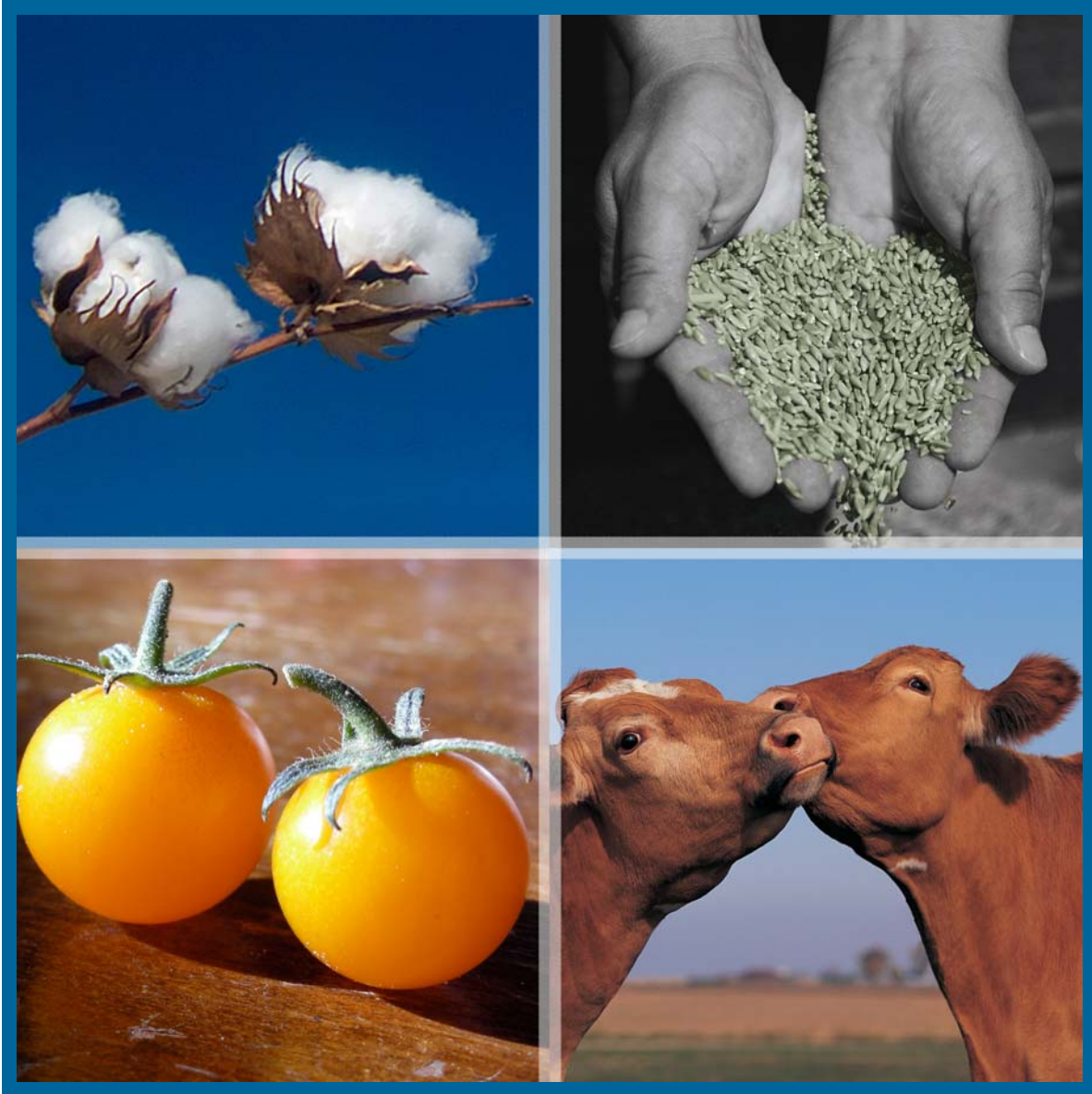


California Agriculture and Climate Change *Challenges and Opportunities for Profitability*



Background

In the late 1990s, responding to widespread concern from scientists about potential impacts of greenhouse gases building up in the atmosphere, leaders from most industrialized nations met in Kyoto, Japan and agreed to set up a global framework for reducing emissions of greenhouse gases. That system, called the Kyoto Protocol, has the goal of reducing emissions to 1990 levels. The three greenhouse gases of greatest focus are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Other greenhouse gases of concern are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF₆).

Although the United States did not sign the Kyoto Protocol, it has encouraged voluntary measures to reduce emissions of greenhouse gases. California, the world's 12th largest emitter of greenhouse gases and one of the top consumers of fossil fuels for transportation and electricity generation, decided to take proactive steps to control emissions. In 2006, Governor Schwarzenegger signed the California Global Warming Solutions Act (AB 32), which establishes the first comprehensive program in the nation that employs regulatory and market mechanisms to achieve real, quantifiable and cost-effective reductions in greenhouse gas emissions in California. AB 32 will affect many or most sectors of California's economy and provide both new requirements and opportunities for business. Below is an overview of some of the issues, implications and opportunities for California agriculture.

Relevance for California Agriculture

California's climate change legislation aims to reduce greenhouse gas emissions to 1990 levels. Although specific details are still being worked out, it will likely provide both incentives and regulatory mandates to some sectors of California's economy, including agriculture. AB 32's requirement for "early action measures" – immediate priorities for reducing greenhouse gas emissions – includes several agriculture-related provisions. It is important for California growers and producers to understand these emerging opportunities and consider the potential value for their own operations and long-term profitability. That is already happening with some California dairymen who have modified their operations in ways that are beneficial for their farms and for capturing "carbon credit" dollars from methane emission reductions.

Agriculture's Greenhouse Gas Emissions



Types of Emissions

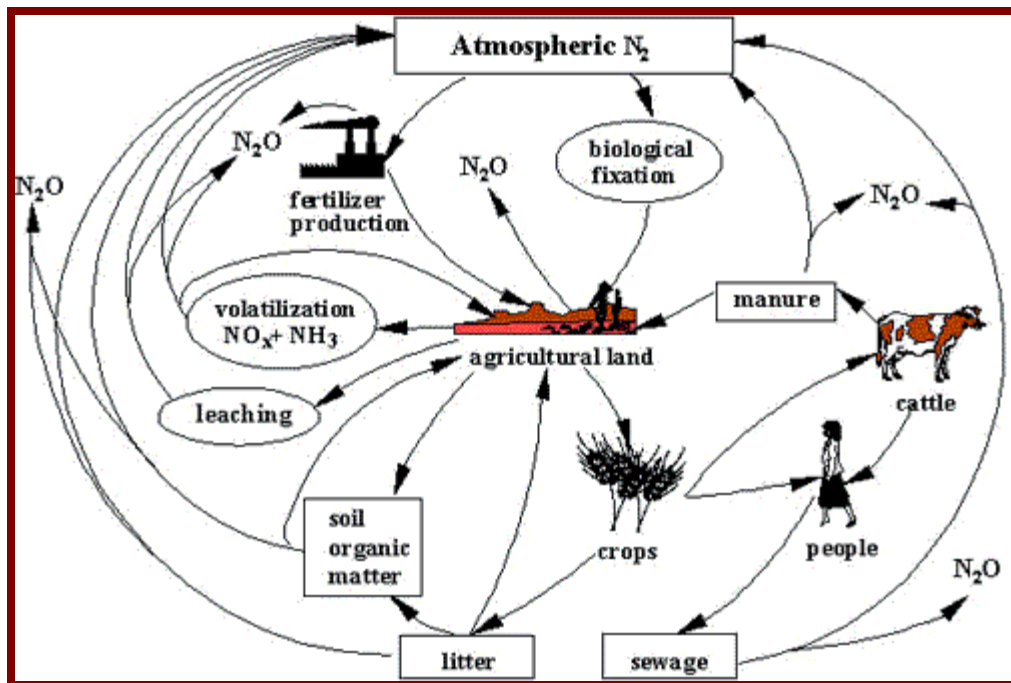
CO₂ is the most prevalent greenhouse gas and therefore has the greatest impact. But pound for pound, methane has more global warming potential – meaning it has a greater ability to drive climate change, 21 times more powerful than CO₂. Nitrous oxide is more potent than CO₂ or methane, over 300 times more powerful than CO₂ in driving climate change, pound for pound. Although there is not as much of nitrous oxide as CO₂ being released into the atmosphere, the amount that is released has a disproportionate effect as does methane when compared to CO₂. Agriculture releases all three types.

Sources of Emissions

Carbon dioxide: Most people know that power plants generating electricity from coal, oil and gas emit CO₂, as do car and truck engines that burn gasoline or diesel fuel. Farm tractors, trucks and other vehicles associated with agricultural operations also emit CO₂. In addition, CO₂ can be emitted from the soil, particularly during tillage or other operations that expose soil to oxidation. Over time, soil carbon can be converted to CO₂, reducing the organic matter content and adversely affecting soil properties. Scientists estimate that since California farmers first broke ground to plant crops, over half the organic matter in soil has been lost. The good news is that changing practices can potentially reverse this decline.

Methane: Of the approximately 29 million metric tons of methane emitted from U.S. human-related activities, about one-third are from agriculture (as of 1998). Livestock management accounts for a significant portion of these emissions, with the majority of this share from the natural digestive process of ruminant animals. (Methane is given off by dairy cows through flatulence or burping.) The remainder comes from the anaerobic decomposition of livestock wastes. It has been estimated that the dairy industry contributes up to 2% of California's total methane emissions. Rice growing is another source of methane. It results from anaerobic conditions that exist in rice fields, mainly from decomposing rice straw that is now left in the wet fields (where it was once burned). Tractors also produce small quantities of methane from tailpipes. Most of these emissions can be mitigated with existing practices and technologies.

Nitrous oxide: Agriculture accounts for about 70% of U.S. N₂O emissions, primarily the application of commercial and animal-based fertilizers, but also from the production of nitrogen fertilizer. Nitrous oxide typically forms in the soil when nitrate nitrogen denitrifies. This often occurs under wet conditions or where nitrogen fertilizer is applied, particularly in large quantity. Using nitrogen fertilizer and irrigation water more efficiently can reduce N₂O emissions significantly.



From Nevison et al., 1996; Mosier et al., 1998; C. Kroeze, 1998.

California's New Law: AB 32

The regulatory agency in charge of monitoring and reducing greenhouse gas emissions is the California Air Resources Board (CARB). AB 32 includes the following provisions:

- Establish a statewide greenhouse gas emissions cap for 2020, based on January 1, 2008.
- Adopt mandatory reporting rules for significant sources by January 1, 2008.
- Adopt a plan for reducing greenhouse gas emissions from significant sources via regulations and/or market mechanisms by January 1, 2009.
- Adopt regulations to achieve the maximum cost-effective reductions in greenhouse gases, including requirements and alternative compliance mechanisms by January 1, 2011.
- Adopt a list of discrete “early action measures” by July 2008 and adopt such measures before January 1, 2010.
- Convene an Environmental Justice Advisory Committee and an Economic and Technology Advancement Advisory Committee to advise CARB.
- Ensure public notice and opportunity for comment prior to imposing any mandates or authorizing market mechanisms, evaluating factors such as: impacts on the environment and public health; equity between regulated entities; electricity reliability; conformance with other environmental laws, and avoiding disproportionate impacts to low-income communities.

It is noteworthy that AB 32 has a provision that authorizes the Governor to invoke a safety valve in the event AB 32 implementation threatens significant economic harm.

Key Concepts of AB 32 Implementation

To understand how AB 32 implementation will work and how it may affect agriculture, it is important to understand the language and concepts that are part of the process. The terminology also has meaning in the regulatory and financial contexts. A brief overview of relevant terms and issues is presented below.

Cap and Trade

A key concept of AB 32 (and Kyoto Protocol) is setting up a “cap and trade” system which combines government regulation with market mechanisms. Under this system regulators establish a “cap” that limits emissions to a level lower than current emissions. This new threshold provides businesses and other emitters the right to emit a lower amount and trade their emission permits (or allowances) to achieve greater reductions. The goal behind the system is to bring down the overall level of greenhouse gas emissions at the lowest possible cost, without specifying exactly who must reduce which emissions and by how much. This keeps the costs of compliance lower than a fully regulated system. Cap and trade systems are currently used in the U.S. to reduce air pollution and internationally, carbon emissions.



It is a government body that sets an overall ceiling for greenhouse gas emissions that acts as the “cap.” Then individual emitters are allocated emission permits typically through auctions. The total number of permit allowances add up to the cap. Some emitters will be able to reduce their emissions at a lower cost than other emitters. Those for whom the cost is high may decide that it is more economical to buy emission permits from other emitters who can reduce emissions more cheaply, rather than reducing their own emissions. This gives the low-cost emitter the chance to realize an economic benefit by selling emission credits for a price greater than its cost of reducing their own emissions. As a result, the total level of emissions falls and both companies help meet the regulated cap at a lower overall cost.

Offsets

Sectors of the economy that operate outside of a regulated cap and trade program, including farmers, can still participate in the market through offsets. This option allows regulated participants to offset their own emissions by going to non-regulated entities. They can get paid by the companies that have to reduce their regulated emissions. Offsets are emission reductions achieved by non-regulated market participants, which could include farms. Offsets enable businesses and other emitters to pay for the benefit of greenhouse gas reductions achieved by other parties, including those outside the regulatory system.

For example, as a regulated power plant works to bring their own emissions to within their allocated permits, it can purchase credits or offsets from an entity that can achieve the benefits at a lower cost. California farms can sell offsets related to a variety of practices that reduce greenhouse gas emissions or avoid emissions that would normally take place. Examples of offsets currently recognized are: 1) methane captured from dairy operations to produce energy; 2) cover crops or tillage practices used to build up soil carbon (organic matter) levels; or 3) using biofuels. Others types of acceptable offsets will be added in the future. The Chicago Climate Exchange has standardized offset rules, which are likely to serve as the basis for other programs. Carbon offsets are becoming popular with businesses and consumers who want to counter the effect of their own direct and/or indirect greenhouse gas emissions, or “carbon footprint.”

Carbon Equivalent Emissions

Emissions of greenhouse gases are typically expressed in a common metric – carbon equivalent emissions (CO₂e) – so that their impacts can be directly compared even though some gases have a higher global warming potential than others. A calculation is used to convert the methane, nitrous oxide and other greenhouse gas emissions to the equivalent impact of carbon dioxide emissions. For example, 1,000 tons of methane emissions converts to 21,000 tons of CO₂e. U.S. Environmental Protection Agency and most other agencies use million metric tons carbon equivalent, or MMTCE.

CONVERSION CHART

Carbon dioxide (CO ₂)	1
Methane (CH ₄)	21
Nitrous oxide (N ₂ O)	310

Standards

At present, the standards for trading greenhouse gas emission permits are evolving. An ideal standardized product for trading greenhouse gas reductions would provide high assurances that a ton of greenhouse gas reductions from one project has the same impact as a ton or reductions from another. A complete standard should contain detailed methods, procedures and criteria for ensuring that greenhouse gas reductions are:

- **Real** – actual emission reductions and not artifacts of incomplete accounting;
- **Surplus** – a response to the buyer’s promise to purchase them, not reductions that would have happened anyway per business-as-usual (i.e., are “additional”);
- **Verifiable** – from projects whose performance can be readily monitored and verified;
- **Permanent** – permanent and/or backed by guarantees if they are reversed; and
- **Enforceable** – backed by contracts or legal instruments that define their creation, provide for transparency and ensure exclusive ownership.

Renewable Energy Credits/Certificates (RECs)

A Renewable Energy Credit (REC) represents one megawatt hour (MWh) of renewable electricity generated (representing 1,000 kilowatt hours) and delivered somewhere on the power grid (10 light bulbs of 100 watts each burning for an hour represent 1 kilowatt hour). Each 1MWh of clean, renewable electricity avoids 1MWh of electricity generated from coal, natural gas or other fossil fuels. A renewable energy provider is credited for every 1,000 kilowatt hours (kWh) of electricity it produces and generators can aggregate output. Once the renewable energy is fed into the electrical grid, the credit can then be sold on the open market. A REC therefore enables a renewable energy provider to recognize an additional economic benefit that reflects the environmental benefits of replacing dirty power with clean power.

Opportunities for Row Crop Agriculture



As government and businesses work to mitigate greenhouse gas emissions, significant opportunities are emerging for California growers and producers. Farmers can benefit economically from their ability to store carbon in the soil or directly reduce their greenhouse gas emissions. The economic benefits come from selling carbon offsets and potentially from trading carbon credits in the future.

Already, some California farmers are participating in voluntary programs to reduce their carbon emissions and are getting paid for doing so. For example, dairy farmers who install methane digesters are capturing economic value from the methane destruction that occurs when it is combusted to generate electricity. Meanwhile, some row crop farmers in the Midwest have begun participating in carbon sequestration programs, something wheat farmers in Washington and Oregon have been doing for some time. These programs are paying farmers for changing tillage practices to store carbon in the soil. Although California growers are not yet participating in these types of programs, clear opportunities will emerge in the next few years. There are many opportunities for row crop farmers to reduce greenhouse gas emissions. Three categories of opportunities discussed here are:

1. Carbon sequestration (e.g., storing more carbon in the soil by using cover crops);
2. Reducing greenhouse gas emissions (e.g., becoming more efficient by using more efficient motors);
3. Removing or destroying greenhouse gases (e.g., burning methane gas in a digester).

Specific opportunities for row crop growers:

1. Carbon Sequestration

Soil is a major reservoir for carbon and nitrogen. It contains twice as much carbon as terrestrial vegetation (e.g., trees) and the atmosphere *combined*. Much work has been done on Midwest crops such as soybeans and corn on storing carbon in the soil, but less is known about the carbon sequestration potential of California's many row crops that have diverse management practices and rotation systems. It has been estimated, however, that approximately 3 million metric tons of carbon equivalents could be stored in California soils. Some of the approaches that may help do that include:

- a) **Conservation tillage:** The term "conservation tillage" designates crop production systems that maintain a minimum of 30% plant residue cover on soil after planting. By reducing fossil fuel consumption it can reduce greenhouse gas emissions. In reality, conservation tillage covers a wide range of practices and technologies and doesn't necessarily require a fixed percentage of residue on the surface. Irrespective of how it is defined, reducing plowing of the soil can have a beneficial impact on carbon storage, particularly when combined with other practices like cover crops or adding compost. Although it is not suitable for all crops, it is currently underutilized as a technology in California, with less than 2% of annual cropland employing conservation tillage.



- b) **Cover crops:** Winter cover crops are sometimes used to improve soil health, add nitrogen, prevent wind or water erosion, or produce a forage crop. California growers, however, have not used cover crops as widely as may be feasible or desirable. There is opportunity to grow significantly more cover crops than is currently the case. Although cover crops may not be appropriate in all rotations, they can improve soil quality, add nitrogen to the soil or provide a winter forage crop. As such, they offer cost saving potential or new revenue opportunities.
- c) **Soil amendments/compost:** Research has shown that adding amendments to soil, such as manure, biosolids or compost, can increase the organic matter content. Some products, like prepared compost, can be expensive to add, while others, like biosolids, can generate revenue. Although each has its own limitation, these resources have not been fully exploited by row crop growers. Recognizing that high quality products have destroyed pathogens, they are worth a closer look, particularly where there are other benefits to their utilization beside nutrient value.

2. Reduction in Greenhouse Gas Emissions

- a) **Irrigation efficiency:** In recent years, California farmers have been making significant strides to improve water use efficiency in crop production. Additional efforts at optimization will have the added benefit of decreasing greenhouse gas emissions, both in reduced energy that may be used to pump the water and in decreasing nitrous oxide emissions (since water-saturated soil conditions are often associated with higher emissions). Highly efficient drip systems are now widely used in some crops and may become more suitable for others as water becomes scarcer. Center-pivot irrigation systems, widely used in parts of the western U.S., are also relevant to California growers. Whatever systems are considered, their economic viability could shift to positive if there is a revenue opportunity from the reduction in greenhouse gas emissions.



- b) **Nitrogen use efficiency:** Improving fertilizer efficiency appears to be a promising way to reduce N_2O emissions. Increased emissions are associated with higher levels of nitrogen fertilizer use (e.g., ammonium nitrate, anhydrous ammonia). Precision farming using GPS tracking is one option that can help. Other approaches include more frequent and representative soil nutrient sampling to tailor application rates on different parts of a field, remote sensing technology and other methods to provide information for more efficient application of fertilizer.

- c) **Farm machinery:** There are opportunities to reduce fuel use, increase engine efficiency and better control emissions. The Carl Moyers program can help pay for newer and more efficient engines; practices and technologies that reduce fuel use will lower emissions; and biofuel blends (i.e., 20% biodiesel) can decrease greenhouse gas emissions. The cost-effectiveness of these and other approaches will need to be evaluated for any specific situation, but there are farms in California and elsewhere that have made these and other changes and found value in doing so.

3. Preventing or Destroying Emissions

One way to prevent or destroy emissions involves rice growers who remove their straw from the field and inhibit production of methane. Putting a field into permanent pasture might be another example. There also are opportunities for permanent plantings on field borders or establishing woodlots or tree crops on more marginal ground. Whatever the approach, it would be useful to discuss with UC Cooperative Extension, USDA-NRCS or university researchers the opportunities that may be appropriate for any specific operation, including issues of food safety and government programs that can help pay for plantings and installations.

In many cases, adopting new or more efficient practices will have additional environmental and economic benefits, including decreases in dust emissions and soil run-off, lower water consumption and savings on fuel and/or labor. Taking a closer look at innovative or non-standard approaches could produce multiple benefits, aside from climate change policies.





Federal and State Agencies

- U.S. Environmental Protection Agency climate change website
www.epa.gov/climatechange/index.html
- The California Climate Change Portal
www.climatechange.ca.gov/
A central information resource for state wide efforts in addressing climate change. This website includes the most current information about the Climate Action Team, climate change research, implementation of the global warming and solutions act (AB 32) and greenhouse gas inventory.

Carbon Offset and Carbon Credit Trading Programs

- Chicago Climate Exchange
www.chicagoclimatex.com/content.jsf?id=781
The largest and first U.S. voluntary greenhouse gas emission reduction and trading institution. Programs specific to conservation tillage and manure management have been developed here.
- California Climate Action Registry
www.climateregistry.org/Default.aspx?refreshed=true
The purpose of the Registry is to help companies and organizations with operations in the state to establish greenhouse gas emissions baselines against which any future greenhouse gas emission reduction requirements may be applied. Baselines, or protocols, that have been developed include ones for forestry and dairy anaerobic digesters.
- Point Carbon
www.pointcarbon.com/category364.html
Point Carbon is a world-leading provider of independent news, analyses and consulting services for European and global power, gas and carbon markets. This site is a useful resource for keeping track of the U.S. and international market pricing of carbon.

Federal and State Funding Programs

Few federal programs specifically fund climate change efforts in agriculture. There are several USDA programs that focus on improved land management and production practices. Environmental Quality Incentives Program (EQIP), Conservation Security Program (CSP), Agricultural Management Assistance Program (AMA), Conservation Incentive Program (CIG) and Wildlife Habitat Incentives Program (WHIP) fall in this category. These programs may fund practices that result in carbon being sequestered.

- Environmental Quality Incentives Program (EQIP)
www.ca.nrcs.usda.gov/programs/eqip/
The Environmental Quality Incentives Program (EQIP) helps to fund voluntary conservation projects for farmers and ranchers that promote agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist those eligible to install or implement structural and management practices on eligible agricultural land.
- Conservation Security Program (CSP)
www.ca.nrcs.usda.gov/programs/csp/
The Conservation Security Program (CSP) is an opportunity for California farmers who have been practicing good soil and water conservation on their farmland. The purpose of CSP is to reward the best conservation farmers and motivate others to become good stewards of the land.
- Agricultural Management Assistance Program (AMA)
www.nrcs.usda.gov/programs/ama/
Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Growers may construct water management or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming.
- Wildlife Habitat Incentives Program (WHIP)
www.nrcs.usda.gov/programs/whip/
WHIP is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed.
- Conservation Innovation Grant Program (CIG)
www.nrcs.usda.gov/programs/cig/
Conservation Innovation Grants (CIG) is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging Federal investment in environmental enhancement and protection, in conjunction with agricultural production. There is also a state component specific to California.
- California Climate Change (CCX) Funding Portal
www.climatechange.ca.gov/funding/index.html
Greenhouse gas reductions achieved through CCX are a legally binding compliance regime, providing independent third party verification by the Financial Industry Regulatory Authority. CCX employs independent verification, includes six greenhouse gases, and has been trading greenhouse gas emission allowances since 2003.