Carbon Farming
Can Be A Big Contributor To Carbon Neutrality

MOM Foundation

Abstract

To combat climate change and reduce greenhouse-gas emission, abundant resources are being put into clean energy, renewable energy, and other related technologies, but without certainty being guaranteed.

Carbon farming, though still at a very early stage of exploration and with a lot of unknown, can be a potentially big contributor to help reduce carbon emission and mitigate climate change. At the least, carbon farming can help farmer improve soil quality, increase farm productivity and thus profitability.

In this paper, we first look at what carbon farming is all about, and as a whole-farm approach, how it can drive a system change in agriculture - reversing its leading position as a contributor to global carbon emissions and transforming it to a net sink. Though at a preliminary development stage, the combined activities of education, knowledge transfer, soil restoration and product-yield improvement, together with carbon-credit development, recognized practice and appropriate incentive for stakeholders, the agriculture community can help reduce or offset emissions through the practice of carbon farming.

The Movimiento Organico Mexicano Foundation (M.O.M.) is starting this movement by bringing awareness to the farmers and the agricultural value chain. There is a good Chinese saying, "Journey of a thousand miles begins with a first step." M.O.M. is bringing about the awareness of carbon farming and its potential benefit to humankind in our embarkment of this sustainability journey.

With the help of experts and conscientious people, M.O.M. contributes to the repair of the environment, researching, disseminating, and acting in such a way that we transform the educational, cultural, economic, and spiritual processes that allow us to complete the ecological cycle of life on the planet.
Email: info@mom-mundo.org

Overview

Agriculture and forestry practices account for at least 24 percent of global carbon emissions. Under current land management practices, agriculture remains one of the leading contributors to global carbon emissions. However, it is the only economic sector with the potential to transform itself from a net carbon emitter to a net sink using practices broadly classified as "carbon farming."

Carbon farming practices can help remove carbon dioxide from the atmosphere, and store it for long periods of time in soil, microorganisms, and plant matter. Climate scientists estimate that 200 billion tons of carbon dioxide would need to be removed from the atmosphere to halt and begin to reverse the effects of climate change. The world's agricultural soils can meet this challenge if we change the way we grow food.

According to a study by The National Academy of Sciences, "global farmland could capture and store as much as 3 billion tons of additional carbon dioxide if farmers adopted a number of improved practices, including adding organic matter like manure or compost, shifting cultivation to favor crops that contribute more of their carbon to the soil, or using offseason to plant cover crops."

I. Carbon Farming and Its Benefits

What is Carbon Farming?

Carbon farming is a broad set of agricultural practices across a variety of farm types that result in increased storage of atmospheric carbon in the soil. Many of these practices are common in organic farming, regenerative agriculture, permaculture, and other approaches to food production.

When plants photosynthesize, they remove carbon dioxide from the atmosphere and store it. When they die, this carbon is either released back into the atmosphere or it is stored for long periods of time in the soil. Many conventional agriculture practices result in the release of carbon, while practices classified under carbon farming aim to do the opposite.

Some examples of practices that farmers or gardeners can employ to help sequester carbon and improve soil health include:

- Leftover biomass is returned to the soil as mulch after harvest instead of being removed or burned.
- Conventional tillage practices are replaced by conservation tillage, no till, and/or mulch farming.
- Cover crops are grown during the off-season instead of leaving croplands bare.
- Continuous monocultures are replaced by high-diversity crop rotations and integrated farming practices.
- Intensive use of chemical fertilizers is replaced by integrated nutrient management and precision farming.
- Intensive cropping is replaced by croplands integrated with trees and livestock.
- Surface flood-irrigation is replaced by drip, furrow, or sub-irrigation.
- The indiscriminate use of pesticides is replaced by integrated pest management techniques.
- Marginal and degraded soils are restored to their natural states instead of being used as cropland.

Many of these practices can be used in combination with one another or applied one at a time. Almost all crop land can be improved with these practices and more.

Benefits of Carbon Farming

In addition to offsetting emissions, carbon-farming practices have the added benefits of restoring degraded soils, enhancing crop production, and reducing pollution by minimizing erosion and nutrient runoff, purifying surface and groundwater, and increasing microbial activity and soil biodiversity.

The added benefits of carbon farming mean that more food can be produced with less pollution while building soil and sequestering carbon dioxide. If accomplished at a large enough scale, carbon-farming practices have the potential to begin to reverse the catastrophic effects of climate change. Promoting and growing the use of these practices is one of the best avenues for meeting carbon-emissions-reduction goals and mitigating climate change.

II.Carbon Farming is A Whole-Farm Approach

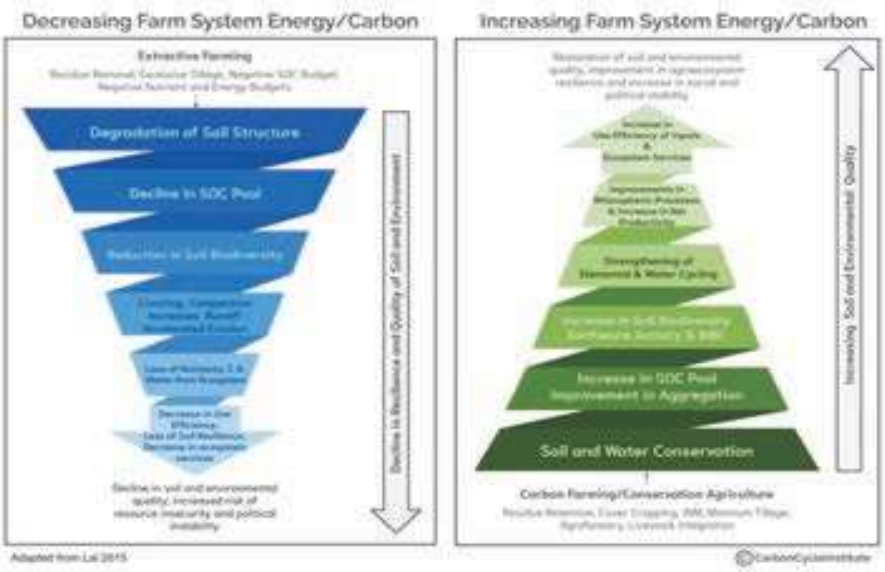
Carbon farming as a whole-farm approach is to optimize carbon capture on working landscapes by implementing practices that are known to improve the rate at which CO2 is removed from the atmosphere and stored in plant material and/or soil organic matter. Carbon farming is a framework for engaging with the agroecosystem processes that drive system change.

Carbon is the Carrier of Energy within the Farm System

Carbon farming explicitly recognizes that it is solar energy that drives farm ecosystem dynamics and that carbon is the carrier of that energy within the farm system. Carbon farming is synonymous with the term "regenerative agriculture" when that term is explicitly rooted in an understanding of the underlying system dynamics and positive feedback processes that actually make a "regenerative" upward spiral of soil fertility and farm productivity possible, as depicted

in Figure-1.

Figure-1: Regenerative Agriculture

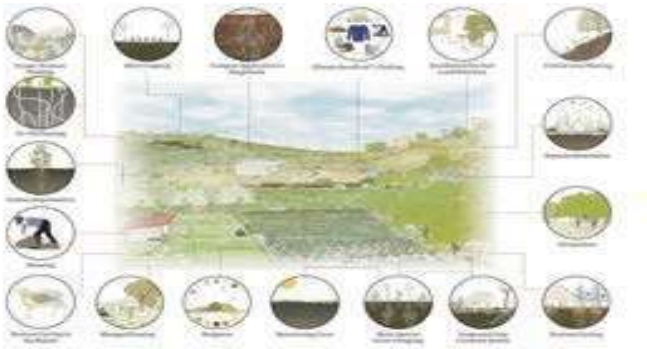


Aldo Leopold defined soil fertility as the "ability of the soil to receive, store and release energy," a succinct definition of "soil health." Recognizing that carbon is the energy currency of living systems - as the medium through which solar energy enters and radiates throughout the food web and the farm system - carbon farming focuses on opportunities for increasing the capacity of the farm system to "receive, store and release" that energy; as work, as system processes, and as biological and structural diversity within the farm ecosystem, particularly recognizing the critical role of soil organic matter as both a sink for solar energy and as driver of both soil and overall agroecosystem dynamics. Carbon farming is successful when carbon gains resulting from enhanced land management and/or conservation practices exceed carbon losses.

Carbon Farming Practices

Carbon farming practices are management practices that are known to sequester carbon and/or reduce greenhouse gas (GHG) emissions. At least 35 of these practices are identified by the Natural Resource Conservation Service (NRCS) as conservation practices that improve soil health and sequester carbon while producing important co-benefits, including: increased soil water holding capacity, hydrological function, biodiversity, and resilience. See Figure-2.

Figure-2: Carbon Farming Practices



Source: Carbon Cycle Institute, *https://www.carboncycle.org/what-is-carbon-farming*

But, there is still a lot we do not know about the extent of carbon farming and how it benefits sustainability efforts to mitigate climate change.

Noah Deich, Executive Director of Carbon180: "There are still a lot of unknowns about how soil microbe ecosystems actually work and what practices are most effective at capturing and storing carbon dioxide."

Tim Searchinger, Princeton Researcher: "There may be limits on what farmers can do to change their soil management practices. And, we still don't know how much more carbon farmers can store in soil that is continually farmed."
David Stark, President of Holganix Agriculture: "While there is a lot we still don't know about carbon farming, we do know that incorporating carbon farming practices improves soil health which can improve crop yield and farm profitability. We also know that carbon farming practices can promote a farm's sustainability practices."

III.Increase Farm Profitability
Farmers are beginning to look into carbon farming as a method to increase farm profitability, improve soil quality, and to help combat climate change.

According to an article by AgProfessional, "the global carbon market is estimated at US$160 billion." Indigo Agriculture has stated publicly that it believes there is a US$15 trillion opportunity to sequester carbon for farms.

Regardless of the size of the market for carbon sequestration, most experts agree that the practices that sequester carbon also happen to be better for the overall health of the soil. Practices like no-till/strip-till, sub-surface application of nutrients, and the use of cover crops among others, help increase organic matter, reduce erosion, and improve soil resilience in addition to sequestering carbon. They are all positive for the long-term health of the soil.

In addition to improving soil quality which could translate to improved yield, farmers could be paid carbon credits by private companies or government agencies to promote the practice, ultimately providing additional revenue to the farm.

<u>Carbon-Market Participation</u>
As for all markets, carbon markets require buyers and sellers:

- A buyer of carbon offsets would be an entity needing to reduce or offset emissions. The largest buyers of carbon offsets are likely to be the largest emitters, such as power plants, transportation companies, and industry as a whole.

- Potential sellers come from various sources such as agricultural farms and ranches, wind farms, and hydroelectric plants, among others.

In general, suppliers of GHG offsets can sell their offsets through direct contracts with buyers or through a carbon exchange. A potential hurdle for agriculturists to participate in the carbon exchange is to meet the minimum entry requirements (a minimum of certain CO2e may mean an acreage that few may own), which means that they have to work with an aggregator (an entity that pools or aggregates producers and combines carbon credits from agricultural offset projects initiated by farmers, ranchers, and private forest owners).

There are two main categories of carbon markets: voluntary markets and compliance markets. Voluntary carbon markets serve businesses and individuals who wish to offset some or all of their GHG emissions to accomplish business or personal sustainability goals but who are not legally required to do so. Compliance carbon markets serve regulated entities that are legally required to reduce their GHG emissions.

How Agriculturists can Reduce or Offset Emissions

Farmers and ranchers can participate in the offset process by either reducing emissions or by capturing and storing emissions. In fact, most tonnage of potential soil-carbon storage come from forest management activities - avoided grassland conversion to cropland, and planting cover crops.

To reduce emissions, producers can:

- decrease fertilization
- alter manure management
- reduce fuel consumption
- change feeding practices
- switch to alternative fuels, such as from coal to natural gas or bioenergy
- produce biofuels feedstock
- implement rotational grazing programs

Agriculturists can also capture and store emissions in a process called sequestration. One type of sequestration is biological sequestration, which uses the characteristics of plants to capture emissions. Agricultural forms of biological sequestration include:

- changes in tillage practices
- crop rotations
- conversion of acreage to grasslands
- afforestation - planting of trees or seeds to change open land into forest or woodland

A practice that both reduces and sequesters emissions is the reduction of stocking rates.

However, these activities are costly, and producers must have an economic incentive to change their production practices to participate in the carbon market.

Three Key Things for a Farm to Earn Carbon Credits

In the United State, for a farm to get ready to earn carbon credits, attention should be paid to these three things: the impact of capturing farm data, how carbon credits affect lease income, and the evolving value of carbon credits.

1. Capturing Farm Data: Having good records and accurate data is the gateway to participating in carbon markets. Carbon markets work by rewarding the implementation of practices that sequester more carbon than the status quo. To earn a credit, a farmer or landowner must prove that they have implemented a practice that sequesters carbon, underscoring the importance of capturing quality farm data.

2. Impact of carbon credits on lease income: How to incorporate the revenue from carbon credits into the farm lease agreement depends on what type of lease arrangement the landowner has with the farmer.

3. Evolving value of carbon credits: The long-term success of carbon markets is unknown, but they are gaining substantial momentum and most industry players now offer some type of solution. More importantly, the practices that carbon credits promote will have a very real impact on the value of the farm with an increased focus on the long-term benefits that they create. A more resilient farm with high organic matter should sell for more because it is more productive and has lower-input costs.

It is important to note that there is a key drawback of agricultural carbon credits in leased cropland because when the carbon contract expires, the land can be plowed up and the stored carbon released back into the atmosphere. One

solution at the moment is to sign long-term agricultural carbon contracts - 10-20 years or more. As for forests, the issue is not as acute because they are managed on a longer timeframe than cropland.

IV.Agricultural Carbon-Credit Market Today

"How to Grow and Sell Carbon Credits in U.S. Agriculture" is a report released by Iowa State University Extension and Outreach, updated in November 2021: a set of 26 questions based on conversations with farmers and agricultural stakeholders was developed, and answered based on publicly available information collected via online search and interviews with representatives from some of the 11 carbon programs.

The report summarized its findings as follows:

• The emerging agriculture credits market can be currently characterized as an unarticulated patch of coexisting programs with different rules, incentives, and penalties, rather than as a cohesive and transparent market where the same activity has the same implication across programs.

• In its formative stage, the incipient agriculture credits market is very dynamic, focused on testing protocols through small-scale pilot programs, and lacks transparency and liquidity. While all programs require additionality to generate a credit, not all programs require that farmers change their production practices.

• Additionality means that farmers must do something different to reduce carbon and increase ecosystem services. However, programs use a wide array of benchmarks to determine what is different. Some programs require a change of practices with respect to past practices on the same field, while some others require that practices in the field be different from common practices in the area (even if the same practices have been implemented for many years in the field under consideration).

• With the exception of Bayer Carbon, which compensates farmers for implemented practices, all other programs compensate farmers for carbon-credit generation.

For farmers to participate in the carbon-credit market more confidently, there should be some sort of standardization of equivalences for farming practices across initiatives, with the introduction of transferable partial-and-full-credits across protocols, so that the farmers' risk can be better mitigated.

Iowa State University Extension and Outreach's market assessment is echoed by J. David Aiken in his April 21, 2021 Agricultural Economics article, titled "Ag Carbon Credits." Aiken noted that the agricultural carbon-credit market today is "the wild, wild west" with no rules or regulations exist. The two largest players in the market, he pointed out, are speculators and pilot-project developers.

Aiken described speculators as people who are attempting to contract as many acres as they can with the expectation that carbon market will explode in the next few years and they will sell their carbon credits at a large profit. Pilot projects are being developed by several different groups, many with agribusiness partners or connections. The basic idea is to sign up some acres and use them as a test to develop the soil carbon-storage information to credibly document that the improved management practices have sequestered more carbon in the farm or ranch land. These firms or groups want to be the intermediary between ag producers and carbon markets or carbon-credit buyers over the long haul.

V. Going Forward

Great attention is placed in replacing conventional energy sources with clean energy and renewable energy, carbon-capture-and-storage technologies, and others, which demand time and huge financial resources but involve much uncertainty. Great emphasis is also put in GHG emission and manufacturing, while a very basic element in our everyday

life - farming and GHG emission - is mostly overlooked.

Rodale Institute's research, "Regenerative Organic Agricultural and Climate Change," suggested that the "Net Zero CO2" discussion should be redirected from the "swarm" to the "simple." An obvious and immediately available solution, it noted, is to put the carbon back to work in the terrestrial carbon "sinks" that are literally right beneath our feet.

Agriculture and forestry practices account for at least 24 percent of global carbon emissions. Under current land-management practices, agriculture remains one of the leading contributors to global carbon emissions. However, it is the only economic sector with the potential to transform itself from a net carbon emitter to a net sink using carbon farming. While experts noted that there are still a lot we do not know about carbon farming, we do know that incorporating carbon-farming practices improve soil health which can improve crop yield and farm profitability.

The United States government, institutions and businesses are starting to explore how they can help the farmers improve their yields, restore the land, and sell farm carbon credits. No other country is known yet to have put in much effort in this area.

The United Nations is expecting the world population to increase by 2 billion people in the next 30 years to reach 9.7 billion in 2050. With limited availability of arable land and increasing demand to produce food to feed the world population, being able to improve crop yields, retore the land, increase farmers' profitability by helping them sell farm carbon credit, and at the same time combat climate change should be a multiple-win undertaking for countries and regions in the world.

References

"What is Carbon Farming?" Green America, https://www.greenamerica.org/food-climate/what-carbon-farming

"What Is Carbon Farming: How It Works And What We Still Don't Know," Kaitlyn Ersek, Holganix, September 17, 2020, https://www.holganix.com/blog/what-is-carbon-farming-how-it-works-and-what-we-still-dont-know

“What is Carbon Farming?" Carbon Cycle Institute, https://www.carboncycle.org/what-is-carbon-farming

"Carbon Markets: A Potential Source of Income for Farmers and Ranchers," Luis A. Ribera and Bruce A. McCarl, Texas A&M AgriLife Extension, https://agrilifeextension.tamu.edu/library/agricultural-business/carbon-markets-a-potential-source-of-income-for-farmers-and-ranchers

"Is Your Farm Ready to Earn Carbon Credits?" Jamieson Potter, Tillable.com, December 15, 2020, https://tillable.com/blog/is-your-farm-lease-carbon-ready

"How to Grow and Sell Carbon Credits in U.S. Agriculture," Ag Decision Maker, File A1-76, Iowa State University Extension and Outreach, Updated November, 2021, https://www.extension.iastate.edu/agdm/crops/pdf/a1-76.pdf

"Ag Carbon Credits," J. David Aiken, Agricultural Economics, April 21, 2021, https://agecon.unl.edu/ag-carbon-credits

“Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming," Rodale Institute, October 6, 2015, https://rodaleinstitute.org/wp-content/uploads/rodale-white-paper.pdf