

Lesson Plan: Fertilizers and Climate

Teacher-submitted lesson plan, contributed by Dr. Shikha Gulati, Assistant Professor, Sri Venkateswara College (University of Delhi), India.

As an **undergraduate-level Chemistry** teacher, you can use this set of computer-based tools to help you in teaching about **fertilizers, types of fertilizers, the assessment of different types of fertilizers, the possible effect of fertilizer use on the environment due to greenhouse gas (GHG) emissions, and best practices to mitigate these effects.**

The teaching tools in this lesson plan help students to understand the significance of GHG emissions from fertilizer use. Further, the lesson plan triggers a discussion on practices to mitigate such emissions because GHGs are possible contributors to climate change. Thus, the use of this lesson plan allows you to integrate the teaching of a climate science topic with a core topic in Chemistry.

Use this lesson plan to help your students find answers to:

- Why are fertilizers important for agriculture globally?
- What is the potential impact of fertilizer use on climate?
- How does nitrogen (N) fertilizer contribute to nitrous oxide emissions?
- What are the best practices to mitigate greenhouse gas emissions caused by fertilizer use?

About the Lesson Plan

1. **Grade Level:** Undergraduate
2. **Discipline:** Chemistry
3. **Topic(s) in Discipline:** Fertilizers, Types of Fertilizers, Fertilizers in Agriculture, Effects of the Use of Fertilizers on the Environment, Management of Fertilizers
4. **Climate Topic:** Climate and the Atmosphere, The Greenhouse Effect
5. **Location:** Global
6. **Access:** Online
7. **Language(s):** English
8. **Approximate Time required:** 30-50 minutes

1 Contents

1. Micro-lecture (~6 min)

A micro-lecture to introduce the topic of fertilizers, the need for fertilizers, the types of fertilizers used in agriculture, and the benefits and potential risks of using them.

<https://ifdc.org/2013/03/15/introduction-to-fertilizer/>

2. Visualization (~10 min)

A simplified diagram to explain the nitrogen cycle in agricultural practices and the resultant emission of a GHG nitrous oxide (N_2O) by the application of nitrogen (N) fertilizers.

[http://www.ipni.net/ipniweb/portal.nsf/e0f085ed5f091b1b85257900057902e/80d63105b8462c3c85257b670057917f/\\$FILE/N%20Cycle.002.pdf/N%20Cycle.pdf](http://www.ipni.net/ipniweb/portal.nsf/e0f085ed5f091b1b85257900057902e/80d63105b8462c3c85257b670057917f/$FILE/N%20Cycle.002.pdf/N%20Cycle.pdf)

3. Visualization and Data Set (~10 min)

A visualization and corresponding data set to show the global warming potential (GWP) of one-unit masses of various GHGs, including N_2O , relative to that of carbon dioxide.

<https://ourworldindata.org/grapher/global-warming-potential-of-greenhouse-gases-over-100-year-timescale-gwp>

4. Video (~5 min)

A video that briefly explains how fertilizers affect plant growth and how a GHG N_2O is released to the atmosphere due to soil bacterial action on N fertilizers. Best management practices (BMPs) to mitigate these adverse effects of fertilizer use are also introduced here.

<https://www.youtube.com/watch?v=eD2SeH8lZZw>

5. Suggested questions/assignments for learning evaluation

- Why are fertilizers important for agriculture globally?
- What is the potential impact of fertilizer use on climate?
- How does nitrogen (N) fertilizer contribute to nitrous oxide emissions?
- What are the best practices to mitigate greenhouse gas emissions caused by fertilizer use?

2 Step-by-step User Guide

Here is a step-by-step guide to using this lesson plan in the classroom/laboratory. We have suggested these steps as a possible plan of action. You may customize the lesson plan according to your preferences and requirements.

1. Introduce the topic by playing a micro-lecture

Play the micro-lecture (video) "[Introduction to Fertilizer](#)" by Dr. John Shields, interim director of the IFDC Research and Development Division. The tool will help you to introduce the topic of fertilizers, the different types of fertilizers and their compositions and their relative advantages and disadvantages. Use the video to explain how excess nutrients added to the soil are harmful to the environment and discuss what the consequences could be. Finally, discuss the need for using fertilizers in agriculture to feed the increasing global population.

The micro-lecture (video) can be accessed at: <https://ifdc.org/2013/03/15/introduction-to-fertilizer/>

2. Discuss the topic further by using a visualization

Explain the nitrogen cycle (with reference to agricultural practices) and supplement by using this simplified diagram "[N Cycle](#)". Discuss how nitrogen fixation in the soil occurs through natural processes and how it can be carried out artificially through the usage of fertilizers. Discuss the role of microbes in the nitrogen cycle and how bacterial actions on N fertilizers added to the soil can cause the emission of nitrous oxide (N_2O) to the atmosphere.

This diagram can be accessed at:

[http://www.ipni.net/ipniweb/portal.nsf/e0f085ed5f091b1b852579000057902e/80d63105b8462c3c85257b670057917f/\\$FILE/N%20Cycle.002.pdf/N%20Cycle.pdf](http://www.ipni.net/ipniweb/portal.nsf/e0f085ed5f091b1b852579000057902e/80d63105b8462c3c85257b670057917f/$FILE/N%20Cycle.002.pdf/N%20Cycle.pdf)

3. Explain using a visualization and the analysis of a data set

Use the visualization and associated data set "[Global warming potential of greenhouse gases over 100-year timescale](#)" to explain the global warming potential (GWP), over a 100-year time-scale, of one-unit masses of various GHGs, and specifically of N₂O, relative to that of carbon dioxide. With a much higher GWP than carbon dioxide per unit mass, students will learn that the possible impact of N₂O emissions from fertilizers on climate is more potent than that of carbon dioxide. Discuss why a small change in N₂O emissions could have a significant impact on global warming.

This visualization and data set can be accessed at: <https://ourworldindata.org/grapher/global-warming-potential-of-greenhouse-gases-over-100-year-timescale-gwp>

4. Play a video to explore possible ways to mitigate the undesired effects of fertilizer use

Play the video "[The Role of 4R Nutrient Stewardship in reducing Greenhouse Gas Emission](#)" for an overview of the need to use fertilizers in agriculture and best management practices (BMPs) to mitigate the adverse effects of fertilizer use on global warming.

The video is available at: <https://www.youtube.com/watch?v=eD2SeH8IZZw>

5. Questions/Assignments

Use the tools and the concepts learned so far to discuss and determine answers to the following questions:

- Why are fertilizers important for agriculture globally?
- What is the potential impact of fertilizer use on climate?
- How does nitrogen (N) fertilizer contribute to nitrous oxide emissions?
- What are the best practices to mitigate greenhouse gas emissions caused by fertilizer use?

3 Learning Outcomes

The tools in this lesson plan will enable students to:

- Describe fertilizers and their types.
- Describe the need for fertilizers in agriculture and in increasing food productivity.
- Assess the usage of different types of fertilizers.
- Discuss the potential effects of fertilizers on climate.
- Discuss the best practices to mitigate the potentially adverse effects of fertilizers on global warming.

4 Additional Resources

If you or your students would like to explore the topic further, these additional resources will be useful.

1. Reading (60 min)

A reading that describes, in detail, the different types of fertilizers and their usage.

<http://utbfc.utk.edu/Content%20Folders/Forages/Fertilization/Publications/PB1637.pdf>

2. Visualization (30 min)

A visualization that allows students to explore data of GHG emissions across different sectors, thereby providing insights on the GHGs that are particularly significant in agriculture.

<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#emissions-by-sector>

3. Reading (10 min)

A reading that describes the impact of agriculture on climate change in Manitoba, Canada, by using a study spanning 25 years.

<https://www.gov.mb.ca/agriculture/environment/climate-change/agriculture-and-climate-change.html>

5 Credits/Copyrights

All the teaching tools in our collated list are owned by the corresponding creators/authors/organizations as listed on their websites. Please view the individual copyright and ownership details for each tool by following the individual links provided. We have selected and analyzed the tools that align with the overall objective of our project and have provided the corresponding links. We do not claim ownership of or responsibility/liability for any of the listed tools.

1. Micro-lecture/Video, “Introduction to fertilizers”

Narrated by Dr John Shields, published by [International Fertilizer Development Centre \(IFDC\)](#)

2. Visualization, “Nitrogen Cycle”

[International Plant Nutrition Institute \(IPNI\)](#)

3. Visualization, “Global warming potential of greenhouse gases over a 100-year timescale (GWP₁₀₀)”

Hannah Ritchie and Max Roser (2018). *Published online at OurWorldInData.org.*

Retrieved from: '<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>' [Online Resource]

4. Video, “The Role of 4R Nutrient Stewardship in Reducing Greenhouse Gas Emission”

[International Plant Nutrition Institute \(IPNI\)](#)

5. Additional Resources

- [University of Tennessee Institute of Agriculture \(UTIA\)](#)
- Hannah Ritchie and Max Roser (2018). *Published online at OurWorldInData.org.*
Retrieved from: '<https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions>' [Online Resource]
- [The Government of Manitoba, Canada](#)