

ALMONDS

ADVANCING CLIMATE SMART AGRICULTURE

CALIFORNIA AND THE CALIFORNIA ALMOND INDUSTRY, LEADERS IN SUSTAINABILITY

As concerns about climate change increase, both California's state government and the California almond industry have been leading the way toward mitigating emissions and sequestering carbon in working lands. California was the first and only state so far to pass comprehensive climate regulations going back to 2006. The state continues to focus on efforts to reduce greenhouse gases (GHG) across all industrial sectors, including caps on major emitters, reducing reliance on fossil fuels, electrification of transportation, and urban planning.

California has integrated working lands into the state's climate strategies, modeling its role in climate mitigation and investing in multiple incentive programs to encourage reduction of greenhouse gases and sequestration of carbon on farms. Tactics include mitigating methane emissions through dairy manure management, giving grants to farms to upgrade irrigation systems and invest in tractors to reduce emissions, and supporting the flagship Healthy Soils Initiative Program aimed at sequestering soil carbon.¹

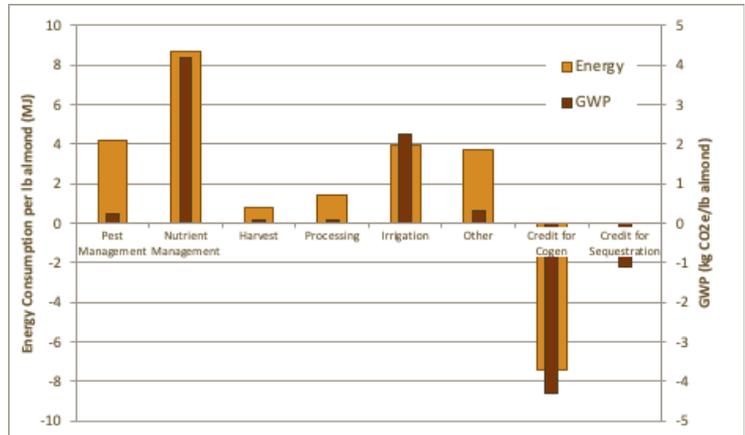
Like the state, the California almond industry has been an early investor in broadening our sustainability to include climate smart agriculture, research funding and outreach to growers to improve the carbon footprint of almonds. This research spans understanding GHG emissions across the life of the orchard as well as the use of co-products such as hulls and shells.

MANAGING EMISSIONS AND TARGETING ZERO WASTE

Like all crops, the main sources of GHG emissions come from nitrogen fertilizers and energy to pump irrigation water. In turn, however, the trees themselves store carbon as they grow, and the utilization of the annual hull and shell co-products, together with the woody biomass at the end of the orchard's lifespan, reduces the carbon footprint by nearly 50%. This early research on the carbon footprint of almonds spurred additional Almond Board research investments including:

SEQUESTERING CARBON IN TREES

As almond trees grow, they sequester carbon in the tree biomass as well as in the roots and soil. With an average lifespan of 25 years for an almond orchard, and increased acreage of perennial cropping systems across the California landscape replacing annual crops, more carbon is sequestered in our working lands.



Based on Kendall et al (2015): Life Cycle-based Assessment of Energy Use and Greenhouse Gas Emissions in Almond Production, Part I. *J of Industrial Ecology* 19:1008-1018.

WHOLE ORCHARD RECYCLING

ABC-funded research has paved the way to show growers how to recycle the trees at the end of the orchard's lifespan by grinding them up and incorporating the wood chips into the soil. Models show that recycling the orchard sequesters a minimum 2.4 tons of carbon per acre per year,² equivalent to living car-free for a year.³ Based on this scientific evidence, the state recently included whole orchard recycling in the Healthy Soils Initiative program.

NITROGEN MANAGEMENT

As a major source of GHG emissions, and to meet state water quality regulations, ABC-funded research has shown that applying nitrogen in smaller amounts but more frequently, i.e. spoon feeding the tree, can reduce emissions and leaching while retaining high yields.

COVER CROPS

Recent research on planting cover crops in the rows between almond trees shows improved organic matter content, improved soil moisture retention, improved water infiltration, reduction in weeds, and benefits to honey bees. To expand the use of cover crops, the Almond Board is working with researchers and extension specialists to develop best management practices to address issues in the state where frost or water may be limiting.

¹ <https://www.cdfa.ca.gov/oefi/healthysouls/IncentivesProgram.html>

² Michael Wolff, et al. Whole Orchard Recycling report for the Environmental Farming Act Science Advisory Panel. 2019.

³ Seth Wynes, et al. The climate mitigation gap: education and government recommendations miss the most effective individual actions. *Environmental Research Letters*. 2017.

COMPOST

With California's legal framework for separating green and food waste from trash, together with the state's large dairy industry, there is abundant compost available in the Central Valley. Almond Board-funded research will provide guidance to growers on how best to apply compost, as soil is not disturbed annually in an orchard, along with how to release nutrients in combination with drip and micro-sprinkler irrigation and ensure food safety. The research indicates applications over several years increase the soil organic matter content and the compost can provide some of the nitrogen needed.

CO-PRODUCTS

Hulls: Almond hulls are nutritious food for dairy cows and currently hulls are sold to local dairies. According to the life cycle analysis, the use of hulls means another feed item doesn't need to be grown, thus providing further reduction in overall GHG emissions. Current research is looking at additional uses for hulls, from food for black soldier fly larvae for chicken feed, to extracts for use in making beer or other products, to simply returning them back to the orchard and releasing nutrients into the soil.

Shells: Historically, shells are primarily used as bedding for cows. Current research is looking at their use in energy production (pyrolysis, torrefaction) and in stabilizing bio-based or recycled plastics.

Tree Removals: Traditionally, tree removals went to co-generation facilities contributing to electricity production, which was a significant factor in reducing the orchard's carbon footprint. With changes in the market, that route has been diminished. Research into pyrolysis and torrefaction of almond co-products seeks alternative ways for almonds to contribute to energy production, while also looking at uses of the remnants from those processes. And, we are encouraging growers to consider whole orchard recycling.

ENERGY USAGE

The almond industry has also been looking at energy usage, or sources of energy, as well as where almonds can contribute to energy production.

- ▶ Over 50% of the almond processors have installed solar power to supply some of their electricity needs.
- ▶ Growers have been adding solar power to run pumps.
- ▶ With the help of incentives there has been a tremendous demand to convert to electric ATVs.
- ▶ Improving irrigation efficiencies including adding the use of variable rate pumps.

REGENERATIVE AGRICULTURE AND CALIFORNIA ALMONDS

The term "regenerative agriculture" has captured the imagination of the public as a way to encapsulate the goals of not only growing food and fiber, but also the goals of improving soil health and biodiversity as well as storing carbon as part of the farming system. Most of the focus and experience with regenerative agricultural practices comes from row crops in rain-fed environments. As the concepts are applied to specialty crops, practices that maintain food safety need to be considered. Thus, animals will not directly be a part of many specialty cropping systems including almonds. However, as noted above, almond growers use composted manures from nearby dairies while providing almond hulls for dairy feed.

And, there are opportunities unique to perennial cropping systems. Roots are in the ground year-round. Almonds have long been a no-till system once the orchard has been planted. And practices that are returning some of the biomass grown, such as whole orchard recycling, very much fit the philosophy behind regenerative agriculture.



WHAT'S NEXT IN ADVANCING CLIMATE SMART AGRICULTURE FOR ALMONDS

As research on these practices shows, the benefits go beyond reducing the carbon footprint. Many of these practices improve soil health, can provide additional tools for integrated pest management, and provide habitat in the orchard.

- ▶ The Almond Board of California's Board of Directors included "use 100% of what we grow" as part of their Strategic Goals. In that context we are seeking to increase the adoption of whole orchard recycling as a key metric, while continuing to fund research on additional value-added uses of almond co-products.
- ▶ In the context of the goal aiming "to increase the use of environmentally friendly pest management techniques by 25%," we included planting pollinator friendly cover crops with the help of the how-to manuals being developed by the University and continue to work with Project Apis m on "Seeds for Bees".
- ▶ The continuing extension of the Almond Irrigation Improvement Continuum practices as a part of the goal of "reducing water uses to grow a pound of almonds by 25%" contributes to reducing the energy footprint of irrigation.
- ▶ We continue to engage with the state and federal agencies to ensure almond relevant GHG practices are eligible for incentives. We are engaged with a consortium exploring how to improve grower access to ecosystem services markets for practices that store carbon, improve water quality and/or water quantity.