As farmers switch from flood irrigation to drip, California's water tables are falling

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In the early 1980s, Tom Rogers grew alfalfa, row crops and a few almond trees on his family's farm near Madera, on the east side of the San Joaquin Valley. At the time, Rogers watered his land by flooding it several inches deep many times through the year — a simple technique called flood irrigation. It took about five feet of water annually to keep the farm in full production.

Thirty years later, Rogers has converted his entire 170-acre farm to almonds — one of the thirstier crops around. Yet he is at a pace to put just three feet of water on his trees this year. That's because he and his brother Dan, the farm's co-owner, have shifted to drip irrigation, the gold standard of watering methods in a land stricken by drought. Compared to flood irrigating, which loses a significant portion of water into the earth, drip lines feed out meager trickles of water into the soil slowly enough that a tree's underground tangle of roots is able to use nearly all of it. Less water may be needed, and the trees still thrive. In fact, crop yields often increase on drip systems, since flood irrigating can stress a tree and reduce its productivity.

The Rogers are just two of many farmers in California trying to get the most out of their water, usually by swapping out flood irrigation systems for drip lines and micro-sprinklers, which are nearly as efficient. For the farmer, growing more food using less water is a clear double win. It can also mean removing less water from rivers and aquifers, providing an environmental benefit. Agricultural groups and the federal government are actively encouraging growers to improve their irrigation systems to save water, usually by graduating from flooding, and farmers who haven't upgraded have received stinging criticism.

But drip irrigation is not necessarily a panacea for water shortages. It can come with surprising costs and in some scenarios may even accelerate, rather than slow, the depletion of already dwindling groundwater reserves. That's because the seepage and runoff that occurs when farmers flood their land mimics the annual flooding cycles that historically recharged the Central Valley's aquifers. Those natural floods, which once inundated the valley floor during wet winters, no longer occur, thanks to dams that hold water in reservoirs.

Now, with drip and micro-sprinkler lines replacing flood irrigation systems, aquifers in need of recharge are being pumped intensively while receiving almost nothing in return.

"Flood irrigation is not the big evil that it has been made out to be," says Matt Visser, an almond farmer near Ripon. "There's a groundwater recharge benefit from flooding, and as we've shifted away from flood, we've seen a drop in the water table in places."

Maurice Hall, a hydrologist and water resources engineer with M&M Hall Consulting, says some California aquifers rely on flood irrigation and other methods of watering that produce underground seepage for a large portion of their recharge volume. This means farmers who use groundwater are indirectly dependent on the seepage water from their neighbors.

"Water wasted by flooding usually isn't really wasted," Hall explains. "On their own land, it may appear lost, but from the perspective of the region or the water district, it's not lost." Rather, most of the water that sinks past a tree's root zone and into the ground, or flows into streams, can be recovered by other farmers, cities or ecosystems.

In a 2011 report, Fresno State University's Center for Irrigation Technology noted that drip and micro-sprinkler systems often use groundwater, not surface water, because of its constant availability — a necessity for systems that feed out slow but steady trickles. This can easily translate into a double whammy against aquifers, which end up providing additional water for an irrigation system that produces virtually no return seepage. The authors added that groundwater reserves take a similar hit when farmland is converted to residential use, since most water used by cities is channeled away in surface drain systems.

Drip and sprinkler systems are also energy-intensive to run, since they are pressurized, whereas flood systems generally work via gravity flow.

But perhaps the most surprising drawback about highly efficient irrigation systems is that, under some circumstances, they may cause a greater net loss of water from a drainage basin — like, say, the Central Valley — than flood irrigating. Because trees fed by slow rivulets of water are often healthier and more productive than flood-

irrigated trees, they also produce more foliage and fruit, which means they transpire more water into the air. Such evaporated water is totally lost until it falls again as rain, usually far away.

Flood irrigation, Hall notes, causes relatively little evaporation, even in hot weather.

"People see all that water standing in a field, and they think it's evaporating into the air, when actually much more water transpires off the plants themselves," Hall says.

In spite of such a suite of consequences, farmers are upgrading their irrigation systems to produce financial savings on an individual level. Flood irrigation is commonly said to have about a 50-percent efficiency rate, meaning that only half of the water applied to the crop gets used by the crop. Traditional sprinklers run at about 75-percent efficiency, micro-sprinklers around 90 percent and drip systems closer to 100 percent.

Seventy percent of almond farmers, and about 40 percent of all farmers statewide, were using efficient micro-irrigation systems as of 2013, according to data from the California Department of Water Resources. To the farmer, the financial incentive to improve efficiency is clear. Visser says he recognizes the potential collective benefits of flooding. Still, he has installed a state-of-the-art micro-sprinkler system that receives water from the South San Joaquin Irrigation District only when Visser, who monitors moisture conditions on his property, requests it. Visser's system allows him to apply a minimum amount of water to his land.

"It wouldn't make financial sense for me to go back to flood," he says.

The U.S. Department of Agriculture is encouraging a shift toward more efficient irrigation practices with a program that financially assists small farmers in making operational changes that benefit the environment. Called the Environmental Quality Incentive Program, this directive, in place since the 1990s, funnels $1.5 billion annually to American farmers earning less than $900,000 per year to incentivize them to do things like install micro-sprinklers or level their land using laser technology, which can reduce the amount of water needed for complete flooding.

Jim Spear, a USDA official in Red Bluff who helps oversee the subsidy program, says helping farmers install more efficient irrigation systems is frequently beneficial. While flooding cropland can help replenish groundwater reserves, Spear says it has some potential drawbacks. Sometimes, Spear says, water that sinks underground past a tree's root zone can impact groundwater quality by picking up nutrients such as nitrates. In other cases, percolating water may be perfectly clean. However, if the aquifer below already contains salt or other undesirable compounds, as some do, any water that enters can become unusable.

Reducing such percolation can be an environmental benefit. According to Spear, roughly half the $100 million that the EQIP spends each year in California is aimed at irrigation enhancements to save water.

But there are critics who say the program is missing its mark, since most of the water savings it has produced have been offset by unrestrained growth of the agriculture industry. Almond farmers, for example, are now using a third less water to grow each almond than 15 years ago, according to industry representatives. However, the savings produced through improved irrigation methods have been entirely recirculated back into the growth of more trees. Since 2000, acreage of almonds has nearly doubled, from about 500,000 acres then to more than one million, and all told, the industry's annual water consumption is growing. Many almond growers, though not Visser or the Rogers, have been assisted by EQIP funds.

"[The Environmental Quality Incentive Program] is a complete subsidy to the farmer," says Tom Stokely with the California Water Impact Network. "The public is paying for agricultural water conservation, but there is no benefit to the public, like for the environment or for cities that need it. Farmers are just using the public support to expand their acreage."

Spear says it is not his agency's job to watch what happens with water savings after irrigation improvements are made.

"Our objective is to reduce water demand and to help farmers give their plants just what [the plants] can use and let as little water as possible sink past the root zone," he says. "Congress has directed us to see that farmers apply water as efficiently as possible, but we have no ability to decide what happens with the savings."

But in some cases, there may not actually be any savings. "This is public money that almost certainly benefits the individual farmer but not necessarily the entire system or water district," Hall says. He cites research from the University of New Mexico that shows subsidies supporting irrigation improvements in the upper Rio Grande basin ultimately increase depletion of water supplies, since drip irrigation contributes less to groundwater reserves while accelerating water loss by vaporization.

The environmental community seems to have different ways of viewing the benefits and drawbacks of irrigation efficiencies. While farmers who remain on flood irrigation systems have drawn fire from those critical of agricultural water waste, some scientists feel flood irrigation — and land inundation in general — provides a host of benefits that more efficient irrigation systems do not, like aquifer recharge and habitat for fish and birds. Rene Henery, the California science director with Trout Unlimited, believes agriculture should be practiced in a way that allows water to behave more like it would under natural conditions. This would mean using flood irrigation on low-lying river plains and perhaps using these areas to grow crops that can handle wet soils or even full inundation, like rice. However, most agriculture is practiced in an unnatural way, on a landscape heavily altered with levees and expensive water conveyance infrastructure.

"There's a cost to not having agricultural practices in alignment with how the hydrology would have worked historically, and usually those costs are borne by the public," Henery says.

Heather Cooley, the director of the water program at the Pacific Institute, says incidental recharge of aquifers may be a benefit of flood irrigation — but it isn't always. In many places, water that is allowed to sink into the earth cannot be recovered, she says.

"We need to make sure that water is flooded over areas where there is a connection to the groundwater basin," Cooley says.

Like Henery, Cooley believes relying on flood irrigation to replenish aquifers can work only if the method is applied strategically, with an understanding of the geology, hydrology and history of the area.

There seems to be no two ways around the fact that California's thirst has outgrown its water supply, Hall says. He believes decreasing agricultural water consumption could be achieved in three ways: either by reducing the total acreage cultivated, growing fewer water-intensive crops or simply giving crops less water, even if it means crop yields decrease. Many fruits and row crops can withstand reduced irrigation or even none at all. Grapes, tomatoes, potatoes and melons all may benefit from dry-farming.

Improving irrigation efficiency doesn't produce more water. Instead, it just changes the way existing water moves and where it goes. Still, Hall understands why farmers who are paying for their water improve their irrigation to use less of it.

"If you divert less water from streams, it makes sense," Hall says. "It's very appealing. It's good for the farmer, and it appears to be good for the environment."