

# Impacts of AB 32 on Agriculture

**Daniel A. Sumner and John Thomas Rosen-Molina**

---

AB 32 is not scheduled to cap agricultural emissions. The main impacts of the legislation include higher energy costs for farming, processing, and transport. The induced changes in California farm practices will do little to reduce net global emissions.

California climate policies under the implementation of AB 32 have the potential for significant effects on agriculture in California. Although much of agricultural production and processing will not fall under mandatory greenhouse gas (GHG) emission caps, the *Climate Change Scoping Plan*, developed to implement AB 32, includes: (a) voluntary measures for GHG reductions in agriculture, (b) potential for supplying GHG offsets to capped industries and firms, (c) GHG emission regulations affecting producers and processors, and, perhaps most importantly, (d) increases in costs of energy inputs that will affect farming and processing industries.

This article focuses specifically on likely effects of the implementation of AB 32 on agriculture in California, and does not deal with the effects of agriculture on climate change or the effects of climate change itself on agriculture. Details of implementation are not yet known and many potential effects have not been studied in detail.

Nonetheless, we consider potential impacts on the agricultural economy and consequent effects on the environment, including global emissions.

## The California Agricultural Economy and its Contributions to Greenhouse Gas Emissions

The 2007 Census of Agriculture reports that there are more than 25.3 million acres of land in California farms. About 52% of this land is in permanent pasture and rangeland, while cropland, mostly irrigated, makes up about 37% of land in California farms.

Farm sales vary from year to year, with variations in commodity prices and yields. Variations for individual commodity industries are even larger than the aggregate, and as a result, the shares of individual commodities in total farm sales also vary substantially over time. Gross farm sales in California for 2008 and 2009 averaged about \$36.6 billion, with dairy accounting for about 16% and beef cattle another 5% of the total. Among the crops, grapes (used for wine, table grapes, raisins, and grape juice) accounted for about \$3.1 billion, followed by almonds with \$2.3 billion in gross sales. Tree and vine crops were 31% of gross sales, vegetables and melons were 22%, greenhouse and nursery products 10%, and field crops 8%. The large share of dairy and beef cattle in California agriculture has important implications for greenhouse gas emissions and the potential for reductions. Similarly, the large share of tree and vine crops indicates the potential for additional plantings as a mitigation strategy.

While California agriculture is the largest among the states, production agriculture accounts for only a bit more than 1% of gross state product.

When upstream and downstream industries are included, agriculture, broadly defined, accounts for less than 7% of the California economy.

Farming is a significant contributor to GHG emissions in California. The greenhouse gas inventory, developed by the California Air Resources Board (ARB), indicates that agriculture and forestry account for about 6% of total California greenhouse gas emissions. Dairy and other livestock production account for almost 60% of the farm emissions. Enteric fermentation (internal fermentation in the gut) that leads to methane releases from livestock, mostly cattle, is responsible for nearly one-third of GHG emissions from forestry and farming (Figure 1). Manure management accounts for another 27%. Soil management yields about one-quarter of all emissions from farming. Energy use on farms and other activities make up the remaining 17%, of which methane from rice cultivation alone accounts for about 2% of emissions.

Estimated emissions from agriculture are large relative to agriculture's share in the total economy. However, such calculations are only approximations and are not based on tracing all emissions back to the source. For example, agricultural emissions do not include the emissions from fertilizer production, just as food retailing emissions do not include the emissions that occur on the farm. Sectors such as electricity generation (both within the state and imported into California) account for a significant share of total GHG emissions for the economy, even though this industry is a small share of the whole economy. As with food and raw materials produced from farming, electricity is a crucial input to household consumption and other

industries. And, of course, even if food were not produced within California, residents here would still consume and the production of food would continue to have global GHG impacts.

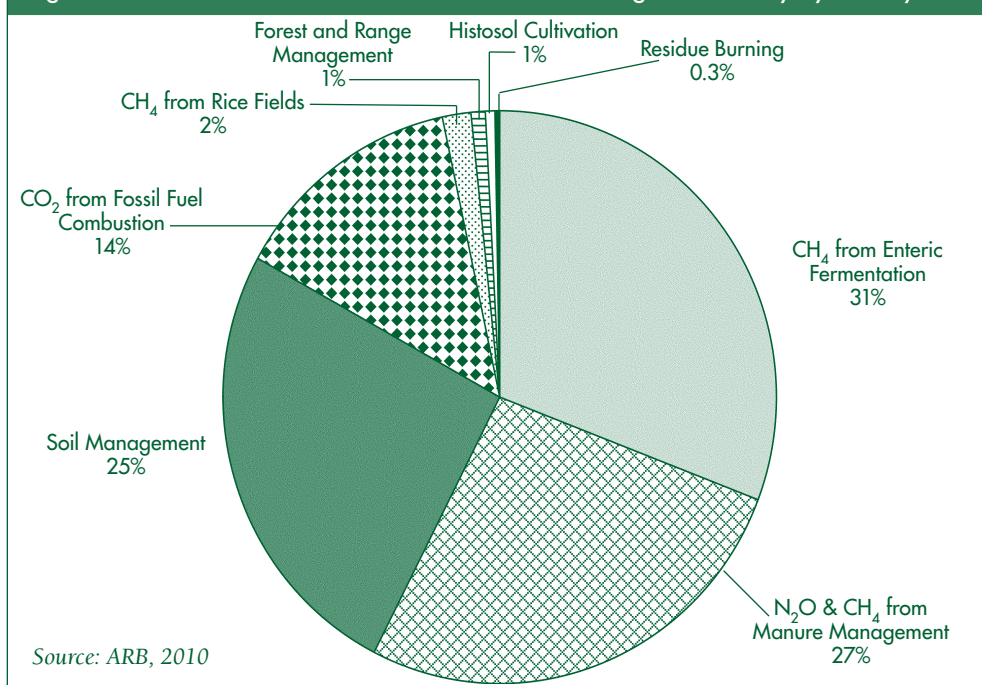
### Agricultural Emissions and AB 32

Agricultural emissions are not scheduled to be capped under AB 32. Nonetheless, the California ARB assumes that by 2020, the implementation of AB 32 will reduce emissions of greenhouse gasses by about 1–3%, compared to estimates for business as usual. Given the wide range of uncertainty about emissions accounting and projections, such small changes cannot be considered significant. Moreover, these reductions are not included in the ARB's overall GHG reduction calculations.

ARB assumes that agriculture will undertake “voluntary” measures to reduce GHG emissions, including methane capture by digesters at dairy operations. ARB estimates that implementation of these digesters will reduce GHG emissions by the equivalent of about 7.7% of 2008 emissions from dairy cattle. The technology for methane digesters has existed for decades, but widespread commercial adoption has not occurred without subsidies. As it stands now, AB 32 does not provide incentives for, or mandate the use of, methane digesters. Nonetheless, ARB sees them as the driving force behind GHG reductions in the agricultural sector and is currently developing compliance-offset protocols for their implementation. (If the price for offsets is high enough, they could encourage adoption of digesters that would not otherwise occur.)

AB 32 will mainly affect farming through measures that affect the cost of farm inputs—such as fuel, fertilizer, and energy for irrigation—and costs of processing of agricultural outputs. Emissions from food processing plants, such as dairy, tomato and wine processors, will be capped under AB 32 if they emit

Figure 1. 2008 California GHG Emissions from Farming and Forestry by Activity



more than 25,000 tons of carbon dioxide equivalent (CO<sub>2</sub>eq) GHG per year.

GHG emissions are reported by facilities through the ARB's Mandatory Reporting Program and the average reported emissions for food processors in California in 2008 was about 46,700 tons of CO<sub>2</sub>eq. Tomato-processing facilities emitted an average of about 47,000 tons, wine distilleries 44,000 tons, and dairy and cheese plants about 49,000 tons of CO<sub>2</sub>eq. These processors and others will face higher costs of meeting the cap by making costly adjustments, or by buying emission-allowance credits. Returns will fall for processor cooperatives, leading to a reduced demand for farm raw materials and lower prices offered to growers. Together with higher energy costs, higher compliance costs will encourage some firms to raise prices or reduce their operations in California.

Energy is a significant input to farm production, farm raw material processing, and agricultural inputs—such as fertilizer and irrigation water. Moreover, the shares of energy costs in producers' total operating costs tend to be relatively high for crops that are grown in California. For example,

the share of energy costs out of total operating costs for rice cultivation is about 9.2%, counting only oil and fuel inputs. If the energy used in the manufacture of fertilizer inputs is included, the share increases to about 16.7%. The corresponding shares for wine production are about 6% and 9.3%.

When complementary input costs rise in processing and marketing, the demand for farm raw materials falls. Therefore, as energy costs to processors rise, farm prices and quantities demanded by California processors decline. Shifts of production are more likely for intensive livestock industries such as dairy or poultry, which are more mobile and not as land-dependent as crop cultivation. For crop industries that are land- and climate-dependent, shifting production out of California is not likely. In such cases, higher California processing and marketing costs will lead farmland prices to be lower than they would be otherwise. For crops where California's market share is high, higher farm and processing costs will tend to cause consumer prices to rise. As a result, it is likely that some food prices, especially for tree crops

and vegetables, will rise as a result of the energy cost impacts of AB 32.

## AB 32 and Agricultural Emissions Trading

AB 32 distinguishes between “allowances” and “offsets.” As with other cap-and-trade programs, capped firms can choose to abate their emissions more than required and trade excess allowances with other firms in the “capped” sectors. “Offsets” refer to GHG reductions that occur outside of the capped sectors, and are purchased by firms in the capped sectors to meet their emissions reduction requirement.

Under AB 32, farmers will be outside of the regulated cap but may be able to sell offsets. AB 32 stipulates some requirements for offsets to be certified as acceptable to the cap-and-trade program. First, offsets must be additional, meaning only GHG reductions that would not have otherwise occurred can be counted and sold. Second, reductions must be non-reversible. That is, a firm cannot sell emissions reductions that can be overturned by another action a short time later. Third, offsets must be quantifiable, in that reductions must be demonstrable against a known baseline and follow standard protocols. Fourth, offsets must be verifiable and enforceable; meaning that practices must allow a transparent verification process and firms receiving offset credits must be accountable if they fail to comply with regulations.

Although ARB has acknowledged some practices as potentially valuable for GHG reductions, including the use of methane digesters on dairies, no farm offsets are currently certified by ARB and the development of protocols and certification may be a long and difficult process.

In its *Climate Change Scoping Plan* (2008), ARB outlines suggested practices for agriculture, indicating that potential certified offsets will fall into three categories—abatement,

sequestration, and efficiency gains. Abatement refers to the removal or destruction of GHGs before their release into the environment. Examples of abatement activities include the conversion of methane gas in digesters to provide fuel or power, and the use of feed additives for livestock that reduce an animal’s production of methane.

Sequestration is the removal of carbon dioxide from the atmosphere through biological, chemical or physical processes, and long-term storage of this GHG in a reservoir. For example, farmers could sequester carbon through minimal or “conservation” tillage. Cover crops also sequester carbon, at least temporarily. However, neither conservation tillage nor the planting of cover crops are widely practiced in California because the benefits are small relative to the losses, including loss of yield potential.

Efficiency gains outlined by ARB include increased irrigation efficiency, which would reduce energy for pumping water and may lower N<sub>2</sub>O emissions. Nitrogen-use efficiency can be raised by applying fertilizer more precisely on the places and in the amounts most needed by the crop. Abatement, sequestration, and efficiency-enhancing techniques may eventually be certified by ARB as potential offsets that could be sold.

## Practices for GHG Offsets from California Crop Production

There is still debate over the potential for some alternative practices to mitigate GHG emissions, and considerable study is needed before these can be certified for offsets. De Gryze et al. (2009) consider GHG reductions from alternative-cropping practices such as conservation tillage, cover cropping, and organic fertilization in the Sacramento and San Joaquin Valleys. The emission reductions modeled by the authors were mostly attributable to increased

carbon sequestration in the soils. Additional decreases in N<sub>2</sub>O emissions from reduced fertilizer application were more modest. However, unlike reductions in nitrogen application that generate permanent GHG reductions, increases in carbon sequestration do not lead to permanent GHG reductions. In addition, the authors’ results imply that up to a 25% reduction in nitrogenous fertilizers could cause up to an 8% decrease in crop yields.

Importantly, De Gryze et al. observe that changes in GHG emissions differed across location and crops. For instance, conservation tillage slightly increased GHG emissions for wheat (due to a rise in N<sub>2</sub>O), but decreased emissions for tomatoes. The modeling in this study considers alternate practices for production of each crop, but not the potential shifts of land between crops. Shifts between crops are an important consideration in the computation of overall changes in GHG emissions from all of agriculture.

The simplest way to reduce GHG emissions from farming is to reduce farm production. However, reducing emissions for offsets is surely not the only objective for agriculture—food, fiber, and foliage remain valuable. Therefore, it is important to consider measuring GHG reductions in terms of emissions per unit of output, not simply on a per-acre basis.

Consider, as an example, a potential GHG-reducing practice that could be adopted by rice growers. Rice is a significant GHG contributor, in part, because of methane emissions. When fields are flooded during the winter, straw residue on the fields decomposes anaerobically, emitting methane in the process. Draining fields mid-season and exposing straw residue to a shorter decomposition period should therefore reduce methane emissions. However, adopting alternate practices such as mid-season drainage is not without costs to producers, and

compensation may be necessary to encourage them to implement these potential GHG-reducing practices. To evaluate whether it is economically feasible for producers to adopt a particular practice, one should compare increased costs with decreased GHG emissions to trace out GHG reductions per dollar of reduced returns.

The University of California Agricultural Issues Center (AIC) has examined practices across more than 6,000 rice fields in the Sacramento Valley (see recommended reading box below). That work finds that the greatest cost to producers, from mid-season drying of rice fields and other practices thought to reduce methane emissions, is low rice yields. Preliminary findings indicate that several alternative practices have, at most, modest GHG reductions per acre, and that withdrawal of mid-season floodwater is not among the most effective practices to reduce GHG emissions per ton of rice. There is also substantial heterogeneity in emissions across fields by soil type in the California rice belt.

GHG emissions from some changes in crop and livestock practices would be relatively simple to measure and evaluate. These include reductions in fossil-fuel use or nitrogen fertilizer application. However, other processes make it difficult to apply AB 32 to agriculture. Agriculture is dependent on biological processes, and these are highly variable and challenging to monitor. Moreover, many potential offsets, such as forest sequestration projects, have a significant lag before they become effective. Sequestration is not a constant process and estimates of carbon storage require frequent calculation of biomass carbon over the project lifetime.

Sequestration also introduces the complex issue of permanence. Permanence requires that sequestered biomass not be removed in order for the stored carbon not to be re-released into the environment. This means that there exists the potential for release

of GHGs at any time during the life of the project. Stored carbon would be released if, for example, trees and vines in orchard plantings were replaced as markets shifted or if trees were pruned. Given the high productivity of California cropland, the permanent displacement of crops with forest is unlikely.

## Broad Concerns and Concluding Remarks

Perhaps paradoxically, the effective use of offsets to pay for changes in crop practices could actually increase GHG emissions from California agriculture. Offsets for practices are likely to be certified crop-by-crop—and thus would not account for shifting land across crops—and there are big differences in emissions by crop. A certified practice that allows payment for offsets for, say, tomatoes would likely raise per-acre tomato revenues and encourage more acres of tomatoes. The result would likely be fewer acres of competing crops such as wheat, which tends to have low GHG emissions relative to tomatoes. Thus, marketable offsets certified for tomatoes could cause a net increase in GHG emissions from agriculture.

Moreover, even a carefully implemented AB 32 for California agriculture could lead to increased GHG emissions from global agriculture. Because agricultural markets are global and food demand does not fall much when prices rise, policies that raise costs or reduce farm production in California tend to raise production elsewhere. That means global GHG emissions from agriculture are unlikely to fall. In fact, production practices elsewhere are often more land-intensive and emit more GHG units per unit of food, leading to more GHG emissions globally, which, of course, is the only scale that matters.

This paper focused on the effects of California climate change policy on California agriculture and, specifically, the potential responses of California

agriculture to AB 32 implementation. Because agriculture is outside the reach of cap-and-trade, AB 32 will primarily affect agriculture through higher energy prices that will affect farming directly and through farm inputs and post-harvest processing and marketing. We also find difficulties with certification of emission offsets from agriculture, including the inherent complexity of biological processes and issues of permanence. And, even if offsets are correctly certified, shifts between crops and out-of-state may lead to net increases in global agricultural emissions.

---

*Daniel Sumner is the director of the University of California Agricultural Issues Center (AIC) and the Frank H. Buck Jr. Professor in the Department of Agricultural and Resource Economics at UC Davis. He can be contacted by e-mail at [dasumner@ucdavis.edu](mailto:dasumner@ucdavis.edu). John Thomas Rosen-Molina is an economic research analyst at AIC. He can be contacted at [trosenmolina@ucdavis.edu](mailto:trosenmolina@ucdavis.edu).*

### For more information, the author recommends:

California Air Resources Board (ARB). 2008. *Climate Change Scoping Plan*. [www.arb.ca.gov/scopingplan/document/adopted\\_scoping\\_plan.pdf](http://www.arb.ca.gov/scopingplan/document/adopted_scoping_plan.pdf).

De Gryze, S., R. Catala, R.E. Howitt, and J. Six. 2009. *Assessment of Greenhouse Gas Mitigation in California Agricultural Soils*. California Energy Commission. [www.energy.ca.gov/2008publications/CEC-500-2008-039/CEC-500-2008-039.pdf](http://www.energy.ca.gov/2008publications/CEC-500-2008-039/CEC-500-2008-039.pdf).

Garnache, C., J.T. Rosen-Molina, and D.A. Sumner. 2010. "Economics of Greenhouse Gas Mitigation Practices in California Rice Production." Forthcoming working paper, University of California Agricultural Issues Center.