# Carbon in the Soil Case Study

**Purpose of Activity:** The purpose of this activity is to have students build science literacy through articles and news stories. Students are working collaboratively, such as scientists would, to analyze the information in the article and apply the information to real-life situations that are relevant to regenerative agriculture. The goal is to make connections on how soils are formed, the carbon cycle, and why that is important for agriculture. This activity relates to the following Essential Question and Student Learning Outcome:

- **Essential Question:** How is soil a valuable resource and what are humans doing to change soil quality.
- **Student Learning Outcome:** Diagram how matter cycling creates soils and determines the nutrients available. Model soil layers and examine different soil types

**Directions for Teachers:**

Print the article or have students be able to download the article into Notability (iPad) or some other app they can annotate, highlight, and answer the questions on. Have students read individually and use the following annotation and highlighting skills to analyze the text:

- Highlight new words you are unfamiliar with
- Put brackets [ ----] around sentences or paragraphs that confuse you
- Star sentences or paragraphs that help explain how soils, farming, and the carbon cycle are related. • Write comments in the margins to support or better explain the annotations used above Teachers should give examples of how to use the annotations. Perhaps read the first couple of paragraphs together and annotate together.

Once students have read the text, have them **Think: Pair: Share** with their table groups or partners. Have them compare annotations. Things to consider: Did they struggle with the same words, did the same parts confuse them, did they find the same connections of soil, farming and the carbon cycle? Have students share some of their group's conversation to the class. If multiple tables have the same confusions and struggles the teacher should address these before moving on.

Have students work with their groups or partners to answer the questions on pg 6. The last question has them practice Claim, Evidence, Reasoning writing, which may need to be taught prior or refreshed with students.

**Useful Link:**

link to the original article:
https://theconversation.com/to-make-agriculture-more-climate-friendly-carbon farming-needs-clear-rules-160243
link to the youtube video in original article: https://www.youtube.com/watch?v=AY9YVwJZDvw

# Carbon in the Soil Case Study

**Student Direction:**

Read the following article: highlight and annotate using the following annotation skills to analyze the text · Highlight new words you are unfamiliar with

· Put brackets [ ----] around sentences or paragraphs that confuse you

· Star sentences or paragraphs that help explain how soils, farming, and the carbon cycle are related. · Write comments in the margins to support or better explain the annotations used above When you are finished reading, share your annotation with a partner or your group. Compare annotations and notice if you all struggled on the same vocabulary words and concepts.

Pick concepts that your whole table struggled with to share with the class.

With your group answer the questions on pg 6 - work together to come up with a response to the last **CER** question.

## To make agriculture more climate-friendly, carbon farming needs clear rules

**theconversation.com**/to-make-agriculture-more-climate-friendly-carbon-farming-needs-clear-rules-160243

Laura van der Pol, Dale Manning, Francesca Cotrufo, Megan Machmuller

As the effects of climate change intensify and paths for limiting global warming narrow, politicians, media and environmental advocates have rallied behind "carbon farming" as a mutually beneficial strategy for society, the environment and farmers.

Agriculture covers more than half of Earth's terrestrial surface and contributes roughly one third of global greenhouse gas emissions. Paying farmers to restore carbon-depleted soils offers a tantalizing opportunity for a natural climate solution that could help nations to meet
their commitments under the international Paris climate agreement to stabilize global warming below 2 degrees Celsius.

An international initiative called "4 per 1000," launched at the 2015 Paris climate conference, showed that increasing soil carbon worldwide by just 0.4% yearly could offset that year's new growth in carbon dioxide emissions from fossil fuel emissions.

A free-range pig at the Stone Barns Center for Food and Agriculture in New York. Raising livestock and crops together can boost soil carbon through the animals' grazing patterns and natural manure distribution. Francesca Cotrufo, CC BY-ND

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Research shows that farmers and ranchers can also make their operations more resilient to increasingly variable weather by adopting practices that promote soil carbon sequestration. This prospect led us to establish a center at Colorado State University that develops and implements soil-based solutions to climate change.

While many policy options exist to reduce emissions from agriculture, carbon farming has sparked bipartisan U.S. legislation and attracted investors' attention. Critics question its true potential, however. Some environment and justice advocacy groups argue that paying farmers won't do much to increase soil carbon, and could allow polluting industries such as manufacturing to avoid necessary emission reductions by buying soil carbon credits from farmers instead.

Given the momentum behind carbon farming as a climate change mitigation strategy, we believe now is the time to establish clear standards that ensure that only real net changes in carbon receive financial rewards.

## Carbon farming basics

As plants grow, they pull carbon from the atmosphere, and soil soaks it up and stores it. The amount of carbon stored varies significantly across soil type and climate.

Traditional farming methods that sequester carbon have existed for millennia. For example, minimizing soil disturbance through no-till farming reduces carbon loss to the atmosphere. Diversifying crops and planting legumes, perennials and cover

crops returns more carbon to the soil, and sustains soil microbes that play key roles in carbon storage.

Another climate-friendly strategy is raising livestock and crops together. Rotating cows among pastures allows grasses to recover from grazing, and the animals' manure and the impacts of their grazing regenerate carbon in soils.

Some farmers use these practices, which often are called "regenerative agriculture," particularly in Black and Indigenous communities that have been excluded from access to capital and government subsidies.

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deep roots of Kernza, a perennial grain, reduce erosion, help the plant tolerate drought and add soil carbon deeper in the ground than shorter-rooted annual grains. Kernza, the first commercially viable perennial grain in the U.S., was developed by The Land Institute, based in Salina, Kansas. Francesca Cotrufo, CC BY-ND

## Soil: A low-cost solution

Increasing soil carbon through techniques like no-till is relatively inexpensive. Studies estimate that carbon farming costs US$10-$100 per ton of $CO_2$ removed, compared with$100-$1,000 per ton for technologies that mechanically remove carbon from the air.

Carbon farming is also a potential revenue stream for farmers and ranchers, who can sell the credits they earn in carbon markets. Large-scale greenhouse gas emitters, such as manufacturers, purchase these credits to offset their

own emissions.

Companies such as IndigoAg and Nori are already facilitating payments to farmers for carbon credits. And on June 24, 2021, the U.S. Senate passed the Growing Climate Solutions Act of 2021 by a vote of 92-8. The bill would authorize the U.S. Department of Agriculture to help farmers, ranchers and private forest landowners participate in carbon markets.

So far, however, there are no universal standards for measuring, reporting or verifying agricultural carbon credits. Here are the questions we see as top priorities.

## Assessing carbon storage

One major challenge is that soils absorb varying amounts of carbon depending on depth, texture and mineral content. While certain practices increase carbon storage, quantifying how much is stored and for how long is critical for assigning dollar values to them. The markets and practices that work in different locations also vary widely.

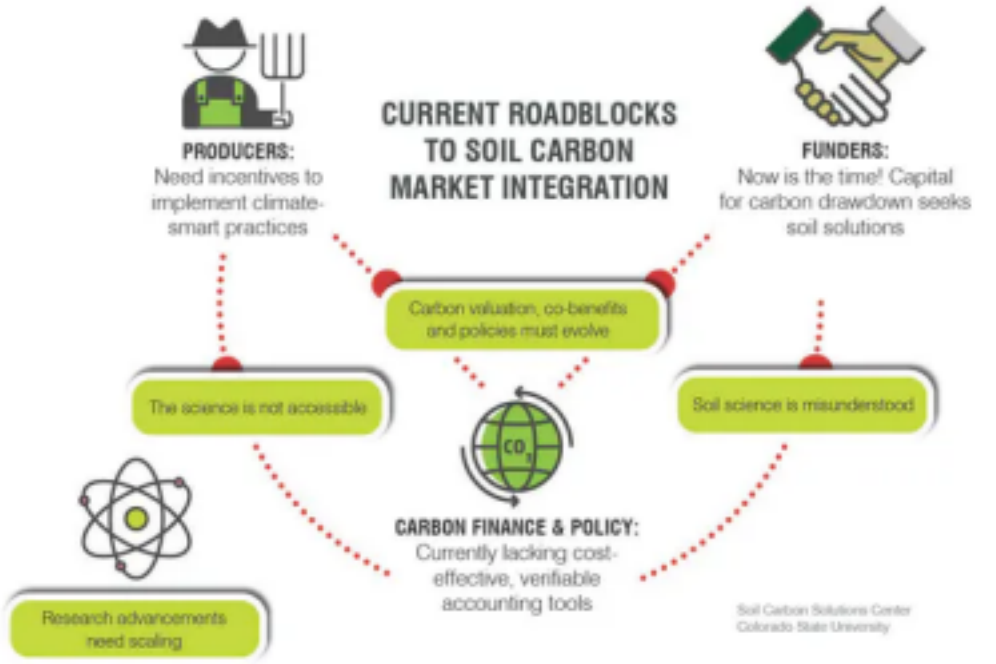
Some scientific models offer estimates of carbon sequestration for various climates and soil types based on averages over large areas. We believe that regulators need rigorous models verified by measurements to avoid crediting carbon that never ends up in soil or doesn't remain there for long.

But verification isn't easy. Scientists are still searching for quick, accurate, cost-effective ways to sample and analyze soils.

Possible approaches include infrared spectroscopy – which identifies materials in soil by analyzing how they absorb or reflect infrared light – or machine learning, which can find patterns in large data sets quickly. Studies conducted in the U.S. Great Plains, the United Kingdom and the European Union suggest these are promising, low-cost methods.

Another priority is developing national minimum standards to predict and properly value soil carbon capture. Carbon may reside in soil anywhere from days to millennia, so time scale is an important consideration for markets. In our view, credits should reflect the duration carbon resides in soil, with full offsets generated only for longer-lasting storage.

We also believe that these programs must consider an operation's net greenhouse gas emissions. For example, practices may store more carbon in soil but also increase emissions of nitrous oxide, another greenhouse gas.





## Benefits and challenges

Rebuilding carbon-rich soil supports farmers' bottom lines by improving soil health and increasing crop yields. But federal incentives could preferentially provide resources to big operations that have greater ability to sequester carbon on their vast acreage.

That’s been the case with U.S. farm subsidies: Over the past 25 years, 10% of the largest farms received 78% of subsidies.

Since these practices benefit farmers, some may use them even without policy incentives. As we see it, to avoid paying for soil carbon increases that would have occurred anyway, carbon banks should avoid crediting farms for adopting practices known to be profitable in their regions.

Ultimately, the goals of climate policy include curbing greenhouse gas emissions and actively removing carbon dioxide from the atmosphere. Before farmers receive soil carbon credits they can sell to offset other sources of emissions, we believe their value must be accurately assessed to ensure that society gets what it pays for.

*Editor’s note: This article has been updated to reflect that IndigoAg does not purchase carbon credits.*

# Analysis Questions

Directions: Answer the following questions with your group:

1. Is the article a reliable source of information? Provide 2 pieces of evidence that supports this article is reliable.
    a. use the link to the original article:

https://theconversation.com/to-make-agriculture-more-climate-friendly-carbon-farming-needs-clear-rules-160243

2. Based on the article and what you have learned from class, how does carbon get into the soil?

3. Why is it a good thing that carbon is stored in soil?

4. What are processes that remove carbon from the soil? Where does it go?

5. What are the impacts on the environment of carbon being released from the soil?

6. How are farmers changing agricultural practices so they can store more carbon in the soil?

7. What new technologies are being developed in agriculture in order to make farming better for the environment?

8. What are the cost benefits of storing carbon?

9. What is one big question you still have about carbon and soil?

10. There is a farmer in your town that has been tilling his lands every year before planting. His soil is bare with no cover crops and is susceptible to wind and water erosion. Over the past couple of years, the farmer has noticed that his crop yields have declined and he is losing money.

Write this farmer a **letter** explaining the issues of his farming practices and suggest what he might do to increase his crop yields and his income. Make a **claim** for what this farmer needs to do, back it up with **evidence** from the lesson and the article, then explain the **reason** WHY your evidence is good and WHY he should change his practices.