Climate Solutions in Agriculture

CalCAN
California Climate & Agriculture Network

CALIFORNIA AGRICULTURE is uniquely vulnerable to climate change. In a state where water is already scarce, climate models 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 industry[1]. Models also predict pressures from weed, disease and pest shifts, 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 $35 billion a year from its 81,500 ranches and farms. With more than 400 agricultural products, California's farmers and ranchers represent nearly every crop and product grown domestically[4].

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

Climate Benefits of Sustainable Agriculture

Altering one agricultural practice to reduce GHG emissions may lead to the unintended consequence of increasing GHG emissions elsewhere in the agroecological 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 and store atmospheric carbon, thereby bolstering California agriculture's resilience in the face of a changing climate.

Energy Efficiency & 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 efficiencies should be among the first improvements growers consider when looking to reduce carbon emissions. Energy audits can reveal opportunities to increase efficiency within an operation such as properly inflating tractor tires to reduce fuel waste[5], repairing water pumps to increase efficiency and/or reducing pumping time[6] and maintaining farm vehicles and equipment[7].

California farms and ranches might also become more energy-independent by producing renewable energy themselves. Wind turbines[8], solar panels[9], anaerobic digesters and biomass projects on farms and ranches can increase the state's production of renewable energy and generate income from the sale of excess energy, or in some cases through lease agreements or royalties. By 2009 close to 2,000 California operations had installed renewable energy, and that number continues to grow[10].

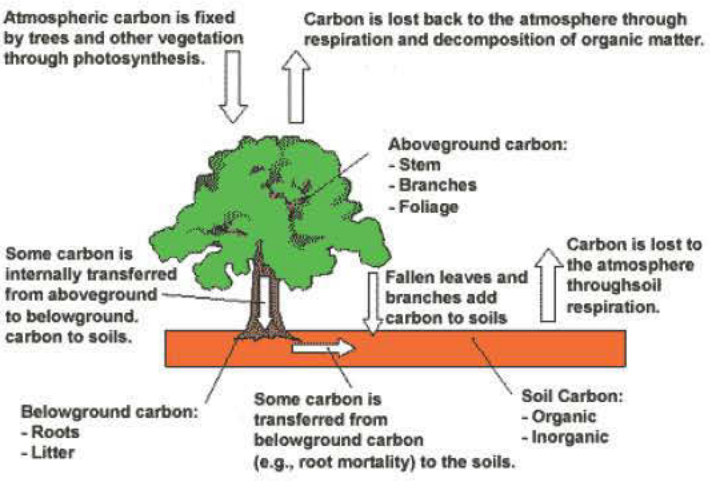
Agriculture as Carbon Sink

Agriculture and forestry offer the only currently available terrestrial 'sinks' of carbon dioxide, the most predominant greenhouse gas. Natural processes in these sectors can remove carbon dioxide from the atmosphere and store it in soils and woody biomass. This process is known as carbon sequestration[11].

The ability of farm and rangeland to sequester carbon in soil depends upon soil type, regional climate, crop systems and management practices. As noted in a California Energy Commission study, soil management practices used in combination offer the best methods to build soil organic matter and sequester carbon[12].

Among the soil management practices that have the greatest potential to sequester carbon are cover crops, perennial cropping,

Understanding Carbon Sequestration



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

reduced synthetic fertilizer inputs, and conservation tillage[13]. Cover crops or green manures have been found to increase soil carbon 1.5 to 4 times as much as in land under cultivation[14]. Composting and adding organic amendments have also resulted in increased carbon storage in soils[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 grow with the use of additional soil management practices—including cover cropping, which can help build soil organic matter[16,17].

Incorporating trees, shrubs or other types of woody vegetation into rangeland or farm landscapes can also sequester carbon in significant quantities[18,19]. Trees and plants absorb carbon dioxide and store it in the woody biomass above ground and in the root system. Planting hedgerows along the margins of farms and buffers in riparian zones can increase carbon sequestration. In California, replanting oak woodlands on rangeland is one of the best opportunities to sequester atmospheric carbon[20].

Sustainable Livestock Management

Sustainable management of rangelands—which cover half of the total land area of California[21]—can be an effective tool for carbon sequestration and GHG emission reductions generally. Cattle grazing can increase aboveground species richness and productivity of vegetation[22] which is frequently correlated with increased soil carbon[23]. Grazing has also been found to increase the rate of soil carbon sequestration[24,25]. Rotational grazing, a practice of intensively grazing and rotating livestock through paddocks, has the potential to increase carbon sequestration by 15 to 30 percent[26]. Converting fields from conventionally-raised feedstock to perennial grasslands for grazing can sequester up to 3,400 pounds of carbon dioxide equivalent per acre each year[27].

Grazing can also reduce the methane emissions generated by the digestive processes of livestock. Animals fed a diet of high quality forage may emit less methane[28]. While research comparing methane emissions from pasture versus feedlot finishing are still limited, evidence suggests that finishing cattle on pasture rather than on grain can reduce methane emissions[29]. Studies comparing livestock systems also suggest that grass-fed livestock require half the fossil fuel energy inputs of conventional feedlot livestock[30].

Manure waste lagoons or slurries produce methane and nitrous oxide[31], two potent GHGs, as the result of the anaerobic (no or low oxygen) decomposition of manure. Methane emissions associated with livestock production can be reduced when manure is applied to the land instead of stockpiled or stored in large ponds or lagoons[32]. Because animal manure contains about 40 to 60 percent carbon, its application to land can increase the soil organic matter content and enhance soil carbon sequestration[33].

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 including animal manure, compost and/or cover crops. Organic systems use inputs with up to 30 percent less embedded energy than conventional systems[34], resulting in lower GHG emissions[35].

Research has shown that significantly more carbon is sequestered in organic soils that are cultivated with animal manures and cover

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crops rather than conventional soils utilizing synthetic fertilizers[36,37,38,39]. In an eight-year study in California, soil organic carbon increased 19 percent in organic and low-input systems compared to an increase of only 10 percent in conventional agriculture[40]. 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 systems[41].

Note: More information on organic agriculture and climate change can be found in a CalCAN fact sheet focused on this topic.

Preserving California Farmland

California is losing farmland to development at an alarming rate—roughly 40,000 acres each year[42]. The loss of California farmland hurts the state's opportunities to mitigate and adapt to climate change[43]. Unlike the dark surfaces of rooftops and pavement that absorb sunlight, farmland and rangeland reflect sunlight and cool temperatures, thereby increasing what's known as the 'albedo effect'[44]. Moreover, protecting farmland around urban areas helps to limit sprawl and transportation-related GHG emissions. Farmland provides numerous additional benefits, including carbon sequestration, open space preservation, water absorption and filtration, and local food sources.

Supporting Climate-Friendly Agriculture

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

A report by CalCAN illustrates that California agriculture is ill-prepared to face the challenges of climate change[45]. More California-specific research on climate change and agriculture is needed, as much of the research to date has occurred in the Midwest. Technical assistance is required to translate those research findings into real opportunities for GHG emission reductions through California agriculture. 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 if they are given realistic payments and assistance[46].

We cannot rely solely on federal farm conservation programs to meet the challenge of climate change efforts in agriculture. The current level of USDA conservation program funding for California producers is woefully inadequate. In recent years in California, more than half of the farmers and ranchers who applied for USDA conservation programs have not enrolled in the programs because of inadequate funding[47]. Increased funding allocations in these federal programs, as well as 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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Environmental Co-Benefits of Climate-Friendly 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
- Increased pollination and beneficial insect populations
- Reduced soil erosion and increased flood control

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The California Climate & Agriculture Network

The California Climate and Agriculture Network (CalCAN) is a collaboration of California's leading sustainable agriculture organizations advocating for policy solutions at the nexus of climate change and agriculture. We cultivate farmer leadership to face the challenges of climate change and to serve as California's sustainable agriculture voice on climate change policy.

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