence (explain how your evidence supports your claim)
- Further research (what additional information might be gathered to answer the exploratory question?)

Notes:




To help guide them in their exploration, provide students with the handouts **Developing a Claim Supported by Evidence** and the **Claim Matrix Rubric**. Once students have completed their matrix on individual pieces of paper, they should transfer their matrix to a large sheet of poster paper.

There is a teacher key that accompanies each phenomenon. On these keys, you'll find summaries for each section of the document as well as an example of a possible student claim, evidence, and further research associated with that phenomenon's exploratory question.

## Explain: Peer Review
(20 minutes)

At this point, each student group should have drawn their matrix on poster paper. Now, partner each group that explored the phenomenon, **Methane on the Rise**, with a group that explored the phenomenon, **Hydrogen Sulfide in the Air**.

The groups should take turns explaining and defending their matrix to each other. The group that is not presenting is expected to give feedback on the content of the other group's matrix. As one group explains their matrix, each person in the other group needs to consider if the claim, evidence, and justification are convincing.

Here are some questions students should ask each other:

- Why did you choose this claim?
- Why did you pick the evidence you chose?
- Did you and your group change your minds while you discussed your claim, evidence, and justification?
- Does the justification make sense? Does it connect the evidence to the claim?

Group members are encouraged to update their matrix with the feedback they receive from other groups to strengthen their claim, evidence, and justification.

**Final Grading**
Once students have updated their matrices using feedback from the rotations, they should grade their own finished matrix using the **Claim Matrix Rubric** and then turn in their poster and rubric to you.

Notes:

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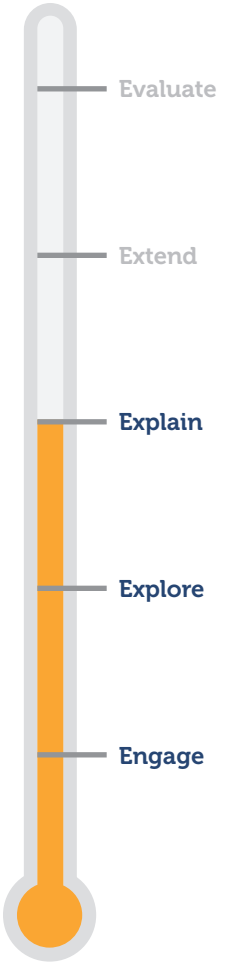


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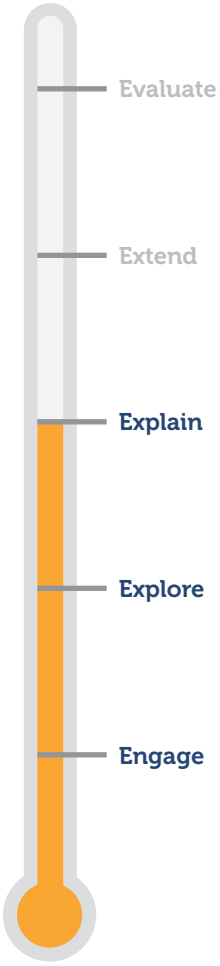


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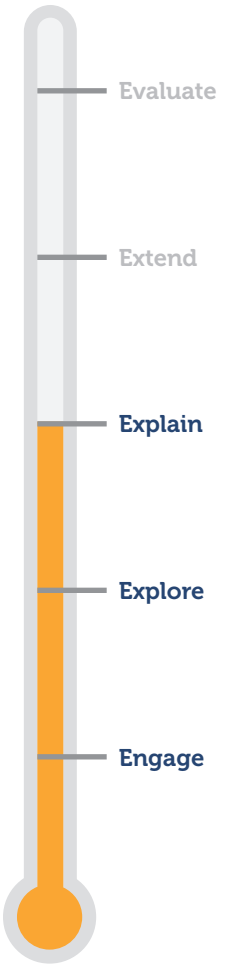


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Notes:

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MS Earth Science Lesson 2 - Section 2

# Environmental Impacts & Our Food System: Exploring the Evidence

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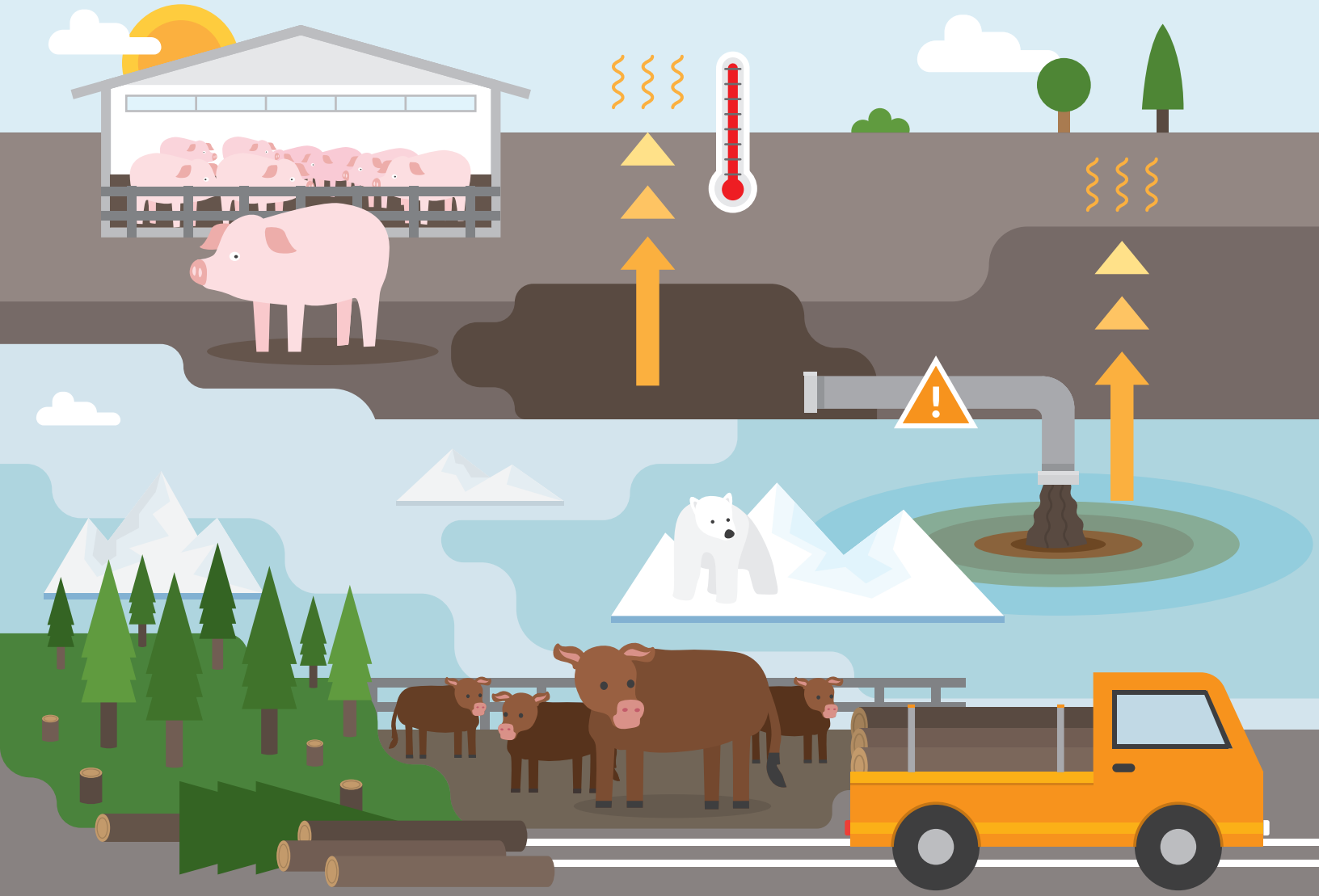


## Overview

Modern animal agriculture has a pronounced impact on natural resources like land, water, and fossil fuel. Industrialized agriculture or factory farms, along with small farms, produce significant amounts of waste and are inextricably connected to the scale at which humans are able to raise billions of animals each year for food. The sheer number of animals raised for food has sparked concerns about animal agriculture, including the magnitude to which it is polluting our land, air, and water as well as contributing to global climate change.

- For this activity, students will learn how the volume and scale of modern animal agriculture is connected to pollution, depletion, and degradation of natural resources and global climate change.
- Students in small groups will construct an argument supported by evidence that explores a phenomenon related to animal agriculture and the environment.

## Essential Question:

- What are the effects that animal agriculture has on the environment?

## Lesson Time:

Section 1 = 60-75 minutes
Section 2 = 60-75 minutes

## Student Learning Objectives:

Students will be able to...

- Understand the volume and scale of modern animal agriculture
- Define industrialized agriculture or factory farming
- Explore the environmental impacts of animal agriculture
- Construct an argument supported by evidence

## Resources:

- **Article:** Millennials are Driving the Worldwide Shift Away from Meat* https://www.forbes.com/sites/michaelpellmanrowland/2018/03/23/millennials-move-away-from-meat/#41bdd473a4a4
- **PowerPoint Presentation:** Environmental Impacts & Our Food System https://www.dropbox.com/s/o7tvflrgaq61cm2/Environmental%20Impacts%20%26%20Our%20Food%20System.ppt?dl=0
- **PowerPoint Reference:** Environmental Impacts & Our Food System
- **Student Activity:** Sticky Note Exercise
- **Student Handout:** Article Worksheet
- **Student Handout:** Terms and Definitions

* Print one copy of this article for each student or students may access the article online.

## Materials:

- Scrap paper
- Sticky notes, one for each student
- Access to YouTube**

** If Internet access in school is not available, YouTube Red is a great resource that allows you to download a video when you have WiFi/Internet access and then be able to play the video when you do not have WiFi/Internet access.

**Website:** www.youtube.com/red/freetrial

## Next Generation Science Standards

**MS-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.

**Clarification Statement:** Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

**MS-ESS3-5.** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

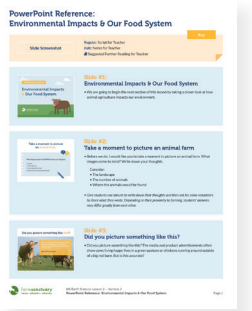
**Clarification Statement:** Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.

# Activities: Section 2

Evaluate
Extend
Explain
Explore
Engage

## Extend: How does animal agriculture impact the environment?
(30 minutes)

**Part A: PowerPoint Presentation**
Begin the PowerPoint presentation, **Environmental Impacts & Our Food System**. A link to the PowerPoint presentation can be found on page 2 of this section's lesson plan. Refer to **PowerPoint Reference: Environmental Impacts & Our Food System** for background information and guiding text that will accompany the presentation.


**Part B: The Hidden Costs of Hamburgers**
Show students the video, **"The Hidden Costs of Hamburgers"** (7:51).* This video explores the ways in which livestock farming is contributing unequally to global warming and environmental destruction. Ask students to make note of three impacts that animal agriculture has on the environment while viewing this video.

- Link: https://www.youtube.com/watch?v=ut3URdEzlKQ
- Published on Aug 1, 2012 by the Center for Investigative Reporting

Following the viewing, have students brainstorm, as a class, the hidden costs of hamburgers. The following are examples of hidden costs, or environmental impacts, that result from animal agriculture:

1. More methane ($CH_4$) and nitrous oxide ($NO_2$) in the atmosphere
2. More waste
3. More diseases (resulting in a higher use of antibiotics)
4. Forests are cut down just to graze livestock (increases $CO_2$ emissions, kills wildlife, and pollutes water and air)
5. Creation of ocean dead zones

*Note: This video highlights how the consumption of beef and dairy, in contrast to any other food, has the most significant impact both on human health and the environment. While chickens and pigs emit less methane and consume less water than cows, in general, foods that come from animals create more greenhouse gas emissions, waste, pollution, and water depletion than foods that come from plants. Refer to Slides #9 and #10 in the PowerPoint, **Environmental Impacts & Our Food System** to review the relative impact of animal-based foods versus plant-based foods on the environment.

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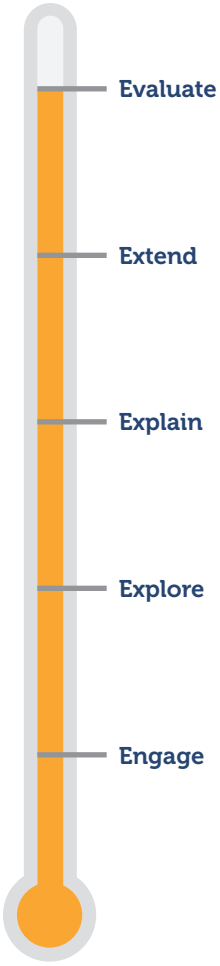



Notes:

## Evaluate: What are individuals doing to protect the environment?
(20 minutes)

Distribute a copy of the article, **Millennials Are Driving the Worldwide Shift Away from Meat** to each student. If students have access to computers, you may provide them the website to read the article online. Give each student a copy of the student handout, **Article Worksheet**. Students should work in pairs, first reading through the article on their own and then discussing with their partner their thoughts and responses to the questions on the handout. A terms & definitions list that accompanies this article is included in the handout.

### Handout Questions and Answers

1. What three things do millennials often think about when they choose what to eat?

   ***Answer:*** *The source of their food, animal welfare issues, and environmental impacts*

2. Name one health concern associated with eating processed meats like bacon and ham.

   ***Answers may include:*** *Processed meats (like bacon and ham) have been linked to cancer. Animal products are linked to an increase in the risk of heart disease.*

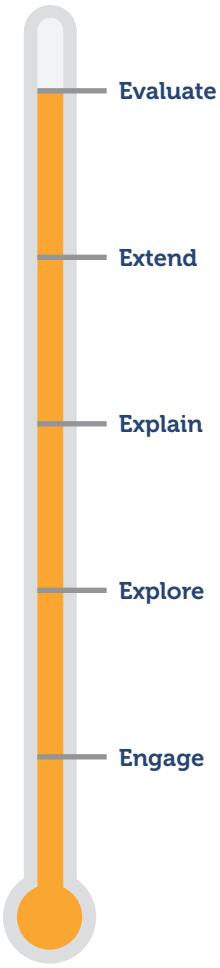
3. Name two things that companies are doing as a result of the demand for plant-based options.

   ***Answers may include:*** *Companies like Cargill are investing in more plant-based food options. Start-up companies are working on lab-grown meat production. Retailers like Walmart are demanding more plant-based products from food suppliers to sell in their stores.*

4. What would you consider eating or not eating to reduce your environmental impact? Feel free to think back to other parts of this lesson including the PowerPoint presentation, **Environmental Impacts & Our Food System**.

   ***Answers will vary.***

Once students have completed the handout, bring the class together once more, and offer students a chance to share their thoughts about the article and their responses to the questions.




## Closure: Student Sticky Note Exercise
(5-10 minutes)

Please refer to **Student Activity: Sticky Note Exercise** for detailed instructions. Each student will write 1-2 sentences on a sticky note about what they consider to be the most important thing they learned in this lesson. The sticky notes should be completed anonymously. Students will then post their sticky notes on a board or wall and engage in a brief class discussion.

Time Permitting: Have the students group together sticky notes with similar ideas. Then ask students to come up with a title to describe each group of sticky notes. Finally, add titles to each group of sticky notes using an additional sticky note.

Conclude by taking a photo of the sticky notes, checking that each sticky note is legible in the photo. Please email the photo of the anonymous student sticky notes to Farm Sanctuary's Humane Educator Maddie Krasno at mkrasno@farmsanctuary.org.

## Teacher Survey and Student Feedback

Teachers who have implemented one complete lesson plan from Farm Sanctuary's Sustainable Future Curriculum are eligible for a **$50 Amazon gift card** by completing our teacher survey and submitting a photo of the anonymous student sticky notes to Farm Sanctuary. Please e-mail Maddie Krasno at mkrasno@farmsanctuary.org for the survey and to submit the photograph of the student sticky notes.

Notes:

## References:

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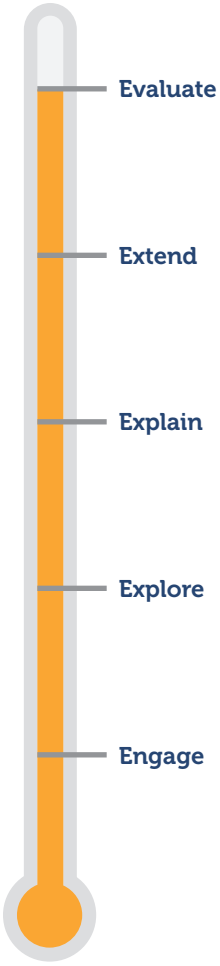


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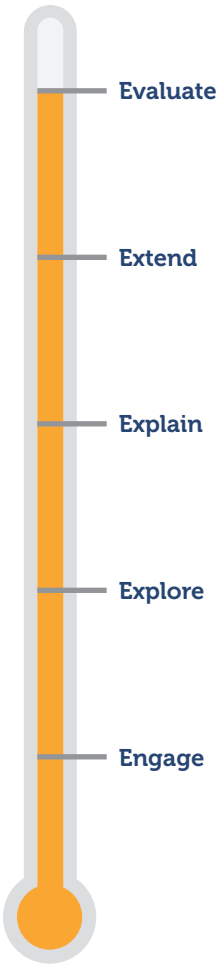


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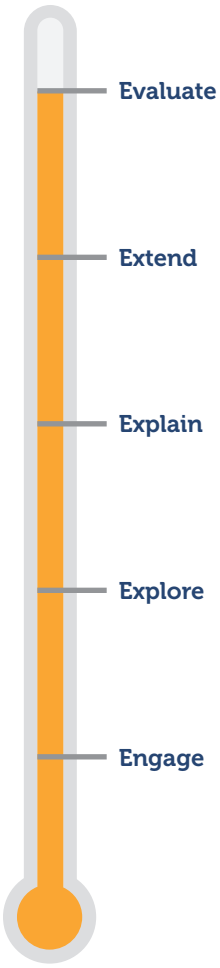


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Notes:

# Phenomenon: Methane on the Rise

## Phenomenon:

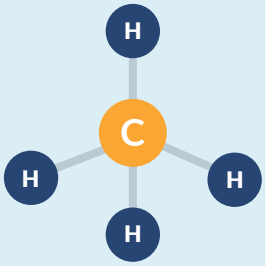
In the last 25 years, the amount of methane in the atmosphere has more than doubled and is thought to be responsible for one-fifth of global warming. In the last decade, methane emissions have increased even more with levels in the atmosphere totaling 1,830 parts per billion, a 20 ppb increase from 2014 to 2015.[3]

## Exploratory Question:

What is causing the rise in methane emissions?

## What is methane?

Methane ($CH_4$) is a colorless and odorless gas that burns easily and is used as fuel. Natural gas is mainly made up of methane. Methane is made up of one carbon atom and four hydrogen atoms.




## Where does methane come from?

Methane comes from fossil fuels, biomass burning, and microbial sources. Microbial sources include landfills and the rumen of certain animals. Scientists can identify where a specific methane molecule comes from based on the type of carbon atoms in it.

### How do scientists do this?

Methane molecules can contain different types of carbon atoms. There are two common forms of carbon in methane molecules: carbon-12 and carbon-13. By studying the amount of carbon-12 and carbon-13 in methane molecules, scientists can figure out where the methane in the air might be coming from.[4]

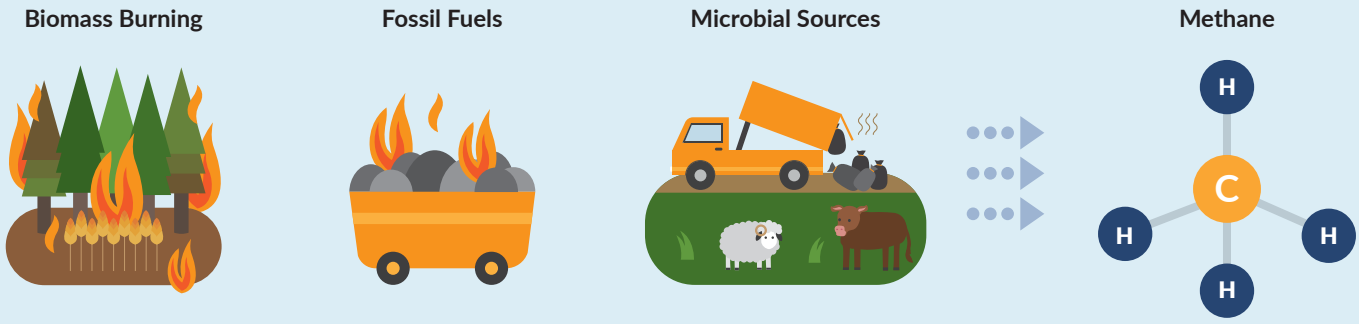



**Figure 1:** Sources of Methane

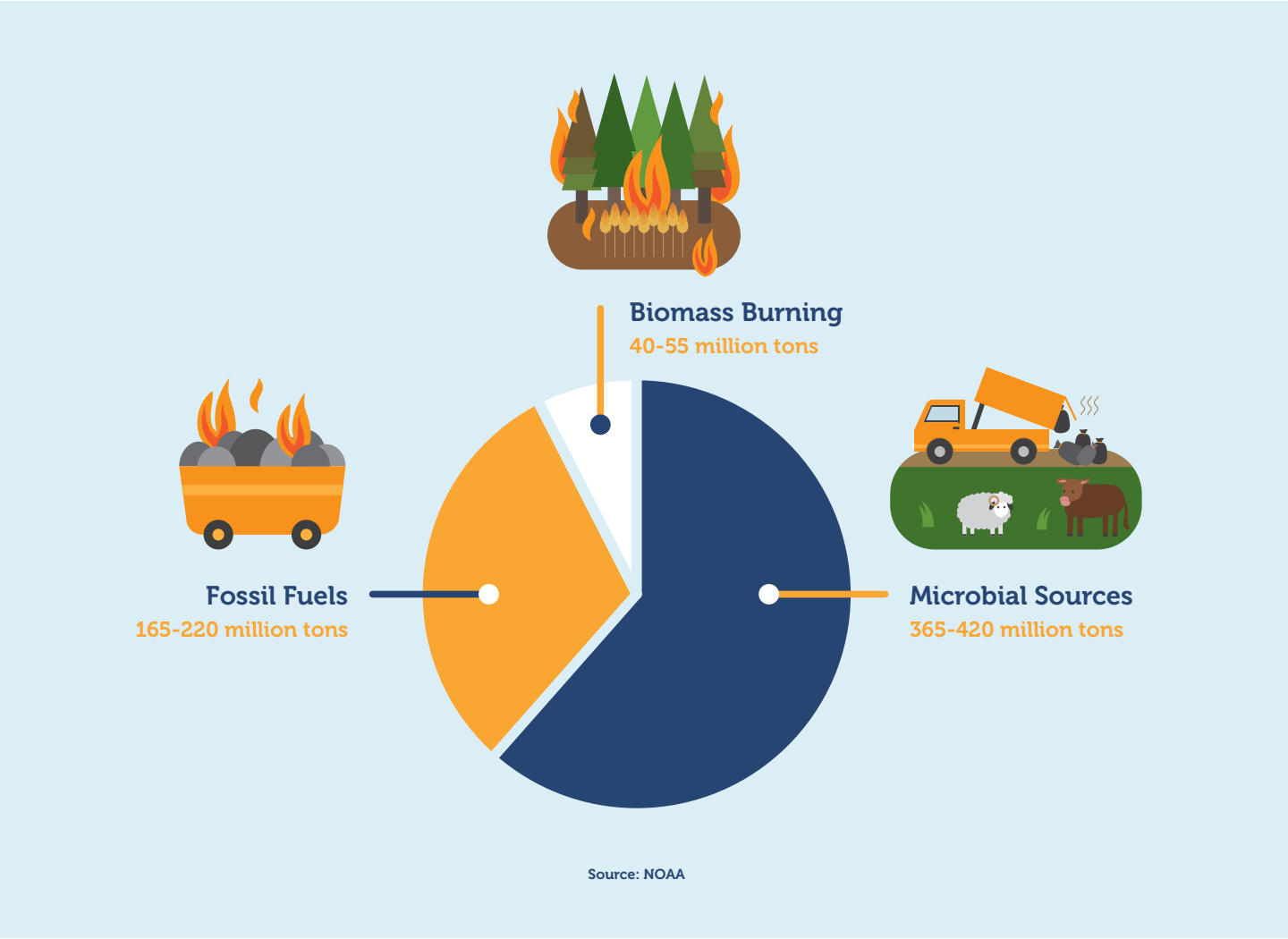



**Figure 2:** Worldwide Methane Emissions Per Year (million short tons)

## What are ruminants?

Cows, sheep, goats, and buffalo are ruminants. Ruminant animals store food in a special part of their stomach called the rumen. They regurgitate their food (called "cud"), which means it goes from their stomach back into their mouth where they then chew it again to help break it down. Microbes inside the animals' stomachs help them digest food, and many of these microbes create methane during this process.[5] Microbes are extremely small living things that can only be seen under a microscope.

## How are cows connected to methane?

One cow produces a small amount of methane. However, there are now 1.4 billion cows being raised annually for beef, milk, and other dairy products worldwide. Most of these cows are crowded inside factory farms, where thousands of cows are kept at each facility.[2]

## Ruminants Raised for Food Worldwide, FAO[1]

The number of ruminants (buffalo, goats, sheep, and cows) raised for food was measured over time from 1961-2009.

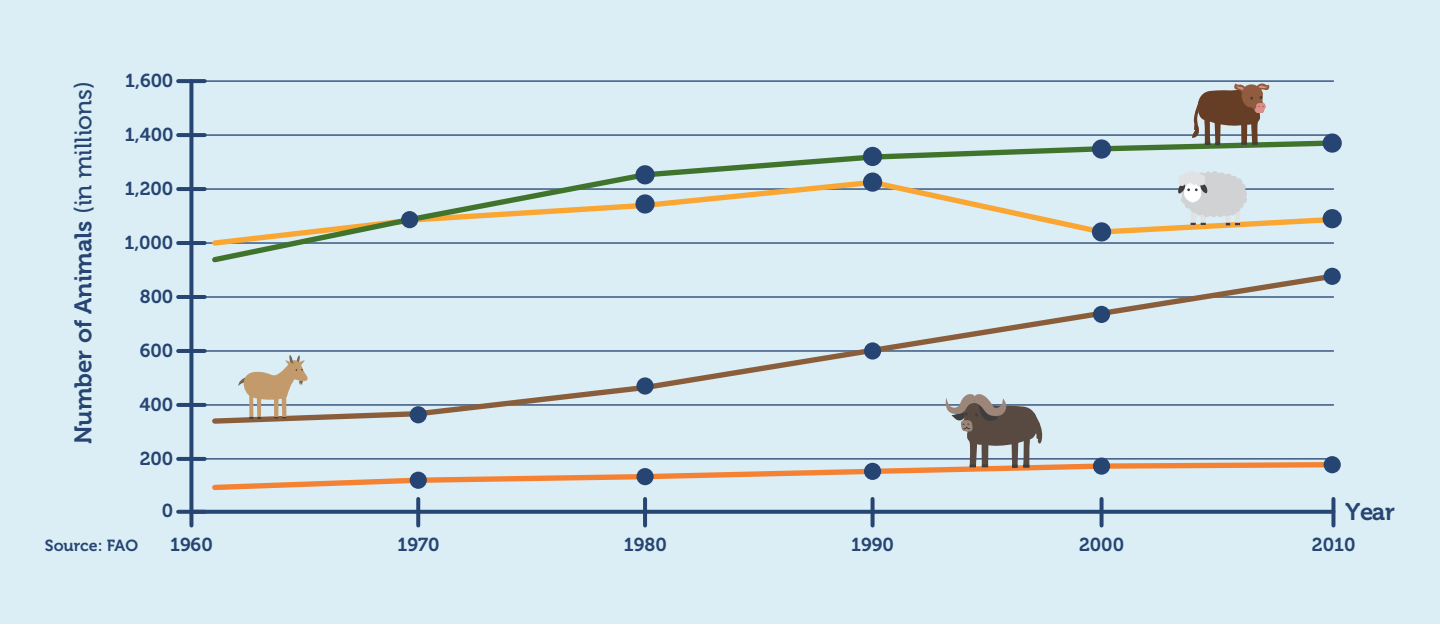



**Figure 3:** Ruminants Raised for Food Worldwide, 1961-2009

## References:


1 **Brown, Lester R. (2011). World on the edge: How to prevent environmental and economic collapse.**
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2 **Counting chickens. (2011, July 27).**
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Teacher Key

# Phenomenon: Methane on the Rise

## Phenomenon:

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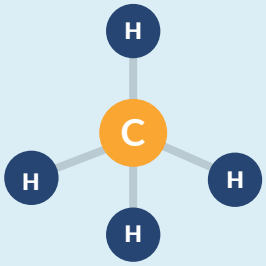
## Exploratory Question:

What is causing the rise in methane emissions?

## What is methane?

Methane ($CH_4$) is a colorless and odorless gas that burns easily and is used as fuel. Natural gas is mainly made up of methane. Methane is made up of one carbon atom and four hydrogen atoms.




## Where does methane come from?

Methane comes from fossil fuels, biomass burning, and microbial sources. Microbial sources include landfills and the rumen of certain animals. Scientists can identify where a specific methane molecule comes from based on the type of carbon atoms in it.

### How do scientists do this?

Methane molecules can contain different types of carbon atoms. There are two common forms of carbon in methane molecules: carbon-12 and carbon-13. By studying the amount of carbon-12 and carbon-13 in methane molecules, scientists can figure out where the methane in the air might be coming from.[4]

### Teacher Note

This section describes the different sources of methane molecules in the atmosphere. In a side note, this concept is explained. Ultimately, the amount of carbon-12 and carbon-13 in the air is what tells scientists the source of methane molecules. If the methane came from a fossil fuel, it has a characteristic ratio of carbon-12 to carbon-13, meaning there are equal amounts of carbon-12 and carbon-13 in the air. If the methane came from a microbial source (like from a cow), the methane in the air has more carbon-12 than carbon-13. If a sample of methane came from biomass burning, such as burning plants, the methane in the air has more carbon-12 than carbon-12.

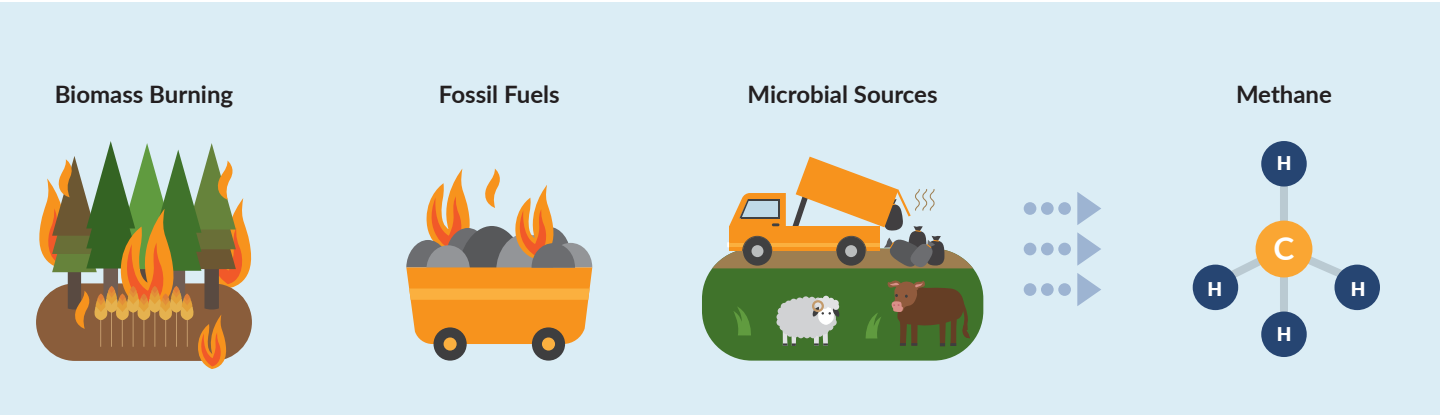



**Figure 1:** Sources of Methane

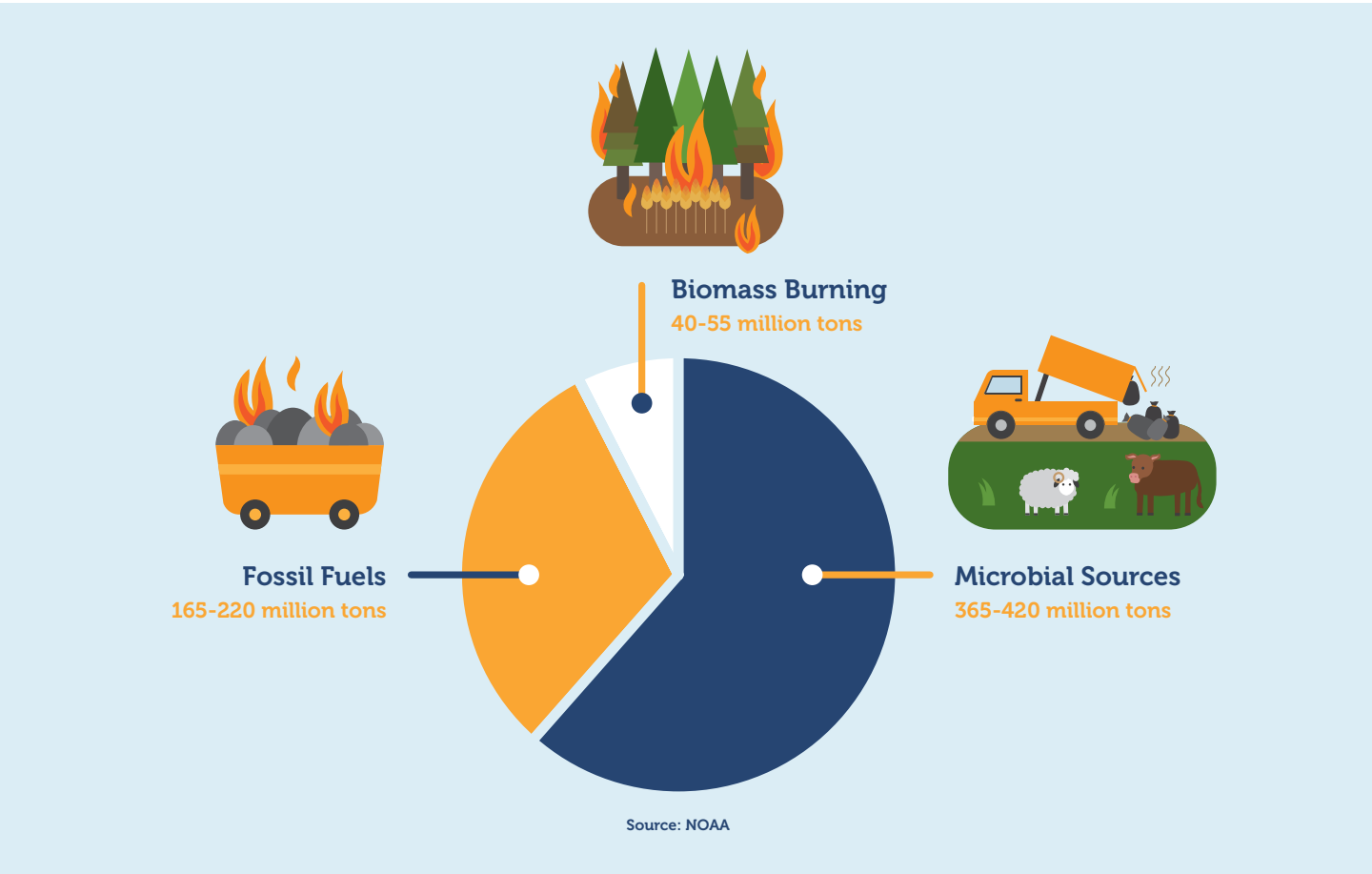



**Figure 2:** Worldwide Methane Emissions Per Year (million short tons)

### Teacher Note

This pie chart shows that there is more methane in the atmosphere from microbial sources, such as cows and landfills, than from burning plants or burning fossil fuels.

Teacher Key

## What are ruminants?

Cows, sheep, goats, and buffalo are ruminants. Ruminant animals store food in a special part of their stomach called the rumen. They regurgitate their food (called "cud"), which means it goes from their stomach back into their mouth where they then chew it again to help break it down. Microbes inside the animals' stomachs help them digest food, and many of these microbes create methane during this process.[5] Microbes are extremely small living things that can only be seen under a microscope.

### Teacher Note

This section explains how methane can be released from ruminants such as cows.

## How are cows connected to methane?

One cow produces a small amount of methane. However, there are now 1.4 billion cows being raised annually for beef, milk, and other dairy products worldwide. Most of these cows are crowded inside factory farms, where thousands of cows are kept at each facility.[2]

### Teacher Note

There has been an increase in the number of cows raised for food as a result of industrial farming.

## Ruminants Raised for Food Worldwide, FAO[1]

The number of ruminants (buffalo, goats, sheep, and cows) raised for food was measured over time from 1961-2009.

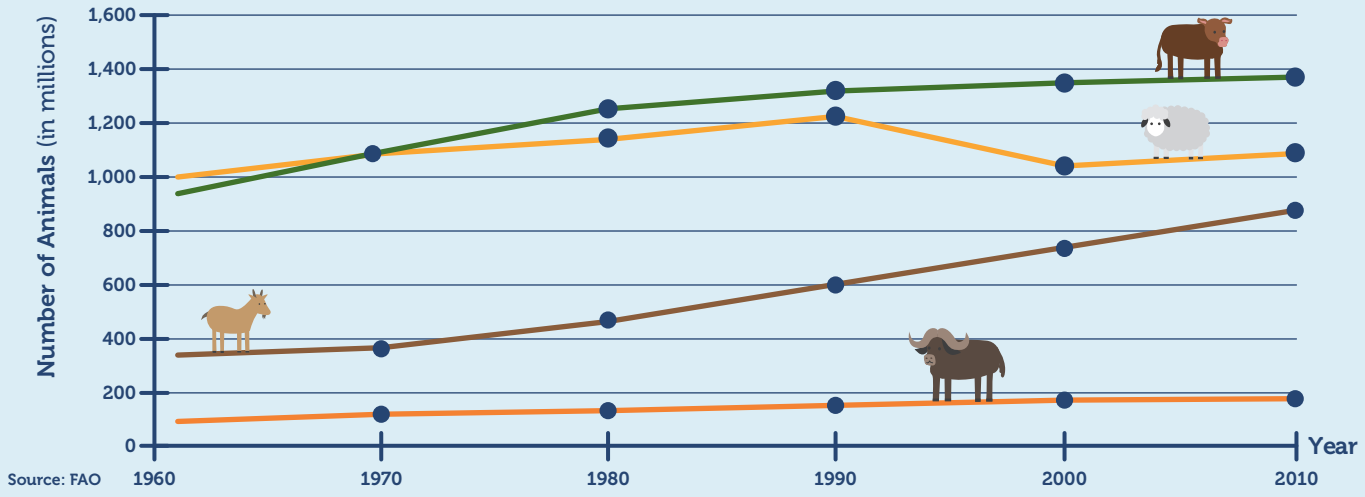



**Figure 3:** Ruminants Raised for Food Worldwide, 1961-2009

### Teacher Note

The graph above shows the number of ruminants being raised for food between 1961 and 2009. While the number of sheep raised for food hasn't drastically changed over time, the number remains high at between 1 and 1.2 billion. The number of cows, goats, and even buffalo being raised for food has been increasing steadily for 50 years.

### Teacher Note

**Possible Student Claim:** The recent rise in methane emissions is from an increase in the number of cows being raised for food.

**Possible Evidence:** Of all the methane in the atmosphere, 60% (420 out of a total of 695 million short tons of methane/year) is coming from ruminants like cows and other microbial sources. Cows produce methane as a result of rumination. Factory farming has enabled more cows to be raised for food, which means more methane is now being produced. Finally, according to the FAO, the number of ruminants raised for food has been steadily increasing.

**Possible Further Research:** Do more monitoring of methane levels in different areas including near and farther away from farms in order to analyze the source of methane in different parts of the atmosphere.

## References:


[1] **Brown, Lester R. (2011). World on the edge: How to prevent environmental and economic collapse.**
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# Phenomenon: Hydrogen Sulfide in the Air

## Phenomenon:

> When the poison control center official spoke to Julie Jansen, his words were shocking:
>
> "Ma'am, the only symptoms of hydrogen sulfide poisoning you're not experiencing are seizures, convulsions, and death. Leave the area immediately."
>
> Panic-stricken, Jansen grabbed her children and drove away from her home. Jansen first thought that the home-based day care center she owned in Olivia, Minnesota had been hit by a flu bug. In the spring of 1995, 17 children ranging in age from newborn to 13 shared a long list of symptoms–diarrhea, nausea, headaches, vomiting, teary eyes, and stuffy noses. She soon noticed that it only happened when the wind blew from the south. Two factory-scale pig farms had recently located not more than a mile and a half away.[3]

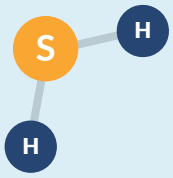
**Excerpt from:** *Cesspools of Shame* (2001)

## Exploratory Question:

What could be the source of the poisonous hydrogen sulfide in the air?

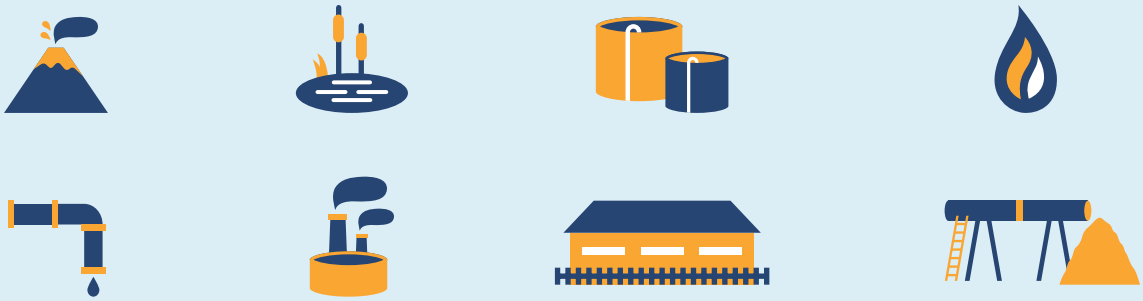
## What is hydrogen sulfide?

Hydrogen sulfide ($H_2S$) is a colorless, poisonous, flammable gas that is made up of two hydrogen atoms and one sulfur atom.




## Where does hydrogen sulfide come from?

Hydrogen sulfide is often produced from the microbial breakdown of organic matter in anoxic environments (where oxygen is not present), such as swamps and standing bodies of water, and occurs naturally in volcanic gases and natural gas. Hydrogen sulfide also exists in engineered systems like sewage treatment plants, pig farms, and manure-handling operations due to the microbial breakdown of organic matter (waste) in the absence of oxygen. Humans are increasing levels of hydrogen sulfide in air near factory farms, as a result of concentrated waste pollution, which can negatively impact neighboring communities. Manure lagoons at industrialized farms, for instance, generate large amounts of hydrogen sulfide because the amount of waste depletes the oxygen in the system.[5]



## How much hydrogen sulfide is in the air?

The typical concentration of hydrogen sulfide in the air is between 0.00011 and 0.00033 ppm (parts per million).[5]

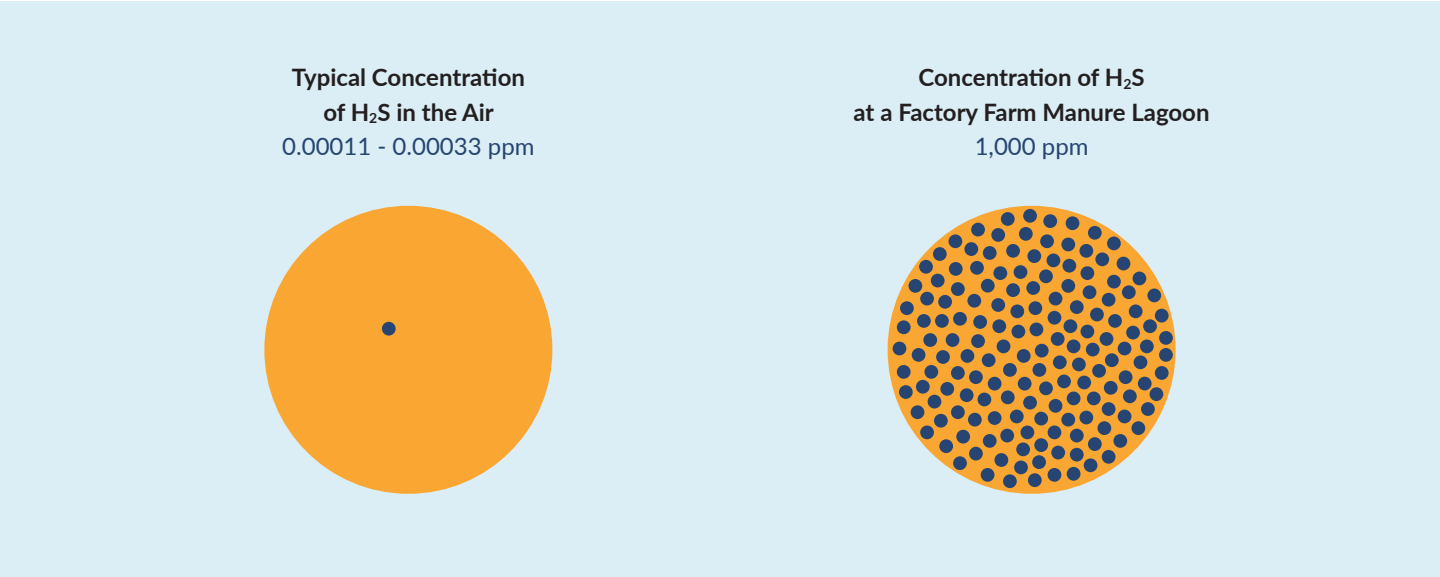



**Figure 1:** $H_2S$ in the Air [5,6]

## How does hydrogen sulfide affect humans?

Hydrogen sulfide has a rotten egg smell at low levels. People have reported symptoms such as eye and throat irritation, shortness of breath, headache, and nausea resulting from hydrogen sulfide levels as low as .1 ppm.[4] Other symptoms experienced at low levels include diarrhea, vomiting, teary eyes, coughing, dizziness, and a stuffy nose. When the level of hydrogen sulfide in the air increases, people can no longer smell hydrogen sulfide, making it very dangerous! At 100 ppm, severe eye and lung problems begin and a potentially fatal lung condition can occur. At 800 ppm and above, a person's respiratory system stops working, causing the person to lose consciousness and typically resulting in fatality.[2]

## What are manure lagoons?

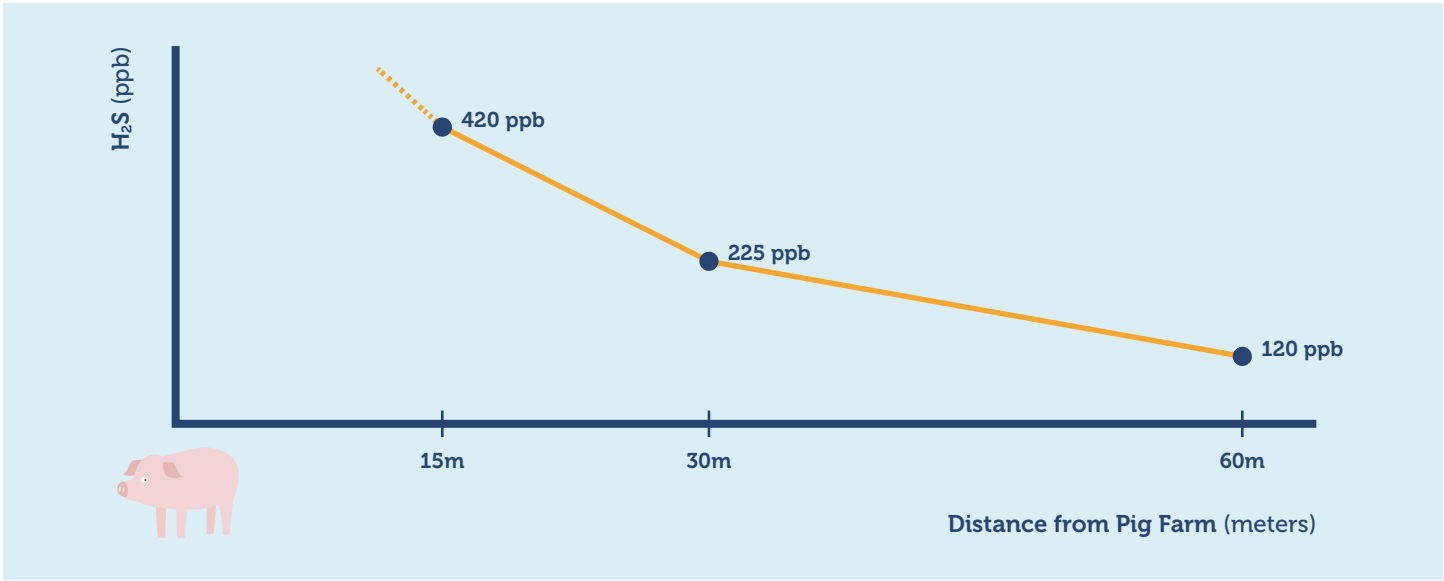
Reports have found that hydrogen sulfide levels at manure lagoons can be as high as 1,000 ppm (Refer to Figure 1: $H_2S$ in the Air).[6] In Iowa, at least 19 factory farm workers have died as a result of hydrogen sulfide exposure during manure agitation, a standard process where solid animal waste is turned to liquid by shifting the waste around inside the manure lagoons.[6]

## Why are manure lagoons dangerous?

Reports have found that hydrogen sulfide levels at manure lagoons can be as high as 1,000 ppm (Refer to Figure 1: $H_2S$ in the Air). In Iowa, at least 19 factory farm workers have died as a result of hydrogen sulfide exposure from manure lagoons.[6]

## Hydrogen Sulfide Levels at Different Distances from Pig Farms[7]

Hydrogen sulfide levels were measured at three distances (15, 30, and 60 meters) from several pig farms. The graph below shows the average level of $H_2S$, in parts per billion (ppb), at each of the three distances from the pig farms.

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Teacher Key

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**Excerpt from:** *Cesspools of Shame* (2001)

## Exploratory Question:

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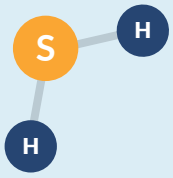


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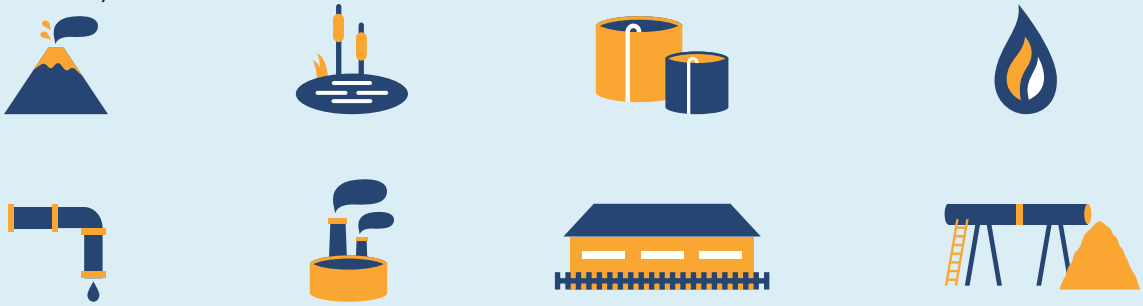


### Teacher Note

There are a variety of possible sources of $H_2S$ in the atmosphere.

Teacher Key

## How much hydrogen sulfide is in the air?

The typical concentration of hydrogen sulfide in the air is between 0.00011 and 0.00033 ppm (parts per million).[5]

### Teacher Note

Normal amounts of $H_2S$ are not at levels harmful to humans.

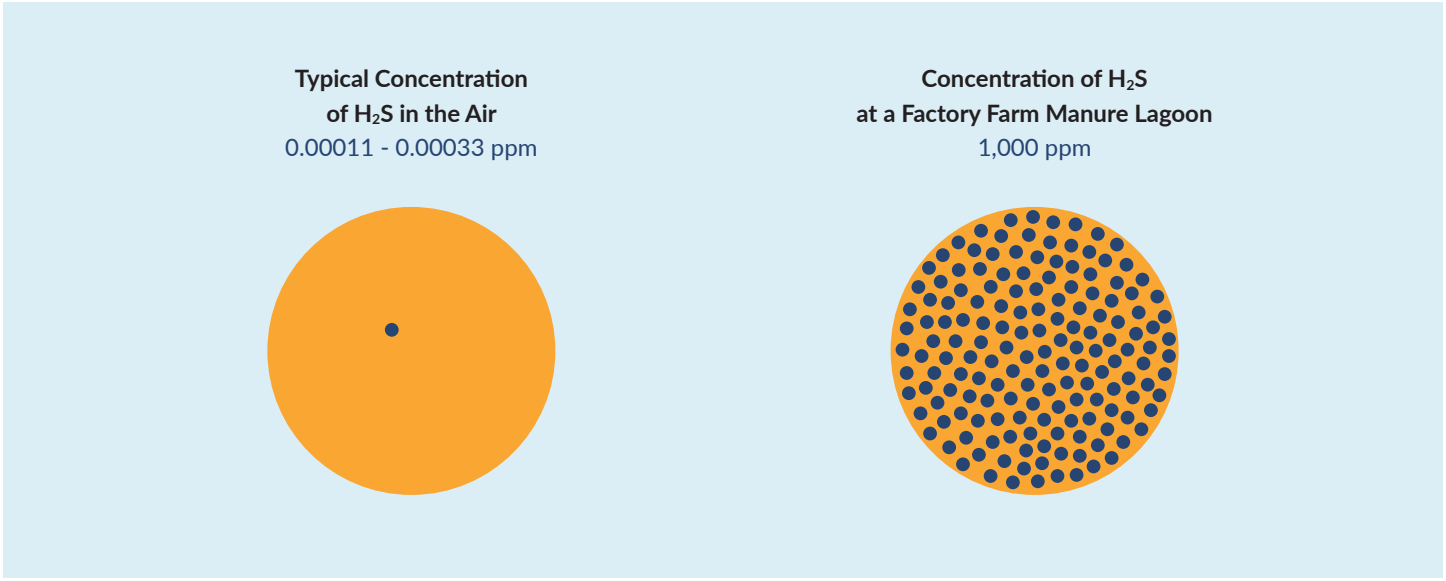



**Figure 1:** $H_2S$ in the Air [5,6]

### Teacher Note

This visual representation shows that the typical concentration of $H_2S$ in the air is significantly lower than levels found at pig farms and manure lagoons.

## How does hydrogen sulfide affect humans?

Hydrogen sulfide has a rotten egg smell at low levels. People have reported symptoms such as eye and throat irritation, shortness of breath, headache, and nausea resulting from hydrogen sulfide levels as low as .1 ppm.[4] Other symptoms experienced at low levels include diarrhea, vomiting, teary eyes, coughing, dizziness, and a stuffy nose. When the level of hydrogen sulfide in the air increases, people can no longer smell hydrogen sulfide, making it very dangerous! At 100 ppm, severe eye and lung problems begin and a potentially fatal lung condition can occur. At 800 ppm and above, a person's respiratory system stops working, causing the person to lose consciousness and typically resulting in fatality.[2]

### Teacher Note

This section provides an understanding of what levels of $H_2S$ are harmful and how high concentrations may not be detectable by smell.

Teacher Key

## What are manure lagoons?

A modern pig farm can hold up to 800,000 pigs, producing over 1.6 million tons of manure (that's pig poop) each year.[1] The manure is drained through pipes to storage tanks known as manure lagoons. At manure lagoons, gases such as hydrogen sulfide, ammonia, methane, and carbon dioxide, can reach levels that are harmful for people.

### Teacher Note

This section provides a possible source of $H_2S$ in the air: manure lagoons.

## Why are manure lagoons dangerous?

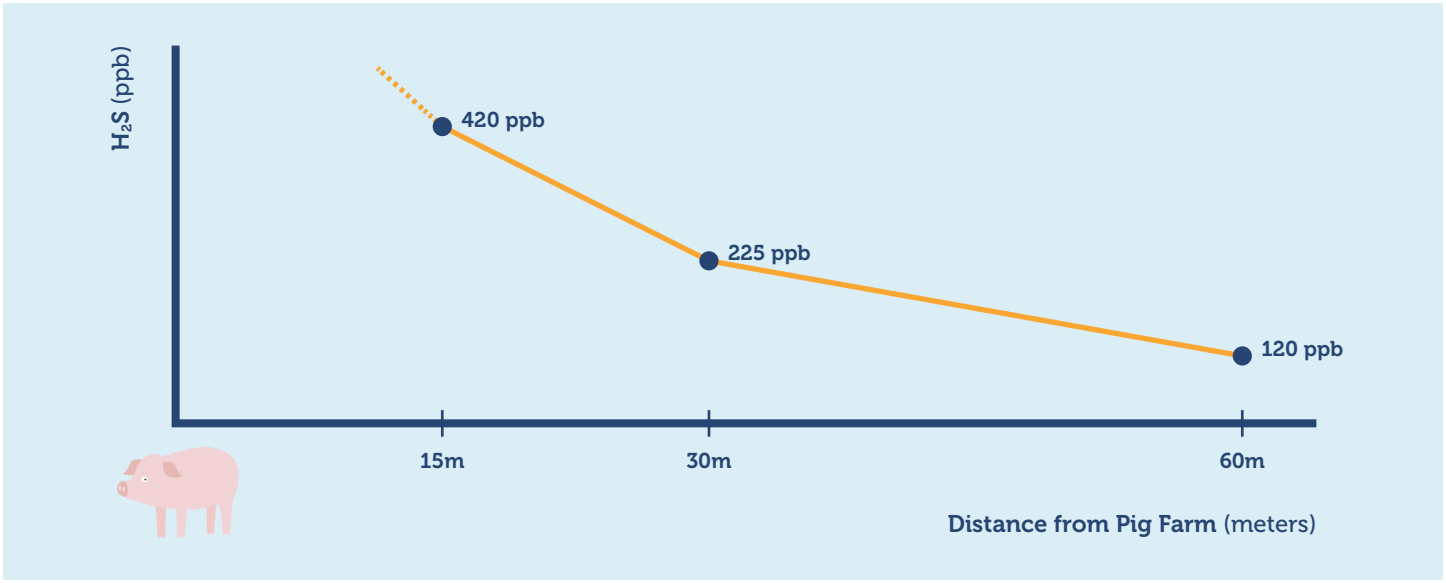
Reports have found that hydrogen sulfide levels at manure lagoons can be as high as 1,000 ppm (Refer to Figure 1: $H_2S$ in the Air).[6] In Iowa, at least 19 factory farm workers have died as a result of hydrogen sulfide exposure during manure agitation, a standard process where solid animal waste is turned to liquid by shifting the waste around inside the manure lagoons.[6]

### Teacher Note

This section provides one example of a source of $H_2S$ in the air: manure lagoons.

## Hydrogen Sulfide Levels at Different Distances from Pig Farms[7]

Hydrogen sulfide levels were measured at three distances (15, 30, and 60 meters) from several pig farms. The graph below shows the average level of $H_2S$, in parts per billion (ppb), at each of the three distances from the pig farms.




### Teacher Note

This graph provides data showing actual levels of $H_2S$ at different distances from pig farms.

Teacher Key

### Teacher Note

**Possible Student Claim:** The source of $H_2S$ in the air is from the two pig farms located within a few miles of Julie Jansen.

**Possible Evidence:** Naturally occurring levels of $H_2S$ are well below those harmful to humans. Pig farms produce large amounts of animal waste in the form of manure. This manure produces hydrogen sulfide in the air. Farm workers have died from exposure to $H_2S$ as a result of manure lagoons. Measurements of $H_2S$ have been taken near pig farms with $H_2S$ levels reaching over 400 ppm at a distance of 15 m and over 100 ppm at a distance of 60 m. Therefore, it is possible that $H_2S$ is polluting the air near Julie Jansen's home.

**Possible Further Research:** Do more monitoring of $H_2S$ farther from pig farms and near residential homes to see what levels of $H_2S$ are present.

## References:


[1] **Hribar, C. (2010). Understanding concentrated animal feeding operations and their impact on communities.**
Retrieved from:
https://www.cdc.gov/nceh/ehs/Docs/Understanding_CAFOs_NALBOH.pdf

[2] **Manure storage pit dangers: Identifying hazardous gases. (2015, July 31).**
Retrieved from Great Plains Center for Agricultural Health website:
http://www.public-health.uiowa.edu/gpcah/wp-content/uploads/2015/08/Manure-Pit-Gas-Selection_Use-7_31_15.pdf

[3] **Marks, R. (2001, July). Cesspools of shame: How factory farm lagoons and spray fields threaten environmental and public health.**
Retrieved from:
https://www.nrdc.org/sites/default/files/cesspools.pdf

[4] **Merchant, J.A., Kline, J., Donham, K.J., Bundy, D.S., & Hodne, C. J. (n.d.). 6.3 Human health effects.**
Retrieved from:
https://www.public-health.uiowa.edu/ehsrc/CAFOstudy/CAFO_6-3.pdf

[5] **Public health statement: Hydrogen sulfide. (2016, December).**
Retrieved from Agency for Toxic Substances and Disease Registry website:
https://www.atsdr.cdc.gov/toxprofiles/tp114-c1-b.pdf

[6] **Raising a stink: Air emissions from factory farms. (n.d.).**
Retrieved from:
http://environmentalintegrity.org/pdf/publications/CAFOAirEmissions_white_paper.pdf

[7] **Tengman, C. L., Goodwin, R. N., & Bicudo, J.R. (n.d.). Hydrogen sulfide concentrations around swine farms.**
Retrieved from:
http://porkgateway.org/resource/hydrogen-sulfide-concentrations-around-swine-farms/

# Terms and Definitions

| Term | Definition |
|---|---|
| **Anoxic** | When no oxygen is present |
| **Atmosphere** | The mixture of gases that surrounds the earth |
| **Atom** | The smallest particle of a chemical element that can exist |
| **Carbon Dioxide** | A gas breathed out by people and animals from the lungs or produced by burning carbon |
| **Cesspool** | A container for the temporary storage of liquid waste and sewage |
| **Climate** | The regular pattern of weather conditions of a particular place |
| **Climate Change** | Changes in the earth's weather, including changes in temperature, wind patterns and rainfall, especially the increase in the temperature of the earth's atmosphere that is caused by the increase of particular gases, especially carbon dioxide |
| **Concentration** | 1. A lot of something in one place<br>2. The amount of substance in a liquid or in another substance |
| **Deforestation** | The act of cutting down or burning the trees in an area |
| **Emit** | To send out something such as light, heat, sound, gas, etc. |
| **Emission** | The production or sending out of light, heat, gas, etc. |
| **Export** | To sell and send goods to another country |

| | |
|---|---|
| **Factory Farm** | A type of farm in which animals are kept inside in small spaces and are fed special food so that a large amount of meat, milk, etc. is produced as quickly and cheaply as possible |
| **Fossil Fuels** | Fuel such as coal or oil, that was formed over millions of years from the remains of animals or plants |
| **Global Warming** | The increase in temperature of the earth's atmosphere, that is caused by the increase of particular gases, especially carbon dioxide |
| **Greenhouse Effect** | A phenomenon where gases allow sunlight to enter Earth's atmosphere but make it difficult for heat to escape |
| **Hydrogen Sulfide** | A colorless, poisonous, flammable gas |
| **Industry** | The production of goods from raw materials, especially in factories |
| **Manure** | The waste matter from animals |
| **Methane** | A gas without color or smell, that burns easily and is used as fuel. Natural gas consists mainly of methane |
| **Microbe** | An extremely small living thing that you can only see under a microscope and that may cause disease |
| **Molecule** | The smallest unit, consisting of a group of atoms, into which a substance can be divided without a change in its chemical nature |
| **Phenomenon** | A fact or an event in nature or society, especially one that is not fully understood |
| **Regurgitate** | To bring food that has been swallowed back up into the mouth again |
| **Ruminant** | Animals, such as cows and sheep, who bring back food from their stomachs and chew it again |

**Sources:**

Greenhouse effect. (n.d.). Retrieved from: https://www.nationalgeographic.org/encyclopedia/greenhouse-effect/
Oxford learner's dictionaries. (n.d.). Retrieved from: https://www.oxfordlearnersdictionaries.com/us/

# Developing a Claim Supported by Evidence

**Name:** _____

**Date:** _____

In this activity, you will work together in a group of students to investigate a phenomenon. You will then be asked to consider a question relating to that phenomenon.

Using the information provided, your group will make a claim that attempts to answer this question, citing three pieces of evidence that support this claim. Your group will need to justify why your evidence supports your claim.

As a group, you will complete the "Supporting a Claim" matrix, which includes the following components:

- The phenomenon
- The exploratory question being asked
- Your claim (which attempts to answer the question)
- Evidence (at least three pieces of evidence, including some numerical data)
- Justification of evidence (explain how your evidence supports your claim)
- Further research (what additional information might be gathered to answer the question?)

## "Supporting a Claim" Matrix

<table>
<tr><td colspan="2">Phenomenon:</td></tr>
<tr><td colspan="2">Exploratory Question:</td></tr>
<tr><td colspan="2">Your Claim:</td></tr>
<tr><td>Evidence:<br>1.<br>2.<br>3.</td><td>Justification:<br>1.<br>2.<br>3.</td></tr>
<tr><td colspan="2">Further Research:</td></tr>
</table>

## Construct Your Argument

1. Individually read the phenomenon and the exploratory question. What questions do you have? What information do you need to know to answer the exploratory question? Jot down some notes.

2. Next, think about the exploratory question being asked as you read the background information on the phenomenon.

3. Now, discuss what you read as a group. What could be a possible answer to the exploratory question being posed? This will be your claim. What evidence exists to support your claim? Be sure to use some numerical data in your response. Fill in the matrix with your groups' ideas. Finally, what further research could be done to better answer this question?

4. When your group is ready, copy your "Supporting a Claim" matrix onto poster paper. Take turns filling out each section of the matrix, perhaps by having each group member use a different colored pen. Each group member should be prepared to explain each part of your group's matrix to other classmates.

## Rotate and Defend

Once your group has copied their matrix onto the poster paper, your teacher will partner your group with another group of students exploring a different phenomenon.

Each group should take turns explaining and defending their matrix to the other group. The group that is not presenting is expected to give feedback on the content of the other group's matrix.

As each group explains their matrix, each person needs to consider if the claim, evidence, and justification are convincing. Here are some questions to ask each other:

- Why did you choose this claim?
- Why did you pick the evidence you chose?
- Did you and your group change your minds while you discussed your claim, evidence, and justification?
- Does the justification make sense? Does it connect the evidence to the claim?

Group members are encouraged to update their matrix with the feedback that they received from the other group in order to strengthen their claim, evidence, and justification.

## Final Grading

Once students have updated their matrix using feedback from their rotation, they should grade their own finished matrix using the **Claim Matrix Rubric**.

# Claim Matrix Rubric

**Name:** _____

**Date:** _____

**Group Members' Names:** _____

| Rubric Areas | 2 | 1 | 0 |
|---|---|---|---|
| **Claim** | The claim was clearly stated. | The claim was unclear. | There was no claim made. |
| **Evidence Set 1** | The evidence provided was appropriate and accurate. | The evidence provided was either not appropriate or not accurate. | Evidence was missing, not appropriate, or not accurate. |
| **Justification for Evidence Set 1** | The justification clearly related to the evidence and supported the claim. | The justification either did not relate to the evidence or did not support the claim. | There was no justification. |
| **Evidence Set 2** | The evidence provided was appropriate and accurate. | The evidence provided was either not appropriate or not accurate. | Evidence was missing, not appropriate, or not accurate. |
| **Justification for Evidence Set 2** | The justification clearly related to the evidence and supported the claim. | The justification either did not relate to the evidence or did not support the claim. | There was no justification. |
| **Evidence Set 3** | The evidence provided was appropriate and accurate. | The evidence provided was either not appropriate or not accurate. | Evidence was missing, not appropriate, or not accurate. |
| **Justification for Evidence Set 3** | The justification clearly related to the evidence and supported the claim. | The justification either did not relate to the evidence or did not support the claim. | There was no justification. |
| **Further Research** | An idea for further research was clearly stated and related to the question. | An idea for further research either was unclear or did not relate to the question. | There was no idea for further research presented. |
| **Total Score:** | | | **___ / 16** |

# PowerPoint Reference:
# Environmental Impacts & Our Food System

**Key**

**Slide Screenshot**

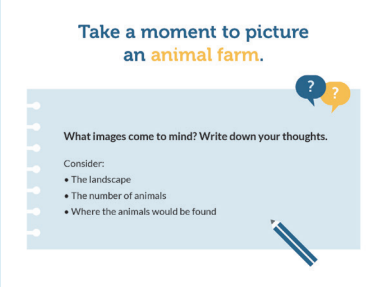
Regular: Script for Teacher

*Italic:* Notes for Teacher

Suggested Further Reading for Teacher


## Slide #1:
## Environmental Impacts & Our Food System

- We are going to begin the next section of this lesson by taking a closer look at how animal agriculture impacts our environment.

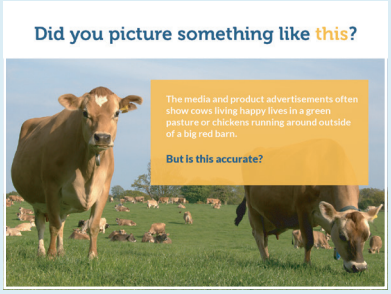



## Slide #2:
## Take a moment to picture an animal farm

- Before we do, I would like you to take a moment to picture an animal farm. What images come to mind? Write down your thoughts.

  Consider:
  - The landscape
  - The number of animals
  - Where the animals would be found

- *Give students one minute to write down their thoughts and then ask for some volunteers to share what they wrote. Depending on their proximity to farming, students' answers may differ greatly from each other.*




## Slide #3:
## Did you picture something like this?

- Did you picture something like this? The media and product advertisements often show cows living happy lives in a green pasture or chickens running around outside of a big red barn. But is this accurate?


## Slide #4:
## What is industrialized agriculture or factory farming?

- Factory farming is a method of farming in which animals are kept inside small spaces and are fed special food so that a large amount of meat, milk, and eggs are produced as quickly and cheaply as possible.[9]
- The demand for cheap meat, dairy, and eggs prompted the rise of factory farms, allowing humans to raise an enormous number of animals for food at any given time.
- Nearly 10 billion land animals are raised and killed for meat, milk, and egg production every year in the U.S. alone (56 billion land animals worldwide).
- Most farms today are controlled by a handful of corporations. While an individual "farmer" may own the land and be responsible for building the animal containment structure and disposing of animal waste, the corporations are the ones who have ultimate control. These corporations make most of the profit, and they supply and own the animals, dictating what the farmers ultimately can and cannot do.[11]

*For further information on this issue, please refer to:*

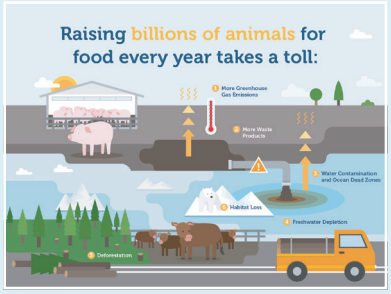
Starmer, E. (n.d.). Corporate power in livestock production: How it's hurting farmers, consumers, and communities and what we can do about it.
Retrieved from: http://www.ase.tufts.edu/gdae/Pubs/rp/AAI_Issue_Brief_1_3.pdf


## Slide #5:
## Inside a Factory Farm

- Here is a glimpse into the lives of animals in factory farms.
    - Most dairy cows live on concrete and never go outside. They are milked by machines, not by hand.
    - Mother pigs are typically kept in crates (called gestation crates) that are so small they cannot turn around or lie down comfortably.
    - Most chickens raised for eggs are kept in tiny wire cages (called battery cages) for their entire lives.

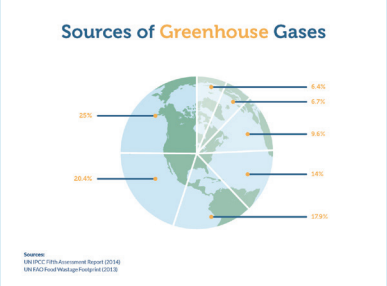
*For more information on these issues, please refer to:*

Factory farming. (n.d.).
Retrieved from: https://www.farmsanctuary.org/learn/factory-farming/



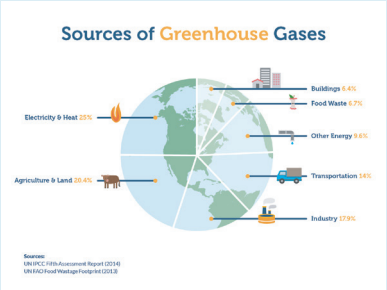

## Slide #6:
## Summary of Environmental Impacts

- Raising billions of animals for food every year takes a toll on our environment. From this infographic, you can see some of these issues and how they relate to each other. For the remainder of the presentation, we will be going over each of these issues more closely.
- In summary, animal agriculture is increasing our greenhouse gas emissions, creating more waste products, contaminating and depleting our fresh water supply, and creating ocean dead zones. Animal agriculture is also responsible for much of the deforestation and loss of habitat belonging to wild animal species that we see today.




## Slide #7:
## Sources of Greenhouse Gases

- *Ask students to brainstorm the worldwide sources of greenhouse gas emissions. Once they've come up with ideas, such as animal agriculture or transportation, ask students which slice of the pie chart they think belongs to each source. In other words, which of their ideas accounts for the largest percentage of greenhouse gas emissions worldwide and which source do they think accounts for the smallest percentage of greenhouse gas emissions worldwide.*
- *An alternative option is to tell students the seven sources of worldwide greenhouse gas emissions in a random order such as "industry, food waste, buildings, agriculture & land, electricity & heat, transportation, and other energy"—and then have students guess which source goes in each slice of the pie chart.*

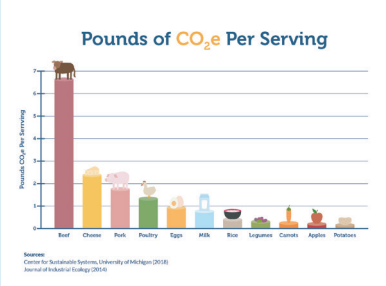



## Slide #8:
## Sources of Greenhouse Gases

- *Students may be surprised to learn that agriculture and land use make up the second largest source for worldwide greenhouse gas emissions.*
- *Share with students that animal agriculture alone accounts for 14.5% of greenhouse gas emissions, which is more than the entire world transportation system combined.*
- *Percentages sourced from: UN IPCC Fifth Assessment Report (2014) & UN FAO Food Wastage Footprint (2013)*

*Suggested further reading:*

*Tackling climate change through livestock. (n.d.).*
*Retrieved from* http://www.fao.org/ag/againfo/resources/en/publications/tackling_climate_change/index.htm




## Slide #9:
## Carbon Dioxide Equivalent by Food Source

• This graph is showing the carbon dioxide equivalent of different foods. The carbon dioxide equivalent ($CO_2e$) is a way of expressing greenhouse gas emissions as a single number in order to show their global warming potential. In other words, this graph is showing which foods create the most greenhouse gases and therefore contribute the most to global warming.

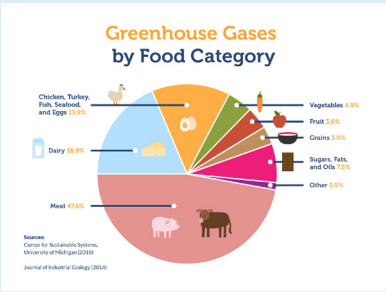
• *Ask students if they can see a pattern regarding which food products create the most greenhouse gas emissions/contribute the most to global warming. Students should understand that the production of animal-based foods creates more greenhouse gas emissions than the production of plant-based foods. This can be explained in terms of energy. Energy is needed to grow feed for animals. A lot of the energy in the food we feed to animals goes toward sustaining the animal or is lost in the manure. A small fraction becomes the energy we would eat in the actual animal-based food.*

• *Ask students why they think the production of foods that come from cows is so much higher than foods that come from other animals. Students should recall learning that cows are ruminants and produce methane during digestion.*

• *Percentages sourced from: Center for Sustainable Systems, University of Michigan. 2018. "Carbon Footprint Factsheet." Pub. No. CSS09-05.*

*Suggested further reading:*

http://css.umich.edu/factsheets/carbon-footprint-factsheet




## Slide #10:
## Greenhouse Gases by Food Category

•The pie chart on this slide reiterates the fact that the production of animal-based foods creates more greenhouse gas emissions than the production of plant-based foods.

• Approximately 80% of the greenhouse gas emissions created from food comes from animal products.

• *Percentages sourced from: Center for Sustainable Systems, University of Michigan. 2018. "Carbon Footprint Factsheet." Pub. No. CSS09-05.*

*Suggested further reading:*

http://css.umich.edu/factsheets/carbon-footprint-factsheet


## Slide #11:
## Manure Lagoon

• Pictured on this slide is a manure lagoon also known as a cesspool. As you learned during the phenomena exploration section of this lesson, raising 10 billion animals for food every year in the U.S. alone (56 billion animals worldwide), makes for a lot of waste! A single pig farm can hold up to 800,000 pigs, producing over 1.6 million tons of manure each year.[3] The manure is drained through pipes to storage tanks known as manure lagoons. When manure is stored this way, different gases, such as hydrogen sulfide, ammonia, methane, and carbon dioxide, can reach levels that are harmful to humans and contribute to global climate change.

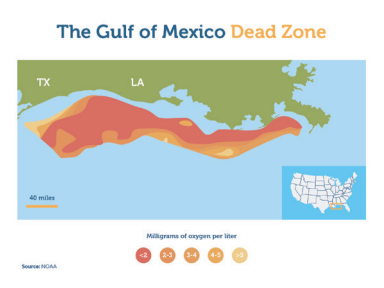
• The EPA estimates that farm animals in the U.S. produce between 3 and 20 times more manure each year than humans in the U.S. produce; this equates to roughly 1.2–1.4 billion tons of waste from farm animals every year.[3]

• Manure is used as fertilizer in smaller amounts, but at quantities currently produced by the farming industry, waste management is a problem. Most farms don't grow their own animal feed, so they can't use the manure they produce as fertilizer. Therefore, factory farms apply the manure to the ground surrounding farms. This application is often accomplished by spraying the manure in a sprinkler-like way; wind can then blow the manure onto neighboring properties and homes. The over-application of manure to the ground contaminates the soil and creates run off that can end up in ground and surface water.[3]

*Suggested further reading:*

*Exposing fields of filth. (2016, June 6).*
*Retrieved from* https://www.ewg.org/research/exposing-fields-filth#.W5gI2vZFwZx

*Hribar, C. (2010). Understanding concentrated animal feeding operations and their impact on communities.*
*Retrieved from* https://www.cdc.gov/nceh/ehs/Docs/Understanding_CAFOs_NALBOH.pdf




## Slide #12:
## The Gulf of Mexico Dead Zone

• The mismanagement of waste contaminates our natural water sources as well as the ocean, leading to dead zones. A dead zone is a part of the ocean, or another body of water, that doesn't have enough oxygen in the water, making it so animals are unable to live there. Without oxygen, animals suffocate and die.[2] This can lead to the collapse of entire ecosystems.

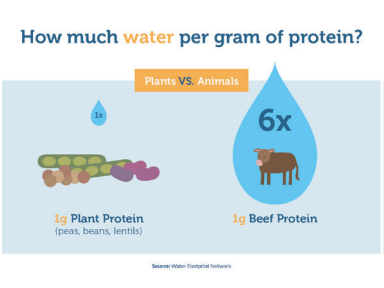
• Animal waste is filled with nitrogen, which is known to cause oxygen depletion, and it is the primary polluter of rivers and bays in the United States. Nitrogen makes its way into waterways from crop fertilizer, animal and human waste, and the burning of fossil fuels. Nitrogen can cause algae blooms and, when the algae blooms die, they sink to the bottom of a body of water and decay, a process that uses up oxygen and makes it impossible for animals to survive.

• Pollution from agricultural runoff is the main cause of the Gulf of Mexico Dead Zone, the second largest dead zone in the world, which is approximately the size of New Jersey.[2,5] Nitrogen, mostly originating from agricultural runoff in the midwest, is carried down the Mississippi River and ends up in the Gulf, producing algae blooms.

*Suggested further reading:*

*Biello, D. (2008, Aug. 15). Oceanic dead zones continue to spread. Retrieved from* https://www.scientificamerican.com/article/oceanic-dead-zones-spread/

*Charles, D. (2017, Aug. 3). The Gulf of Mexico's dead zone is the biggest ever seen. Retrieved from* https://www.npr.org/sections/thesalt/2017/08/03/541222717/the-gulf-of-mexicos-dead-zone-is-the-biggest-ever-seen




## Slide #13:
## How much water per gram of protein?

• In addition to the water contamination that results from animal agriculture, it also takes a lot of water to raise animals for food. It takes approximately six times the amount of water per gram of protein to produce beef in comparison to a plant protein like beans, lentils, and peas. In general, it takes a lot more water to raise animals for food than to grow plants for food.

• *Ask students why it takes more water to raise animals for food than to grow plants for food. Students should understand that not only do animals drink a lot of water, it also takes a lot of water to grow plants, like corn and soy, that are then fed to the animals.*

• *The following are additional comparisons you may wish to share with students.*

*Water consumed per gram of protein*[13]

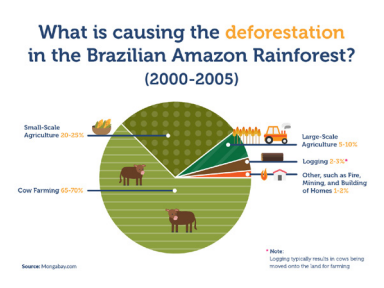
- *Beef = 29.6 gal./gram*
- *Chicken = 9 gal./gram*
- *Milk = 8.2 gal./gram*
- *Eggs = 7.7 gal./gram*
- *Vegetables = 6.87 gal./gram*
- *Pulses (beans, lentils, peas) = 5 gallons of water required per gram of protein*

*Gallons of water required to produce 1 pound of food*[1]

- *It takes approximately 1,581 gallons of water to produce 1 pound of beef*
- *It takes approximately 500 gallons of water to produce 1 pound of chickpeas*
- *It takes approximately 299 gallons of water to produce 1 pound of rice*
- *It takes approximately 250 gallons of water to produce 1 pound of soybeans*
- *It takes approximately 67 gallons of water to produce 1 pound of oranges*
- *It takes approximately 50 gallons of water to produce 1 pound of strawberries*
- *It takes approximately 34 gallons of water to produce 1 pound of potatoes*

*Suggested further reading:*

*Water footprint of crop and animal products: a comparison. (n.d.).*
*Retrieved from* http://waterfootprint.org/en/water-footprint/product-water-footprint/water-footprint-crop-and-animal-products/




## Slide #14:
## What is causing the deforestation in the Brazilian Amazon Rainforest? (2000-2005)

• Deforestation is the cutting down or burning of trees in an area.[9] Land-use change is when we change the way land is used. For example, land may be changed so that it can be developed for industry. Deforestation often begins with forest being cut down to grow crops that will feed cows and other farmed animals. On land that has been deforested, nutrient levels drop and, in 5-10 years, crops will not grow as easily. Once crops stop growing, factory farming corporations move in with cows. In just 5-10 years, a nutrient-filled forest that has been cut down is changed into a wasteland where crops cannot grow.[6]

• According to the National Aeronautics and Space Administration (NASA), deforestation rates in Africa, Southeast Asia, and South America have stayed constant or have increased in the last 20 years, changing carbon emissions and our climate worldwide. Due to this rise in deforestation, Brazil is now the fourth largest greenhouse gas producer with deforestation and land-use change making up 75% of Brazil's greenhouse gas emissions. In the Brazilian Amazon Rainforest, about 7,700 square miles of rainforest are cut down each year.[8]

• Agriculture is the leading cause of deforestation in the Brazilian Amazon Rainforest. Raising animals for food takes up a lot of space. To make room for more animals, humans will cut down trees. In this pie chart, you can see the different causes of deforestation in the Brazilian Amazon Rainforest. It's estimated that 65-70% of the deforestation that has occurred in the Brazilian Amazon rainforest has been done for animal agricultural purposes. The number of cows in the Amazon Rainforest has grown from 5 million in the 1960's to 70-80 million today.[12] It should also be noted that much of the large-scale agriculture pie slice represents the growing of crops, such as corn and soy, which will be fed exclusively to animals raised for food.

• Deforestation decreases oxygen production and increases carbon dioxide levels in our air, since forests actually store quite a bit of carbon in the trees.

• When forests are cut down, wild animals are displaced, injured, and even killed. Therefore, deforestation can be attributed to the endangerment and extinction of species.

*Suggested further reading:*

*Livestock policy brief: Cattle ranching and deforestation. (n.d.).*
*Retrieved from* www.fao.org/3/a-a0262e.pdf

## Slide #15:
## Habitat Loss

• According to the World Wildlife Fund, habitat loss is the main threat to 85% of all species on IUCN's Red list – species that are officially listed as threatened or endangered and face extinction.[4] This classification includes the polar bear, and the World Wildlife Fund states that "the loss of sea ice habitat from climate change is the biggest threat to the survival of polar bears."[10]

• In a study funded by NASA and the Greenland Institute of Natural Resources, based on 35 years of Arctic sea ice satellite data, researchers found that the Arctic sea ice is melting three to nine days earlier and freezing three to nine days later each decade. This means that polar bears, in the last 35 years, have lost nearly seven weeks of good sea ice habitat.[7]

• Polar bears rely on ice for hunting, traveling, and breeding. Polar bears cannot outswim seals, their primary food source, so they depend on patches of ice to ambush their prey.[7] Polar bears spend about 50% of their time hunting for food, which is accomplished by traveling across patches of ice, as you see this polar bear doing (refer to slide). Global climate change is a major threat to the survival of this species because when ice melts, as it is doing now, polar bears lose their hunting ground and are unable to feed themselves, and this loss of habitat also means the bears will have difficulty finding a mate during breeding season.[10]

• *Extension: If you have access to the Internet, show students the yearly Arctic sea ice video (0:43) created by NASA which is a time lapse of annual sea ice change from 1984-2016 (link below). The video highlights the fact that perennial ice (multi-year ice or ice that is over 2-years-old) has nearly disappeared in the last 30 years due to our warming oceans and global climate change.*

*Yearly Arctic sea ice age with graph of ice age by area: 1984-2016. (2016, Oct. 28). Retrieved from* https://svs.gsfc.nasa.gov/4489

*Suggested further reading:*

*Ma, M. (2016, Oct. 3). Polar bears across the Arctic face shorter sea season. Retrieved from* https://climate.nasa.gov/news/2499/polar-bears-across-the-arctic-face-shorter-sea-ice-season/

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# Article Worksheet

Name: _____

Date: _____

## Article: Millennials Are Driving the Worldwide Shift Away from Meat

Author: Michael Pellman Rowland

Published on Forbes.com

## Handout Questions:

**1. What three things do millennials often think about when they choose what to eat?**

**2. Name one health concern associated with eating processed meats like bacon and ham.**

**3. Name two things that companies are doing as a result of the demand for plant-based food options.**

**4. What would you consider eating or not eating to reduce your environmental impact? Feel free to think back to other parts of this lesson including the PowerPoint presentation, Environmental Impacts & Our Food System.**

# Terms and Definitions

**Blistering:** Done very fast or with great energy[5]

**Combat:** To struggle against or to strive to reduce or eliminate[4]

**Conscious:** Aware of something; noticing something[5]

**Cruelty-Free:** Developed or produced without testing on animals[3]

**Diversify:** To develop a wider range of products, interest, skills, etc. in order to be more successful or reduce risk[5]

**Entitlement:** A government system that provides financial support to a particular group of people[5]

**Environmental (Ecological) Footprint:** A measure of the amount of the earth's resources used by a person or a population that lives in a particular way[5]

**Flexitarian(ism):** A person who sometimes eats meat or fish although they do not usually do so[5]

**Heart Disease:** An abnormal condition of the heart or of the heart and blood circulation[4]

**Indulge:** To allow yourself to have or do something that you like, especially something that is considered bad for you[5]

**Lab-Grown Meat**: Cultured meat, also called clean meat, synthetic meat, or in vitro meat, is meat grown from in vitro animals' cell culture instead of from slaughtered animals[1]

**Meat-Free:** Food that is free of meat (animal flesh)

**Millennial:** A person born in the 1980s or 1990s[4]

**Organic:** Produced or practiced without using artificial chemicals[5]

**Pivot:** To turn on a central point[2]

**Plant-Based:** A diet based on foods derived from plants, including vegetables, whole grains, nuts, seeds, legumes, and fruits, but with no animal products.

**Plant-Centric:** A diet centered around foods derived from plants, including vegetables, whole grains, nuts, seeds, legumes, and fruits

**Processed:** A method of doing or making something, especially one that is used in industry[5]

**Secular:** Not connected with spiritual or religious matters[5]

**Sustainable:** Involving the use of natural products and energy in a way that does not harm the environment[5]

**Vegan:** A person who does not eat any animal products such as meat, milk, or eggs. Some vegans do not use animal products such as silk or leather.[5]

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https://www.oxfordlearnersdictionaries.com/us/

# Final Activity: Sticky Note Exercise

**Purpose:** Identify key student learning to assess lesson effectiveness

## 1. Requirements

### Time

5-10 minutes
at end of session

### Materials

- One sticky note for each student
- Thin-line markers (such as sharpies) or pens

### Board or Wall Space

A place where students can post the sticky notes and the class can gather around to view them

## 2. Introduction

Inform the class that the final activity will have them reflect upon what they have learned throughout the lesson. **Ask each student to write 1-2 sentences on a sticky note about what they think is the most important thing they learned. Students should not write their names on the sticky notes.**

## 3. Individual Work Time (2 minutes)

## 4. Posting Sticky Notes (2 minutes)

Students should now post their sticky notes on the board/wall so that they can see what their fellow classmates learned as a whole. Inform the students that they do not have to post their sticky note if they prefer not to do so. Students should remain standing by the board/wall once they have posted their sticky notes.

## 5. Themes (up to 5 minutes)

Now, ask the class if they see similar concepts, facts, or comments referred to on the sticky notes. Encourage a brief discussion.

**Time Permitting:** Have the students group together sticky notes with similar ideas. Then ask students to come up with a title to describe each group of sticky notes. Finally, add titles to each group of sticky notes using an additional sticky note.

**Conclude by taking a photo of the anonymous sticky notes for your records, checking that each sticky note is legible in the photo. You may choose to keep the sticky notes or recycle them. Please e-mail this photo to Farm Sanctuary's Humane Educator Maddie Krasno at mkrasno@farmsanctuary.org.**