K-STATE Research and Extension

Top 10 Questions about Carbon and CO_2 in Agriculture

Department of Agronomy MF3120 Climate and Agriculture

Q. *Isn't carbon dioxide (CO_2) necessary for plant life? Why is it considered to be a problem?*

A. Yes, CO_2 is necessary for photosynthesis, which produces the organic source of energy for most plant life. The amount of CO_2 in the atmosphere is what causes the concern. Only about 16 percent of the total amount of CO_2 in the atmosphere is absorbed by plant life on Earth in any given year, and almost all of that is recycled back into the atmosphere through plant and animal respiration. This increase in CO_2 concentrations has not increased the amount of plant growth on Earth since CO_2 is not the limiting factor for plant growth in most cases. Unfavorable temperatures, deficiencies and excesses of soil moisture, soil nutrient deficiencies, insect infestations, and disease infections are the primary factors limiting plant growth.

In some cases, such as in controlled environments, plants are more productive when CO_2 levels in the air are increased. In these cases, temperatures can be kept constant and water is adequate. If temperatures or water availabilities are not optimal, the higher CO_2 levels do not increase yields, even in controlled environments. In the "real world," plants have more CO_2 than they can use.

Q. *What is meant by "soil carbon sequestration"?*

A. Carbon sequestration is any process that captures CO_2 and either takes it out of the atmosphere for a long period of time or prevents it from being emitted into the atmosphere. Essentially, soil carbon sequestration is the process of transforming CO_2 into stored soil carbon. Carbon dioxide is taken up by plants through the process of photosynthesis and incorporated into living plant matter, both aboveground and belowground. As plants die, the carbon-based leaves, stems, and roots decay in the soil and become soil organic matter. Keeping that soil organic carbon in place for many years is one form of carbon sequestration.

Q. *What is soil organic matter? Where does it come from and where does it go?*

A. Soil organic matter consists of decomposed plant and animal matter. It helps bind soil mineral particles together into clumps, called soil aggregates. Higher levels of soil organic matter lead to more stable soil aggregates, better water infiltration capability and aeration, better water holding capacity, more resistance to wind erosion, reduced potential for compaction, and better overall soil fertility. Organic matter helps hold soil nutrients in place so they are not lost to runoff or leaching. If left undisturbed, soil organic matter can eventually be transformed into long-lasting humus, a stable form of organic matter. If the soil is tilled, however, soil organic matter will be oxidized and carbon will be lost to the atmosphere as CO_2. If the soil erodes, organic matter will be removed with runoff water or as particulate matter in the wind.

Q. *What affects the level of soil organic matter?*

A. Native levels of soil organic matter for any particular site are determined largely by the latitude, location, and annual precipitation received. Native soil organic matter levels generally increase as you move either north or south from the equator and as precipitation amount increases. Land management practices can change native soil organic matter level. As cropping intensity increases, soil organic matter tends to increase. As tillage frequency increases, soil organic matter tends to decrease.

Q. *How can soil carbon sequestration help mitigate climate change?*

A. Atmospheric CO_2 and other greenhouse gases trap heat reflected from the Earth's surface. This buildup of heat could lead to global warming. Atmospheric CO_2 levels are reduced as soil organic carbon levels are increased through carbon sequestration. If soil organic carbon is undisturbed, it can remain in place for many years as stable organic matter. This carbon is then sequestered, or removed from the pool available to be recycled to the atmosphere.

Q. ***Isn't water vapor a more common and more powerful greenhouse gas than CO_2?***

A. Yes. But the amount of water vapor in the atmosphere is beyond the control of humans.

Q. ***How much CO_2 could be sequestered by agricultural soils and trees in Kansas?***

A. Potentially, about 10 to 15 million tons of CO_2 per year could be sequestered by agricultural soils in Kansas if all the acreage was under optimal management practices for soil carbon sequestration. Another 10 to 15 million tons of CO_2 per year might be sequestered in trees and non-cropland grasslands in Kansas.

Q. ***How much CO_2 could potentially be sequestered by agricultural soils and forestry together in the United States? How does this compare to emission levels?***

A. There are about 300 million acres of cropland in the United States. If all of those acres were sequestering carbon at the rate of 270 pounds of carbon per acre per year, that would be a little more than 40 million tons of carbon per year. This assumes all cropland in the United States is in no-till and sequestering carbon at the rate of 0.5 tons of CO_2 per acre per year – and this is unrealistic. A more realistic goal might be for 25 percent of the cropland in the United States to be in no-till production.

Total U.S. carbon emissions for 2012 were estimated to be 5.2 gigatons (or 5,200 million tons), according to the U.S. Energy Information Agency.

Q. ***What are some of the agricultural practices that can increase soil carbon?***

A. There are several agricultural and forestry practices that can increase carbon sequestration.

- Continuous no-till.
- Increased crop biomass production.
- New grass plantings.
- Soil conservation.
- Improved grazing management methods.

Q. ***Are there other benefits to increasing soil carbon?***

A. Agricultural practices that increase soil organic matter also:

- Improve soil structure and quality,
- Improve soil productivity through increased organic matter,
- Reduce erosion through improved soil structure, and
- Improve water quality through reduced erosion.

Focusing on the goal of increasing soil organic matter levels is perhaps the most effective way to achieve all of these objectives. Increasing organic matter levels improves not only soil quality, but also increases short- and long-term soil productivity, improves water quality, increases the sustainability of the ecosystem, and increases the economic value of the land.

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For more information about greenhouse gases, carbon, climate, and agriculture, see *Greenhouse Gases in Agriculture*, MF3119. This and other publications are available at *www.ksre.ksu.edu.*

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