Beef Production and Carbon Sequestration

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Carbon is essential for life and one of the most common elements on earth. Carbon sequestration refers to the long-term capture and storage of carbon from the atmosphere (typically as carbon dioxide, CO_2). Enhancing biological carbon sequestration in soil and plants is a promising method of reducing greenhouse gas (GHG) concentrations in the atmosphere and combating climate change. Anthropogenic or human activities such as burning fossil fuels and land use changes (e.g., deforestation and the tillage of native grasslands for crop production) have led to an increase in atmospheric concentrations of CO_2 (a GHG) since the beginning of the industrial revolution. Carbon dioxide atmospheric concentrations have risen from their pre-industrial level of 280 parts per million (ppm) to more than 400 ppm today[1]. The increase in concentrations of CO_2 and other GHGs in the atmosphere has contributed to global climate change and variability.

The carbon cycle (Figure 1), like any other naturally-occurring process, involves a cyclical recycling, storage and use of a resource in different states. Carbon is stored in reservoirs, such as oceans, soil and vegetation. Plants take in sunlight and carbon dioxide to synthesize carbon-containing sugars and other carbohydrates during photosynthesis. Plants, animals (including humans) and soil microbes consume molecules containing carbon for energy and release some of the carbon back into the atmosphere in the form of CO_2 during the process of aerobic respiration. Organic carbon from animal waste and decaying plants is stored in the soil. Whenever soil is disturbed and exposed to the air, it releases stored carbon back into the atmosphere. Carbon also is released into the atmosphere from anthropogenic activities, such as burning fossil fuels (which are reservoirs of carbon in another form).

Many different agricultural production practices can capitalize on carbon sequestration in both soil and biomass to reduce environmental impact. The goal of these methods is to modify current production practices in a way that enables the use of the natural carbon cycle to replenish carbon stores, while reducing the amount of carbon in the atmosphere[1]. Restorative agricultural production practices have the potential to decrease atmospheric carbon and reverse some of the effects of climate change[1,2]. One example of a restorative practice is no-till crop production, where farmers do not turn

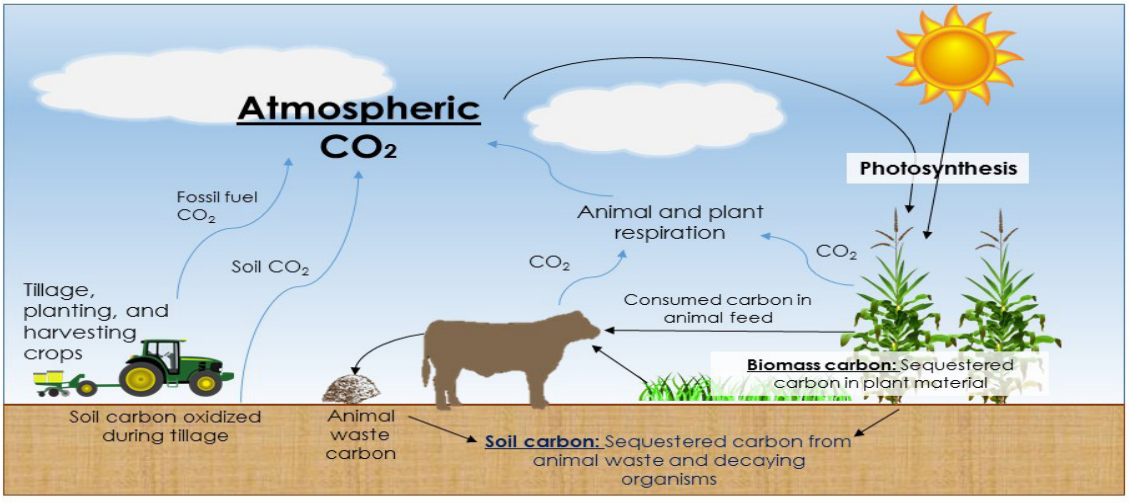

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Figure 1. Carbon cycle demonstrating both additions to and removal of atmospheric carbon dioxide (CO_2)

over or till the soil (commonly done to reduce weed growth) in preparation for planting the next round of crops[3]. Some no-till cropping systems also incorporate cover crops, which involves planting a secondary crop that will not be harvested (such as turnips), but can be utilized for grazing beef cattle, controlling weed growth, reducing erosion and enhancing soil organic matter[2].

In addition to using cover crops, beef production can intersect with carbon sequestration by producing a nutritious food product for humans by utilizing grasslands that can store a large amount of carbon. Research examining the effects of grazing on soil organic carbon storage in North American rangelands has found impacts ranging from no change to up to 268 pounds of carbon per acre per year[4]. The variability in the impact grazing can have on carbon sequestration on rangelands, pastures and grasslands is due to differences in grazing management (e.g., stocking density or the number of cattle grazed per acre), fertilization and the land's prior use[4]. While changes in carbon sequestration due to grazing or other management decisions may be relatively minor on a per acre basis, those changes can translate into large impacts if implemented on a large scale due to the number of acres of grassland in the world. Globally, if soil organic carbon in agricultural and grasslands could be increased 10 percent during the 21st century, the atmospheric concentration of CO_2 could be reduced by 110 ppm[1]. Beside the potential for grazing to increase the capacity of soil carbon sequestration in certain cases, grazing beef cattle and other ruminants provide economic and societal value from pasture and grasslands. That economic and societal value can preserve and prevent untilled land from being cultivated, and reduce soil erosion (another environmental benefit) while producing human food and other products (e.g., leather)[2].

Pasture and grasslands represent 27 percent of the land area[5] in the U.S., and avoiding the conversion of this land to tilled cropland and residential uses could prevent further increases in GHG concentrations. Additionally, establishing permanent pastures for grazing beef cattle on degraded croplands (lands currently tilled, but poor quality) can sequester carbon at rates comparable to forests.[2] Most beef cattle in the U.S. spend the majority of their lives on pastures and grasslands. For beef cattle finished in a feedlot, approximately 65 to 85 percent of their life will be spent grazing. For grass-finished beef cattle and beef cows, up to 100 percent of their life may be spent grazing. Regardless of the beef production system, enhancing carbon sequestration through well-managed beef cattle grazing systems and improved feed production practices (e.g., no-till systems, using cover crops) can reduce the carbon footprint of beef and contribute to the reversal of global climate change.

Summary

Carbon sequestration is the long-term storage of atmospheric carbon in soil and plants. There are many different techniques to achieve carbon sequestration, including reducing tillage of soil and establishing permanent grasslands. Beef cattle production systems can play an important role in carbon sequestration through the production of human food from untilled pastures and grasslands, and the integration of cattle grazing into no-till cropping systems.

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