The Carbon Cycle

Carbon constantly cycles through five pools on planet Earth. Light energy coming from our sun functions as the fuel for the carbon cycle. The carbon cycle is a critical natural process that moves carbon through our atmosphere, biosphere, pedosphere, lithosphere, and hydrosphere.

Human activity has tipped the balance of the carbon cycle through using deeply sequestered fossil carbon as fuels. These dense forms of carbon, when burned, release massive amounts of stored solar energy and carbon dioxide.

More carbon dioxide is now being released from our combustion of fossil fuels than the earth’s plant life and ocean waters can absorb. The excess carbon dioxide has formed a blanket in our atmosphere—trapping the sun’s heat and changing our climate, as seen in shifts in our earth’s jet stream, ocean currents, and air temperature. Rainfall patterns are changing and glaciers (water storage for many communities) and polar ice caps are melting quickly.

We have an opportunity to restore balance within the carbon cycle in a way that will ameliorate climate change, build resilience to drought and increase our agricultural productivity naturally. This document is an introduction to a natural solution called Carbon Farming.
Why Carbon Farming?

Land management is the second largest contributor to carbon dioxide emissions on planet Earth. Yet, land management has the ability to transform itself from a net emitter of CO$_2$ to a net sequesterer of CO$_2$.

Common agricultural practices, including driving a tractor, tilling the soil, over-grazing, using fossil fuel based fertilizers, pesticides and herbicides, result in significant carbon dioxide release. Alternatively, carbon can be stored long term (decades to centuries or more) beneficially in soils in a process called soil carbon sequestration. Carbon Farming involves implementing practices that are known to improve the rate at which CO$_2$ is removed from the atmosphere and converted to plant material and/or soil organic matter.

Carbon farming is successful when soil carbon gains resulting from enhanced land management and/or conservation practices exceed soil carbon losses.

Compost Protocol

Research by Marin Carbon Project scientists indicates that a single application of a half-inch layer of compost on grazed rangelands can significantly increase forage production (by 40-70%), increase soil water holding capacity (by roughly 26,000 liters per hectare), and increase soil carbon sequestration by at least 1 ton per hectare per year for 30 years, without re-application. Compost provides a source of energy to the soil ecosystem, and improves soil moisture conditions, which leads to increased plant growth. More plant growth leads to more carbon dioxide being removed from the atmosphere through the process of photosynthesis, leading to increased transfer of carbon dioxide through the plant to the soil as roots, root exudates and detritus, yielding additional soil carbon and water holding capacity, in an ascending spiral of soil carbon increase, all from one initial compost application.

Implications for Our Climate

Sequestration of just one metric ton of carbon per hectare on half the rangeland area in California would offset 42 million metric tons of CO2e, an amount equivalent to the annual greenhouse gas emissions from energy use for all commercial and residential sectors in California.

The Role of Grasslands

Initial Marin Carbon Project research was conducted on actively grazed rangelands. There are 23 million hectares of rangeland in California alone, and it is the largest land cover type on our planet. Grasslands co-evolved with grazing animals over millions of years. Properly scaled in space and time, grazing stimulates plant growth through a variety of mechanisms, resulting in increased carbon capture by the grazed ecosystem. Because of their vast geographic extent, grasslands have great potential to function as a sponge for carbon dioxide from our atmosphere. However, in trials where grazing alone was compared with grazing plus compost, the grazing-only plots continued to lose more carbon than they sequestered, suggesting that grazing alone may not be a sufficient strategy to increase carbon capture in these ecosystems. Test plots where compost was applied showed net carbon sequestration gains. Not only has compost application on grazed grasslands been demonstrated to be an effective way to increase soil carbon sequestration, composting is a proven method for avoiding emissions related to the anaerobic decomposition of organic waste material in landfills.

Efforts are now underway to support the financial incentivizing of this practice for the benefit of both landowners and the climate. The non-profit organization known as the American Carbon Registry (ACR) has approved a voluntary methodology for greenhouse gas emission reductions from compost additions to grazed grasslands. The ACR is a leader in creating high standards and protocols and has issued 37 million carbon offsets since its inception. The California Pollution Control Officers Association (CAPCOA) has also adopted the protocol, opening the door for the practice to serve as CEQA offsets in the context of local Climate Action Plans.

In Addition to Compost...

Preliminary Carbon Farm Practice List
(The majority of these practices were selected from the USDA-NRCS GHG Ranking Tool and COMET-Planner)

- Compost application
- Residue and Tillage Management, No Till/Strip Till/Direct Seed
- Anaerobic Digester
- Multi-Story Cropping
- Windbreak/Shelterbelt Establishment
- Silvopasture Establishment
- Forage and Biomass Planting
- Nutrient Management
- Tree/Shrub Establishment
- Forest Stand Improvement
- Contour Buffer Strips
- Riparian Restoration
- Riparian Forest Buffer
- Vegetative Barrier
- Windbreak/Shelterbelt Renovation
- Alley Cropping
- Riparian Herbaceous Cover
- Range Planting
- Herbaceous Wind Barriers
- Critical Area Planting
- Residue and Tillage Management
- Forest Slash Treatment
- Filter Strip
- Grassed Waterway
- Hedgerow Planting
- Cross Wind Trap Strips Conservation Cover
- Wetland Restoration