Photo by Jacob Mathers, Corn Growing In Cereal

Regenerative Agriculture: Definition, Principles, Benefits and Carbon Sequestration Potential

A New Paradigm Shift For Regenerative Agriculture

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March 3, 2025

Definition of Regenerative Agriculture

A common, universally accepted definition of Regenerative Agriculture (RA) has not been legally defined for official government and policy use (i.e.. for the next Farm Bill). That said, the practices and principles of regenerative agriculture have been trialed and implemented by numerous farmers and ranchers for decades.

One fairly recent attempt to standardize the definition of RA resulted when over 140 organizations supported a new definition written in 2018 by Carbon Underground.[1]

The consensus was "*for a single, standardized definition for food grown in a regenerative manner that restores and maintains natural systems, like water and carbon cycles, to enable land to continue to produce food in a manner that is healthier for people and the long term health of the planet and its climate."*

Carbon Underground and CSU Chico[2], Institute For Sustainable Development and Regenerative Agriculture Initiative, released their definition of RA on February 24, 2017, that fully defined RA as, " *"Regenerative Agriculture" describes farming and grazing practices that, among other benefits, reverse climate change by rebuilding soil organic matter and restoring degraded soil biodiversity – resulting in both carbon drawdown and improving the water cycle. Specifically, Regenerative Agriculture is a holistic land management practice that leverages the power of photosynthesis in plants to close the carbon cycle, and build soil health, crop resilience and nutrient density."*

The document describes the many benefits of RA which improves soil health, increases Soil Organic Matter (SOM), increases soil diversity and health, increases biodiversity above and below the soil surface, increases water holding capacity, sequesters carbon at greater depths, draws down atmospheric Carbon Dioxide (CO2), and improves soil structure to reverse civilization-threatening soil loss. Recent studies continue to reveal the damaging effects to soil health from tillage, the use of chemicals fertilizers, herbicides and pesticides. Regenerative Agriculture has the potential to reverse the damage industrial agriculture has done to our environment.

The document lists the following Regenerative Agriculture practices:

- No-till/minimum tillage. Tillage breaks up (pulverizes) soil aggregation.
  and fungal communities while adding excess Oxygen (O2) to the soil for increased respiration and CO2 emission.
- Soil fertility is increased in regenerative systems biologically through application of cover crops, crop rotations, compost, and animal manures, which restore the plant/soil microbiome to promote liberation, transfer, and cycling of essential soil nutrients.
- Building biological ecosystem diversity begins with inoculation of soils with composts or compost extracts to restore soil microbial community population, structure and functionality restoring soil system energy (C-compounds as exudates) through full-time planting of multiple crop inter-crop plantings, multispecies cover crops, and borders planted for bee habitat and other beneficial insects.
- Well-managed grazing practices stimulate improved plant growth, increased soil carbon deposits, and overall pasture and grazing land productivity while greatly increasing soil fertility, insect and plant biodiversity, and soil carbon sequestration.

The above was a good start to defining and understanding RA benefits and practices. It should be noted that another organization, the **Rodale Institute**, can claim an earlier definition of RA. Rodale was founded by J.I. Rodale in 1947. (Rodale Institute)[3]

Robert Rodale, the son of J.I Rodale coined the term, **regenerative organic agriculture**. *"Regenerative organic agriculture improves the resources it uses, rather than destroying or depleting them. It is a holistic systems approach to agriculture that encourages continual on farm innovation for environmental, social, economic and spiritual wellbeing."*

Rodale Institute publish a very influential document in 2014 called *Regenerative Organic Agriculture and Climate Change: A Down-to-Earth Solution to Global Warming* [4] It reported that we were at a very critical moment in history for our species, and that global CO2 emissions must drop to a net of 41 GtCO2e to keep warming from surpassing 1.5 degrees Celsius to prevent worldwide crisis.

This environmental crisis is very real and-ongoing as the world may have already surpassed IPCC net-zero goals to reduce CO2 Greenhouse Gas (GHG) emissions by 2050.

Six Key Principles Of Regenerative Agriculture

There are six key principles of regenerative agriculture commonly accepted. Here are the six principles as defined by Kiss The Ground.[5]

1. **Understand Context:** Economic, personal, community, ecological, climate, bioregion, etc.

2. **Minimize Disturbance:** This refers to tillage, chemical fertilizers, pesticides, and more.

3. **Establish a "Living Root":** When plants photosynthesize, they pump carbon-based exudates into the soil to feed microbes throughout the growing season. The more living roots there are, the more this can occur.

4. **Provide Soil Armor:** Also referred to as "cover cropping". Bare soil exposed to the elements harms soil health, so it's recommended to always have some living or dead debris covering the soil.

5. **Integrate Animals:** Integrating grazing animals into your fields, if it can work in your context, is extremely helpful for a variety of reasons, including fertilization, aeration, increased organic matter, water infiltration, resistance to soil erosion, and more."

6. **Enhance Biodiversity:** Add diversity to whatever it is you are growing. This could look like planting diverse hedgerows throughout your farm, installing owl boxes, integrating honeybees, or planting diverse multi-species cover crops.

Benefits of Regenerative Agriculture Practices

Regenerative Agriculture (RA) enhances soil health and nutrition, increases Soil Organic Matter (SOM) and is a proven solution to combat climate change. It offers the following key benefits:

Enhances Soil Health and Nutrition:

Enhancing soil health and productivity is a major goal of regenerative agriculture practices and principles. Soil is the basis for all biological life on the planet and the use of conventional farming practices in the U.S. has caused the loss of more than 57 billion metric tons of topsoil since the 1870s accounting to studies found an article by the National Academies Press[6]

The loss and degradation of soil affect many aspects of farming life including reduced water-holding capacity of the soil, reduced crop productivity and the loss of beneficial microorganisms that affect soil structure, drought tolerance, protection and nutrients for plants and animals (Chapter 1, page 14). This loss directly affects human health.

Loss of soil microbial diversity most likely affects human health and the development of the immune system. The National Academies of Science, Engineering and Medicine and other organizations convened a committee of experts for a year ending in April 2024 to explore the linkages between soil health and human health. The complete report *Exploring Linkages Between Soil Health and Human Health(2024)* [7] can be found and read online**.**

Increases Soil Organic Matter (SOM):

Soil Organic Matter (SOM) is made up of decomposing plants, animals, and microorganisms. It's a key indicator of soil quality.

Added benefits include improved soil structure and aeration, water retention and drainage, nutrient release, root growth and biological activity.

Healthy soil is approximately 45% minerals, 25% water, 25% air and 5% organic matter according to the USDA NRCS[8].

SOM is a key indicator of farmland productivity — and a key indicator in establishing the investment value of a farm.

With every 1 percent increase in SOM, one acre can hold an additional 25,000 gallons of water, reducing demand for fresh water according to the University of California Agriculture and Natural Resources[9].

The climate benefits are also significant. Increasing SOM by 1 percent can capture up to 8 tons of carbon per acre according to, *South Dakota State University Extension article*[10].

Soil Organic Matter is the key to maintaining heathy soils for growing healthier plants, providing nutritional food products and helping store carbon in the soil. More information supporting these statements can be found in the SARE (Sustainable Agriculture Research and Education) report *Building Soils for Better Crops*[11] among many other research studies.

Combats Climate Change:

Agriculture is a main driver of global deforestation and land-use conversion and biodiversity loss on land. Food production systems account for more than 30% of all greenhouse gas emissions worldwide and up to 11% in the U.S. today.

According to a CarbonBrief[12] UN land report, 29% of the world's greenhouse gas emissions come from large-scale and industrial agriculture operations; 80% from deforestation and other land-use change. Agriculture also accounts for 70% of the world's freshwater use.

Two other facts are known today affecting climate change according to NASA[13]. First, since industrial times in the 18th century, human activities have raised atmospheric CO2 by 150% of its value since 1750, reaching over 425 parts per million in December 2024. Second, research shows that the large increase in CO2 in the atmosphere since 1750 comes from living carbon sources, not fossil fuels. The primary causes are from clearing forests and soil organic matter (SOM) loss. (Regeneration International)[14]

The good news is that soil carbon is the largest pool of carbon after the oceans. The soil holds almost three times as much carbon as the atmosphere, forests, and ecosystems combined. The loss of soil carbon through degenerative farming practices has been underestimated in its contribution to atmospheric GHGs according to the above article. The loss of forests from deforestation has made a massive contribution to the current excess CO2 levels due to less photosynthesis.

Fortunately, soil carbon sink capacity is estimated at 178 gigatons of Carbon for soil, 155 gigatons of Carbon for biomass, and 333 gigatons of Carbon for the terrestrial biosphere with a total CO2 drawdown potential of 157 parts per million according to a Rattan Lal research study[15]. The adoption of a system-based conservation agriculture, agroforestry, biochar, and integration of crops with trees and livestock is how it can be accomplished.

Carbon Sequestration Potential From Land-Use Management and Animal Grazing Practices

The Potential of carbon sequestration from proper land-use management and animal grazing practices are topics of major concern when discussing the potential of reducing carbon dioxide levels in our atmosphere, especially in the agriculture sector. It involves two main components:

Carbon Sequestration Potential:

Carbon sequestration potential in agricultural soil from proper land-use management and animal grazing practices is great.

Sequestration of carbon in agriculture soil has extraordinary potential to reduce its carbon footprint according to many articles, current research and field studies done over decades. The latest report on the subject is provided by the U.S. Farmers & Ranchers in Action (USFRA) article published on November 12, 2024, by the Council for Agricultural Science and Technology (CAST). (Hatfield et al.)[16]

This report was authored by 26 leading researchers and peer reviewed by the National Academy of Sciences. The major questions still open for debate are how large is the potential for agriculture to sequester carbon in the soil, how fast can it be achieved, and how long does it last?

These areas need further research and studies to resolve. However, there should be no more hesitancy in continuing the transition to regenerative agriculture practices when there is an overabundance of evidence detailing the harm that conventional farming practices have done to our soil, water supply, environment and health.

Several independent organizations, scientists and researchers have reported on the ability of agriculture to sequester large amounts of carbon into our soil. It has been estimated that the world's soil has lost the equivalent of 116 Pg C (Pentagram of Carbon) over the last 12,000 years of human land use. (Sanderman et al.)[17] One petagram is equal to one billion metric tons. This equates to over 425 billion tons of CO2 released into our atmosphere, most of it still there.

According to one report, global CO2 emissions from land use, land-use change and forestry (LULUCF) averaged 1.3±0.7 Gt C yr−1 (4.7±2.6 Gt CO2 yr−1) for the 2013–2022 period with a projection for 2023 of 1.1±0.7 Gt C yr−1 (4.0±2.6 Gt CO2 yr−1). (Friedlingstein et al.)[18] This equates to 13 billion tons of CO2 emissions over ten years from land-use practices alone.

Animal Paddock Grazing:

Animal paddock grazing methods must replace Concentrated Animal Feeding Operations (CAFOs) to stop monopolizing food resources and polluting the environment.

Perhaps the biggest misconception today about animal grazing is that moving animals from Concentrated Animal Feeding Operations to pasture fed grazing would require too much land to feed the world. CAFOs require huge amounts of deforested land to grow animal feed crops, pollute the environment from animal waste and produce more methane from operations than grazing animals on pastures. Several studies show that regeneratively managed animal grazing systems called Adaptive Multi-Paddock (AMP) result in more carbon sequestration than greenhouse gas (GHG) emissions and significantly increase Soil Organic Matter (SOM).

Another misconception reported by critics of animal grazing is that animals are responsible for a large percentage of methane gas released into the atmosphere. The truth is most methane emissions come from leaking gas and oil wells and from permafrost melting according to a separate article published by Dr. Leu. CAFOs are a major contributing factor, but regenerative grazing livestock emit less methane gas since all their methane is degraded by soil and water-base microorganisms found in nature. (Dr. André Leu, 9/24/2024)[19]

There are several leading experts on the subject of animal grazing practices, Dr. David C. Johnson (AMP and BEAM), Allan Savory (Desertification) and Dr. Allen Williams (AMP) among others. In particular, Dr. Williams promotes AMP grazing systems in his farming and consulting businesses and speaks on the subject at many public events. AMP grazing systems allow ranchers to raise many more cattle per acre than reported in other articles.

Subdividing pastures and increasing stock density can allow ranchers to increase the number of cattle per acre using Dr. Willams' Stock Density Calculations (pounds of beef/acre) to determine the paddock size and number of moves per day to achieve the desired stock density per acre. (Dr. Allen Williams Presentation)[20]

A New Paradigm Shift For Agricultural

A new paradigm shift is needed for agriculture *"to change from chemically intensive to biologically intensive"* farming practices as stated in a recent article by Doctor André Leu from Regeneration International published on 12/8/2024. (Dr. André Leu, 12/8/2024)[21]

There has been a lot of misleading information in previously published articles about the capability to sequester carbon, improve crop productivity, reduce input costs and feed the world using regenerative agriculture farming and ranching practices. Many articles just state the lack of scientific proof or peer-reviewed studies to justify their beliefs. In fact, there are numerous comprehensive studies comparing industrial and RA farming methods over several decades of study and field trials to prove otherwise.

The key to all regenerative land management practices involve photosynthesis and protecting living organisms in Soil Organic Material (SOM). This requires biologically intensive farming instead of using chemical inputs.

There should no-longer be any doubt as to the effectiveness and potential of regenerative agriculture to improve the productivity of our soil, reduce GHG emissions and draw down CO2 from our atmosphere through photosynthesis and carbon sequestration. There are numerous agriculture studies, field trials and research to prove the effectiveness of RA beyond a reasonable doubt. It requires the right governmental policies (i.e., in the next farm bill) to incentivize and achieve the correct outcomes to meet our net-zero emission goals. A growing percentage of farmers and ranchers across America have already implemented RA practices such as low or no tillage, cover crops and biologically enhanced compost to improve crop production and reduce input costs. The goal of regenerative agriculture is to restore soil health to pre-industrial levels across the country and the world and help reverse our climate crisis.

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Date: March 3, 2025

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