

California Agriculture & Climate Change

Climate Solutions in Agriculture

Dependent on weather and the availability of natural resources, California agriculture is uniquely vulnerable to climate change. In a state where water is already scarce, climate change scenarios predict that water supplies will become increasingly constrained, threatening severe shortages in the coming decades and limiting a fundamental resource for the state's agricultural industry¹. Climate change scenarios also predict changing weed, disease and pest pressures, increased animal diseases, loss of chill hours for grapes, fruit and nut tree crops, and changing intensity and number of storms^{2,3}.

Much is at stake. California agriculture is one of the most diverse and productive agricultural systems in the United States, and the fifth largest producer of food globally with revenues of nearly \$37 billion a year from its 75,000 ranches and farms. With more than 400 agricultural products, California's farmers and ranchers represent nearly every crop and product grown domestically⁴.

To keep California agriculture viable in the coming decades, greenhouse gas (GHG) emissions must be reduced and the worst climate change impacts averted. Agriculture can be part of the climate solution. Investments must be made to enhance its role and protect its future in California.

SUSTAINABLE AGRICULTURAL APPROACH TO CLIMATE CHANGE

In biological systems such as agriculture, altering one practice to reduce GHG emissions may lead to unintended consequences of increasing GHG emissions elsewhere in the system. Considering agricultural practices as integrated parts of the whole farming or ranching system will provide a more complete picture of an operation's carbon footprint and the opportunities within it to reduce GHG emissions and sequester carbon. Sustainable agricultural systems, based on ecological principles, offer this holistic approach.

Here we outline some of the sustainable agricultural approaches that may help to reduce GHG emissions, remove and store atmospheric carbon and bolster California agriculture's resilience in the face of a changing climate.

Energy Efficiency and On-Farm Renewable Energy Production

Energy efficiency measures and on-farm renewable energy production can provide energy and cost savings to farms and ranches while reducing GHG emissions.

Energy efficiency measures should be among the first practices to be considered as producers look to reduce their carbon footprint. Energy audits can reveal energy efficiency opportunities within an operation and may include such practices as properly inflating tractor tires to reduce fuel waste⁵, repairing water pumps to increase efficiency and/or reducing pumping time⁶ and maintaining farm vehicles and equipment⁷.

California farms and ranches also have the potential to produce renewable energy and become more energy independent. Wind turbines⁸, solar panels⁹, anaerobic digesters and biomass projects on farms and ranches can increase the state's production of renewable energy and generate income for producers from the sale of excess energy or in some cases through lease agreements or royalties.





Sustainable Livestock Management

Sustainable management of rangelands — which cover half of the total land area of California²¹ — can be an effective tool for carbon sequestration and GHG emission reductions generally. Cattle grazing can increase above ground productivity of vegetation and species richness²², which is frequently correlated with increased carbon in the soil²³. Grazing has also been found to increase the rate of soil carbon sequestration. Utilizing rotational grazing, where livestock are intensively grazed and rotated through paddocks, has the potential to increase carbon sequestration^{24,25} and offset GHG emissions by 15 to 30 percent²⁶.

Grazing livestock can also reduce the methane emissions generated by the digestive processes of livestock. Animals fed a diet of high quality forage may emit less methane²⁷. While research comparing methane emissions²⁸ from pasture versus feedlot finishing are still limited, evidence suggests that finishing cattle on pasture rather than on grain can reduce methane emissions. Studies comparing livestock systems also suggest that grass-fed livestock require half the fossil fuel energy inputs of conventional feedlot livestock²⁹.

Utilizing alternatives to handling waste manure in lagoons or slurries can reduce this significant source of GHG emissions. These lagoons or slurries can often produce methane and nitrous oxide³⁰, two potent GHGs, as the result of the anaerobic (no or low oxygen) decomposition of manure. When manure is applied to the land instead of stockpiled or stored in large ponds or lagoons, methane emissions can be reduced³¹. Because animal manures contain about 40 to 60 percent carbon, its application to land can increase the soil organic matter content and enhance soil carbon sequestration³².

Agriculture as Carbon Sink

Agriculture and forestry offer the only currently available “sinks” of carbon dioxide, our primary greenhouse gas. Agriculture and forestry can remove carbon dioxide from the atmosphere by storing it in soils and woody biomass, a process known as carbon sequestration¹⁰.

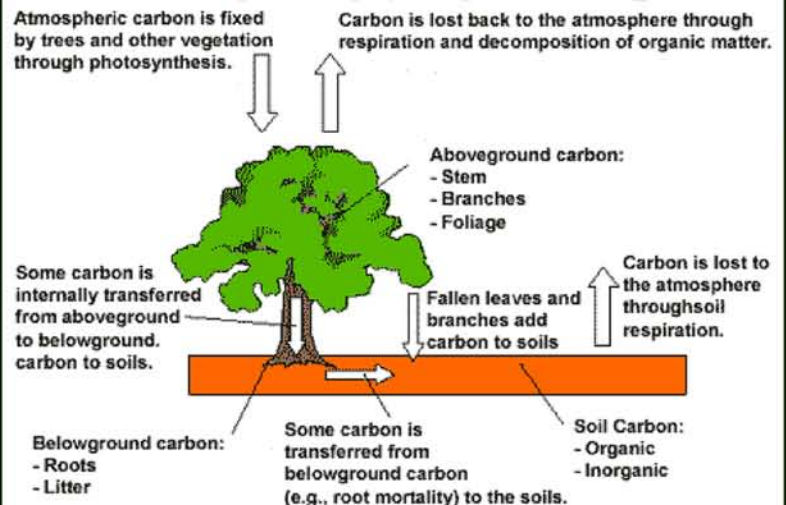
The ability of farms and rangeland to become carbon sinks will depend upon soil type, regional climate, cropping system and management practices. As noted in a recent California Energy Commission study, soil management practices used in combination offer the best opportunities to build soil organic matter and sequester carbon¹¹.

Among the soil management practices that have the greatest potential to sequester carbon are reduced synthetic fertilizer inputs, use of cover crops, planting of fallow land, perennial cropping, and conservation tillage¹². Cover crops or green manures have been found to increase soil carbon on average two to four times as much as land under cultivation¹³. Composting and the addition of organic amendments have also resulted in increased carbon storage in soils^{14,15}. Studies reviewing the carbon sequestration potential of conservation tillage are mixed and sometimes contradictory. The potential for conservation tillage to increase carbon sequestration may be elevated with the use of additional soil management practices including cover crops, which can contribute to building soil organic matter^{16,17}.

Incorporating trees, shrubs or other types of woody vegetation into rangeland or farm landscapes can help to sequester carbon in significant quantities^{18,19}. Carbon dioxide is absorbed by trees and plants and stored in the woody biomass above ground and in the root system. Planting of hedgerows along the margins of farms and plantings in riparian zones can increase carbon sequestration. In California, replanting of oak woodlands on rangeland offers some of the best opportunities to sequester atmospheric carbon²⁰.

Understanding Carbon Sequestration

Source: US EPA, http://www.epa.gov/sequestration/local_scale.html



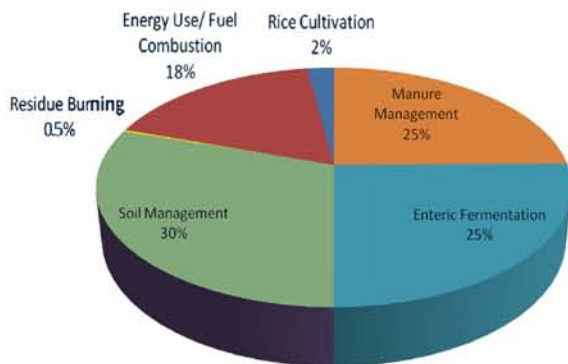
Climate Benefits of Organic Agriculture

Organic farming systems offer some of the best opportunities in agriculture to reduce GHG emissions and sequester carbon. Organic operations are prohibited from using synthetic fertilizers or pesticides and instead use less fossil fuel intensive methods for soil management, including animal manure, compost and/or cover crops. Organic systems use inputs with up to 30 percent less embedded energy than conventional systems³³, resulting in lower GHG emissions³⁴.

Research has shown significantly more carbon is sequestered in organic soils that are cultivated with animal manures and cover crops compared to conventional soils utilizing synthetic fertilizers^{35,36,37,38}. In an eight-year study in California, soil organic carbon increased 19 percent in organic and low input systems compared to only 10 percent in conventional agriculture³⁹. Long-term studies at the USDA have further shown that organic agriculture, even when using tillage, can sequester more carbon than no-till conventional agricultural systems⁴⁰.

2004 Agriculture Sector Emissions by Percentage

(Source: CARB, December 2008. AB 32 Scoping Plan, Appendix C.)



ENVIRONMENTAL CO-BENEFITS OF CLIMATE SOLUTIONS IN AGRICULTURE

Many of the agricultural practices that can reduce GHG emissions and sequester carbon can also provide numerous other environmental and public health benefits, including:

- Improved air quality
- Cleaner water
- Increased water conservation
- Increased biodiversity and wildlife habitat
- Reduced soil erosion



Preserving California Farmland

California is losing farmland to development at an alarming rate - roughly 40,000 acres lost each year⁴¹. The loss of California farmland hurts the state's opportunities to mitigate and adapt to climate change⁴². Compared to the dark surfaces of rooftops and pavement that absorb sunlight, farmland and rangeland increase the albedo effect - the ability to reflect sunlight and cool temperatures⁴³. Moreover, protecting farmland around urban areas helps to limit sprawl and transportation-related GHG emissions. Farmlands provide numerous additional benefits, including the ability to sequester carbon, preserve open space, absorb and filter water, and continue to feed a growing population from local sources.



Photo courtesy of USDA NRCS

Rewards for Climate Friendly Agriculture

Farmers and ranchers can be a part of a climate solution for California and nationally. Encouraging sustainable agricultural practices can reduce GHG emissions, enhance a potentially powerful resource for sequestering carbon, and provide many environmental co-benefits.

More California-specific research on climate change and agriculture is needed as much of the research to date has occurred in the Midwest. Translating those research findings into real opportunities for California agriculture to provide GHG emission reductions requires technical assistance. And in some cases, when transition costs to less GHG-emitting practices may be high, financial incentives for farmers and ranchers are essential. Researchers at UC Davis find that California producers will adopt practices to mitigate climate change given realistic payments and assistance⁴⁴.

We cannot rely only on federal farm conservation programs to meet the challenge of climate change conservation efforts in agriculture. The current level of funding for USDA conservation programs for California producers is woefully inadequate. Of the California producers who applied for USDA conservation programs in 2009, by early 2010, 70 percent of them were still awaiting approval for their conservation projects because of a lack of funding. Increased allocations of funds in these federal programs, and investments at the state and national levels from future carbon pricing policies are needed to support agriculture's role in climate protection.

California agriculture can be a leader in mitigating and adapting to climate change and with adequate research, technical assistance and financial incentives we can ensure that agriculture remains a viable, innovative industry for years to come.

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