WATER TECHNICAL SHEET

CALIFORNIA WATER 101

California is a global agriculture leader, and one of five places on Earth with the Mediterranean climate needed to grow almonds. Its cool, wet winters and hot, dry summers offer ideal growing conditions for many diverse crops, including almonds. To supply the water needed for the nation's largest agricultural state, Californians have invested in one of the most advanced water supply infrastructures in the world. At the same time, because almond farmers in California are committed to water's responsible and efficient use, they have made significant investments in improved production practices and adoption of efficient microirrigation technology. Over the last two decades, these improvements *have reduced the amount of water used to grow a pound of almonds by 33%.*[1] *By 2025, the California almond community is committed to reducing this amount an additional 20%.*

California would not be in the top 10 of the world's economies without the major investments it has made in water infrastructure, which allow water to be moved from the wetter north to drier and more populous areas of the state in the south. Water, for a large portion of the almond-growing areas of the state, is moved through a combination of rivers, pumps in the California Delta and canals. Other parts of the state have more localized systems. A major goal of these systems is to store and move water from the rainier winter to the drier summer by relying on snowpack in the Sierra Nevada mountains.

Surface water supplies are controlled through a number of different state and federal regulations. Among the goals of the various programs are ensuring species protection such as Delta smelt and chinook salmon, enforcement of water rights and making sure that diverted water is used for beneficial uses. These regulations are often revisited to ensure the most recent science is being used and that water used for one purpose (e.g., agriculture) isn't harming water for another (e.g., the environment). Because snowpack is a key method of water storage into summer months, climate change and other precipitation changes are being considered as regulations and infrastructure needs are further developed.

While surface water provides the majority of water for California farms, groundwater is the other important water supply source. On average, groundwater supplies about 30% of California's total water, increasing to 40% in dry years. Almond growers are committed to sustainable management of groundwater under California's recently adopted Sustainable Groundwater Management Act, also known as SGMA. Research has shown that many almond orchards can safely be used to capture flood-flows in the winter when trees are dormant, improving underground aquifers.

As water supplies are carefully regulated, so is water quality, which is important for meeting drinking water standards. The Irrigated Lands Regulatory Program has been tackling both surface and groundwater impacts by agriculture. The CV-SALTS program is just starting to take effect and is focused on nitrates and salts from all sources in the Central Valley. Significant research by the almond community has been focused on how to best apply nitrogen fertilizers and limit any potential impacts to both surface and groundwater.

Figure 1. Extracted from California Water Commission, 6/21/17 Meeting.

DO ALMONDS USE TOO MUCH WATER?

- California's recent drought brought with it broad discussion of the water footprint of food grown in the state, including almonds. Widely reported at the time was the blue component of almonds' water footprint, 1.1 gallon per almond, based on a global average[2].
- All food takes water to grow. In fact, the water needed to grow an almond tree is similar to that of other fruit and nut trees in California[3].
- In general, plants require more energy, and thus water, to grow proteins and fats rather than carbohydrates and sugars[4]. So, while almonds and other nuts need more water per serving than most fruits and vegetables, they are also rich in essential nutrients and good fats and protein, which contribute to their popularity as a healthy, satisfying and heart-smart snack.
- While almond farmers have made strides in irrigation efficiency, further improvements are underway. The Almond Irrigation Improvement Continuum, created by irrigation experts, is a roadmap for California almond farmers to accelerate adoption of research-based, water-efficient practices and technology.
- The water used to grow an almond actually grows four products: the kernel you eat, which is protected by a hull and a shell, as well as the tree. The trees store carbon and are transformed into electricity at the end of their lives, the shells become livestock bedding and the hulls are nutritious dairy feed, reducing the water needed to grow other feed crops. Unlike other foods that can leave behind pits, peels and rinds, with almonds, nothing goes to waste.

1. University of California, 2010. Food and Agriculture Organization of the United Nations, 2012. Almond Board of California, 1990–94, 2000–14.
2. M. Mekonnen & A. Hoekstra. The Green, Blue and Grey Water Footprint of Crops and Derived Crop Products. UNESCO – IHE Institute for Water Education. 2010.
3. Larry Schwankl, et al. Understanding Your Orchard's Water Requirements. University of California, Division of Agriculture and Natural Resources. Publication 8212. February 2010.
4. Munier-Jolain, et al. Are the carbon costs of seed production related to the quantitative and qualitative performance? An appraisal for legumes and other crops. Plant, Cell & Environment. Volume 23, Issue 11. November 2005.

california almonds®
Almond Board of California

HISTORY OF IRRIGATION IN ALMONDS

Although the first almond orchards in California were primarily planted as they have been for centuries in Europe—on hillsides without irrigation—growers eventually discovered that planting orchards in fertile, well-drained soils with irrigation and fertilization could double or triple yields. Technological innovation has continued, with early flood and furrow systems gradually being replaced by various microirrigation methods. Drip hose and microsprinklers are used today by nearly 80% of almond farms [1], almost double the state farm average of 42%.[2]

Besides new systems for distributing water in the orchard, new technologies have been developed to support decisions for optimizing the amount and timing of water applications—soil moisture sensors, tensiometers, evapotranspiration devices, and pressure chambers for measuring plant water stress. Some of these devices are now connected to the Internet and transmit data that can be checked via cell phone.

In addition to yield increases, these remote sensors that will improve efficient timing and delivery of water will also enable more efficient application of crop nutrients, reduce weed and disease pressure, and improve harvest timing. While these technologies require significant money and time to install and maintain, they enable growers to maximize their return on water applied. State and federal incentive funds have often matched farmers' own investments in on-farm irrigation systems. Much of the technology is being optimized through research funded by the almond community.

MOVING THE NEEDLE THROUGH RESEARCH AND INNOVATION

Research-based farming improvements and water-saving technologies have helped California almond farmers reduce the amount of water it takes to grow one pound of almonds by 33% over the past 20 years.[3]

Since 1973, the California almond community has been investing in research to improve how almonds are grown and processed. The Almond Board of California is proud to be rooted in science that serves as the foundation for continuous improvement. California almond farmers have a long history of using research to evolve their practices and continuously challenge themselves to do more. Since 1982, California almond farmers have committed $6.7 million to 201 different water research projects spanning irrigation efficiency, groundwater recharge and water quality. These investments will continue to fuel improvement for years to come.

While almond farmers have made strides in the area of irrigation efficiency, there's more we can do. The Almond Irrigation Improvement Continuum, created by irrigation experts, provides a path to improvement for every California almond farmer through specific irrigation recommendations. Now that research has shown how almond orchards can be used to replenish underground aquifers, farmers will be pursuing policies and implementation under SGMA, California's new groundwater law. Improvements in nutrition management will ensure that drinking water supplies are protected from excess nutrients.

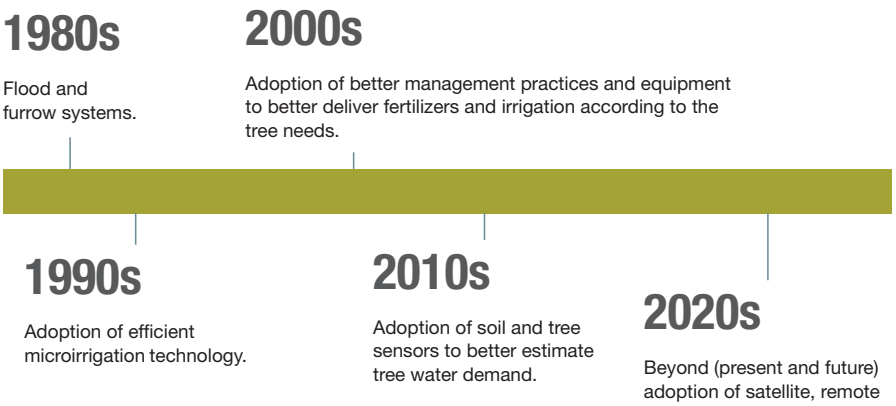

Figure 2. California almonds are on a continuous improvement journey.

BRINGING THE FUTURE CLOSER THROUGH RESEARCH, INNOVATION AND OUTREACH

Over the years, the Almond Board has developed a strong network of researchers from institutions such as University of California, USDA and Stanford University. Working together with these top scientists, hosting a strong outreach program and collaborating with our multi-generational farmers, we aim to accomplish even greater improvements in the years to come. By 2025, the California almond community commits to reducing the amount of water used to grow a pound of almonds by an additional 20%. Progress toward this goal is being measured by comparing almond farmers' annual irrigation water applied per unit of crop yield. The data underlying this metric is derived from the California Almond Sustainability Program's Irrigation Management module in which farmers assess and report their practices. From continued adoption of precision irrigation technologies to on-farm research exploring how California's almond orchards can be leveraged to replenish the state's groundwater, almond farming will be considered part of the solution to retain California's sustainability for years to come.

ALMONDS AND GROUNDWATER RECHARGE

- On-farm groundwater recharge applies excess winter stormwater to dormant orchards, allowing it to seep down and restore groundwater.
- California's aquifers are collectively the state's largest water storage system and used statewide for drinking water and farming. Overreliance on groundwater means that many of the state's aquifers are under pressure.
- To holistically understand how California's one million acres of almond orchards can be leveraged to replenish underground aquifers, the Almond Board has invested $1.6 million in field-trials and experiments to date. Research partners include researchers from University of California, Davis, Stanford University and Lawrence Berkeley National Laboratory, along with NGOs Sustainable Conservation and Land IQ.
- An analysis of soil characteristics found that 675,000 acres of California almond orchards have moderately good or better soil in their suitability for groundwater recharge[4].
- With two years of data available from on-farm trials, University of California, Davis researchers have found winter recharge of groundwater had no negative effect on almond trees and, in some locations, helped trees stay more hydrated during the growing season.

1. California Almond Sustainability Program. August 2019.
2. California Department of Water Resources. California Water Plan Update 2013: Volume 3, Chapter 2.
3. University of California, 2010. Food and Agriculture Organization of the United Nations, 2012. Almond Board of California, 1990–94, 2000–14.
4. Land IQ. Groundwater Recharge Suitability Analysis. November 2015.