

# ALMONDS + GROUNDWATER

Groundwater has always been a vital resource in California and plays a critical role in maintaining California's economic and environmental sustainability. However, the availability of surface water and continuing drought conditions impact California's groundwater aquifers and both managed and natural factors impact groundwater quality.

Globally groundwater is vital in supporting human needs, and in California it is pumped for drinking water as well as other urban and agricultural uses. An appropriate analogy for groundwater is that of a savings account. During dry years, the water is withdrawn (pumped), and can be restored with deposits (recharged) during wet years to maintain healthy and sustainable groundwater basins. During normal water years, groundwater is naturally recharged by winter rains and snowpack. Irrigation has traditionally also contributed to groundwater recharge; however, the use of increasingly precise irrigation methods that improve water use efficiency have reduced the groundwater recharge from irrigation in California.

Since 1973, the Almond Board of California has been funding research aimed at increasing almond growing efficiency and sustainability<sup>1</sup>, an investment totaling nearly \$30 million. For example, through more than 100 Almond Board-funded research projects since 1982, California almond growers have incorporated research-proven irrigation and horticultural practices that have reduced the amount of water needed to grow each pound of almonds by 33 percent.<sup>2</sup> Groundwater quality and recharge is another important area of research focus for ABC and part of the California almond community's commitment to continuous improvement.

## Sustainable Water Resources

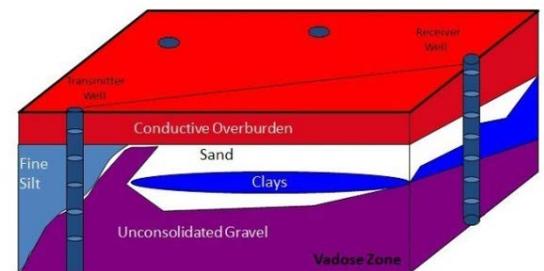
Part of an ABC strategic effort launched in Dec. 2015, Sustainable Water Resources is a targeted initiative aimed at exploring how to best leverage almond acreage for accelerating natural flood-year groundwater recharge of aquifers. This is vitally important given that continuing drought and its associated shortage of surface water supplies have meant the volume of pumped groundwater has been more than can be reasonably expected to be recharged without coordinated efforts to increase recharge. California's aquifers are collectively the state's largest water storage system and water recharged through this program would benefit all Californians, not just farmers. A second part of the Sustainable Water Resources initiative will look for opportunities to recycle water from multiple sources, such as municipal wastewater, as a way of increasing overall water availability for farmers and all Californians.

This initiative builds on ABC's research programs which have previously funded several projects to understand water movement in the soil, and preserving and improving groundwater quality.

ABC is currently collaborating with environmental organization, Sustainable Conservation; University of California, Davis; Lawrence Berkeley National Laboratory and private research firm, Land IQ, to understand the potential of leveraging California's one-million acres of almond orchards for groundwater recharge.

With research trials put in place in late 2015, the research partners will advance the science and practice of groundwater recharge in the coming years through the following actions:

- **Applied Research:** This effort is supported by Almond Board-funded research with the University of California, Davis and Lawrence Berkeley Labs which is being carried out at detailed research trials in the San Joaquin Valley. UC researchers are investigating how floodwater can be best applied on almond orchards for groundwater recharge without negatively impacting orchard health or crop yields, as well as groundwater quality.



Lawrence Berkeley National Laboratory scientists have expertise in using geophysical imaging which allows them to "see" underground without having to drill a well.

<sup>1</sup> California Almond Sustainability Program definition: Sustainable almond farming utilizes production practices that are economically viable and are based upon scientific research, common sense and a respect for the environment, neighbors and employees. The result is a plentiful, nutritious, safe food product.

<sup>2</sup> University of California. UC Drought Management. Feb. 2010. Food and Agriculture Organization of the UN. FAO Irrigation and Drainage Paper 66 – Crop yield in response to water. 2012. Almond Board of California. Almond Almanac 1990-94, 2000-14.

Using geophysical imaging, Lawrence Berkeley Labs is working to understand subsurface water storage, quality and movement in relation to almond orchard recharge test sites. Findings will assist in identifying the orchard practices and conditions best suited for recharge which will together advance the groundwater recharge potential of California's almond orchards.

- **Grower Trials:** Sustainable Conservation is engaging with farmers and growers to understand historic recharge efforts and quantify the costs of groundwater recharge. They are also collaborating with local Groundwater Sustainability Agencies who are forming as part of California's new Sustainable Groundwater Management Act, as well as advocating for groundwater recharge where roadblocks are currently limiting its potential for adoption and researching water quality to ensure water that travels past the root zone dilutes legacy nutrients.
- **Spatial Analysis:** Land IQ, a cutting-edge agricultural technology firm, has built on research by the California Water Foundation to identify where almond orchards overlay soils and geology suitable for groundwater recharge. Preliminary analysis from Land IQ indicates that nearly 675,000 acres of almond orchards are moderately good or better in their ability to recharge groundwater.<sup>3</sup>



Part of the University of California research trials, excess winter flood water fills almond grower Nick Blom's dormant orchard in January 2016. Since the trees aren't taking up water at this time, it is able to percolate into the soil with the potential to recharge groundwater.

These projects are part of the Almond Board's larger Accelerated Innovation Management (AIM) program which accelerates ABC investment in sustainability, almond tree and farming research, and steps up efforts to develop new partnerships and collaborations which will drive four major initiatives to move the entire California Almond industry forward.

## Groundwater Quality

A good nutrient management program for growing almonds calls for supplying enough of the required nutrients annually to keep the trees healthy and to replace the nutrients removed from the trees through each year's harvest. Applying an insufficient amount of nutrients risks the health of the trees and the size and quality of the current and next year's crop. However, oversupplying nutrients is inefficient and may have environmental implications, including impacts on groundwater quality.

ABC is building on a legacy of research in this area and is currently funding several projects designed to continually improve grower management of crop inputs such as nitrogen. To date, ABC has invested \$2 million in 71 scientific research projects helping to increase the industry's nitrogen use efficiency (NUE) to between 75-85 percent, well beyond the 50 percent U.S. agricultural average.<sup>4</sup>

Recently the Almond Board launched a grower decision support tool, the Nitrogen Calculator, an integral part of the industry's sustainable nutrient management goal. Available to growers via the California Almond Sustainability Program (CASP) online system, the free tool allows almond growers to assess tree nitrogen needs to more efficiently use nitrogen and avoid off-site movement.

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<sup>3</sup> Land IQ. Groundwater Recharge Suitability Analysis. Nov. 2015. Based on data from UC Davis Soil Agricultural Groundwater Banking Index, California DWR Groundwater Levels, USGS Central Valley Hydrologic Model Well Logs, USGS Corcoran Clay Extent, DWR Irrigation District Coverage, USGS Hydrology and Points of Diversion.

<sup>4</sup> Silva, S.S., S. Muhammad, B. Sanden, E. Laca, P. Brown. UC Davis and UC Cooperative Extension, Kern County. Almond Early-Season Sampling and In-Season Nitrogen Application Maximizes Productivity, Minimizes Loss Protocol for Early-Season Sampling and In-Season Nitrogen Budgeting.