Sustainable Conservation

On-farm Recharge Pilot Projects Case Study

Grower: Al Costa

Crop: Wine Grapes

Location: Acampo, San Joaquin County

Project Description

Al Costa is a wine grape grower in the San Joaquin County who has participated in on-farm recharge since 2018. His 13.7-acre recharge site is very sandy, allowing the application of large volumes of water without harm to his crops (see tables below for details). The grower also has the benefit of working with an irrigation district that is very supportive of recharge efforts.

The on-farm recharge effort at the vineyard is a prime example of what can be achieved when different entities, such as farm communities, local irrigation districts, and groundwater sustainability agencies, collaborate with the common goal of replenishing groundwater.

The accomplishments of the grower and the recharge benefits observed at his farm are an important reminder that grower participation is critical to achieving Sustainable Groundwater Management Act goals. Incentivized on-farm recharge programs encourage grower participation, because many growers need financial support to cover the cost of infrastructure and electricity required to conduct on-farm recharge. Growers would like to see an expansion of similar programs in the San Joaquin and Sacramento valleys.

Field Description

Category	Details
Acres	• 13.7 acres (recharge site) • 9.1 acres (control site)
Type of crop	Zinfandel grapes
Age of crop	Planted in 1992
Average root depth	6–7 feet
Irrigation infrastructure	Irrigation is applied using a single dripline tape per plant row.
Soil amendment	Periodically, based on need, the grower applies gypsum at a rate of approximately 20 pounds per acre.

Hydrogeology

Category	Details
Soil texture	• Sandy. • Mr. Costa notes it was extremely hard to get irrigation water across the field. Grape vines tended to be less developed at the end of furrows because of low soil moisture retention in sandy soil texture. There are some extremely sandy streaks in the recharge and control sites.
Land IQ rating	Moderately good
Soil Agricultural Groundwater Banking Index rating	Good to excellent
Restrictive layers	None
Depth to groundwater	75–80 feet

On-Farm Recharge Logistics

Category	Details
Source of water	Water for groundwater recharge was provided by North San Joaquin Water Conservation District (NSJWCD).
Maximum diversion rate	10 cubic feet per second
Method of diversion	Water was pumped from the Mokelumne River into an underground conveyance pipe that leads to the vineyard.
Cost of water	• NSJWCD did not charge the grower for the recharge water. • NSJWCD paid for the electricity to pump the water from the Mokelumne River and for the infrastructure to convey the water to the vineyard recharge pilot site. • The grower provided the labor and equipment to prepare the site and manage the applied water.
Field preparation and management during recharge	• A 6-inch berm was installed at the outer perimeter of the recharge field site, and an inflatable gated pipeline was placed on the west side of the field for flooding each row. • Water was conveyed through an underground pipe for approximately 1,500 feet before entering a flood-pipe riser at the head of the multiple rows on the field's west side where the inflatable, gated flood pipe was connected. • The water that was pumped into the rows rapidly infiltrated before reaching the end of the field, which was approximately 1,000 feet from west to east.
Nutrient management	Fertilizer was not applied during the dormancy period from late November to early April.
Average inundation height	The maximum depth of water in the field was 3–4 inches.
Duration of inundation	The infiltration rate was excellent. The water could be turned on continuously for 24 hours without overflooding the field.
Time to dry down	It took 1 day to dry down soil was required after turning off applied water.

Recharge Events

Year 2018

Dates of recharge	Duration (days)	Field size (acres)	Water applied (total acre-feet)	Water applied (feet per acre)	ETc (feet)	Net water recharged (total acre-feet	Net water recharged (feet per acre)
Oct. 5–Nov. 5	32	13.7	237	17.30	0.26	232.73	16.99

Table notes: Dates of recharge, field size, and water applied sourced from the grower. Crop evapotranspiration (ETc) value sourced from California Irrigation Management Information System station #71C.
Net water recharged = water applied – (1.2 x ETc x acres).

Year 2019

Dates of recharge	Duration (days)	Field size (acres)	Water applied (total acre-feet)	Water applied (feet per acre)	ETc (feet)	Net water recharged (total acre-feet	Net water recharged (feet per acre)
Oct.4–Oct. 17	14	23	125.87	5.47	0.07	123.94	5.39
Oct. 21–Oct. 27	7	23	53.76	2.34	0.04	52.66	2.29
Nov. 16–Nov. 30	15	23	115.76	5.03	0.03	114.93	5.00
Rain							0.20
Total	36		295.39	12.84	0.14	291.53	12.88

Table notes: Dates of recharge, field size, and water applied sourced from the grower. ETc value sourced from California Irrigation Management Information System station #71C.
Net water recharged = water applied – (1.2 x ETc x acres).

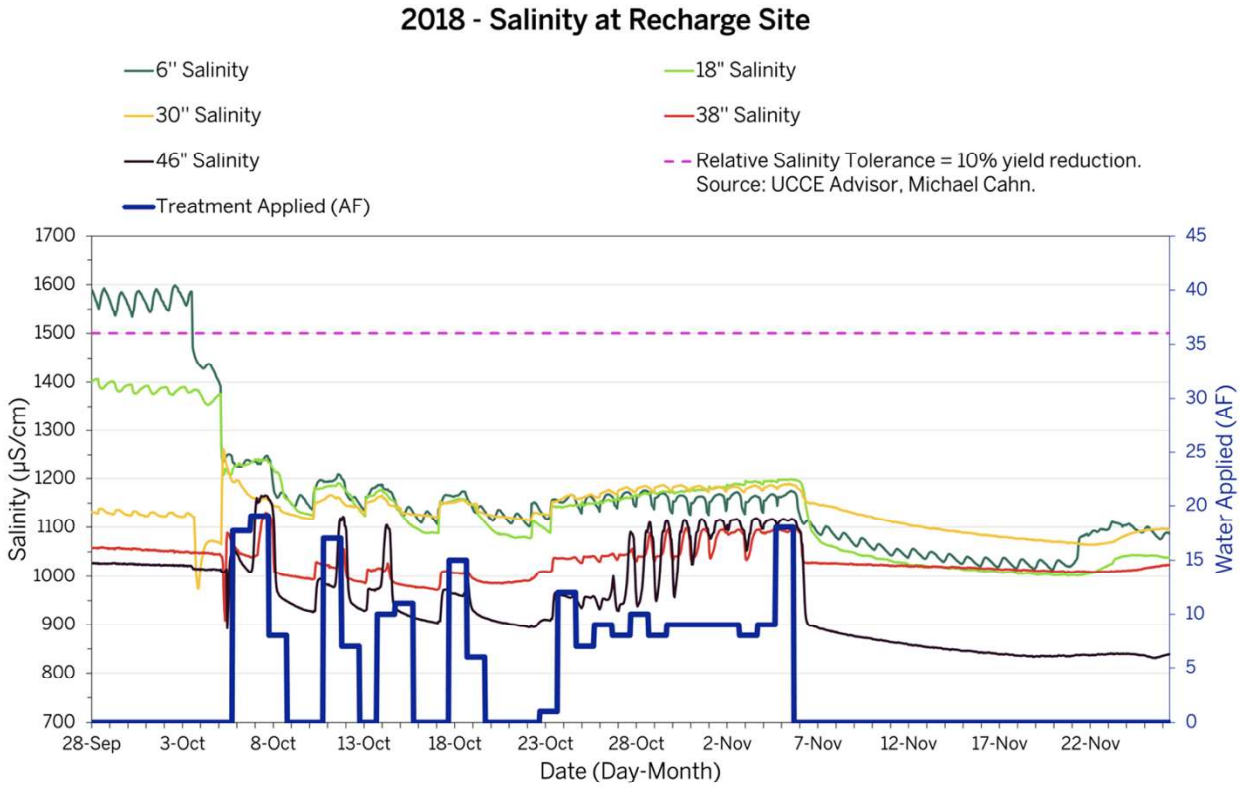
Year 2022

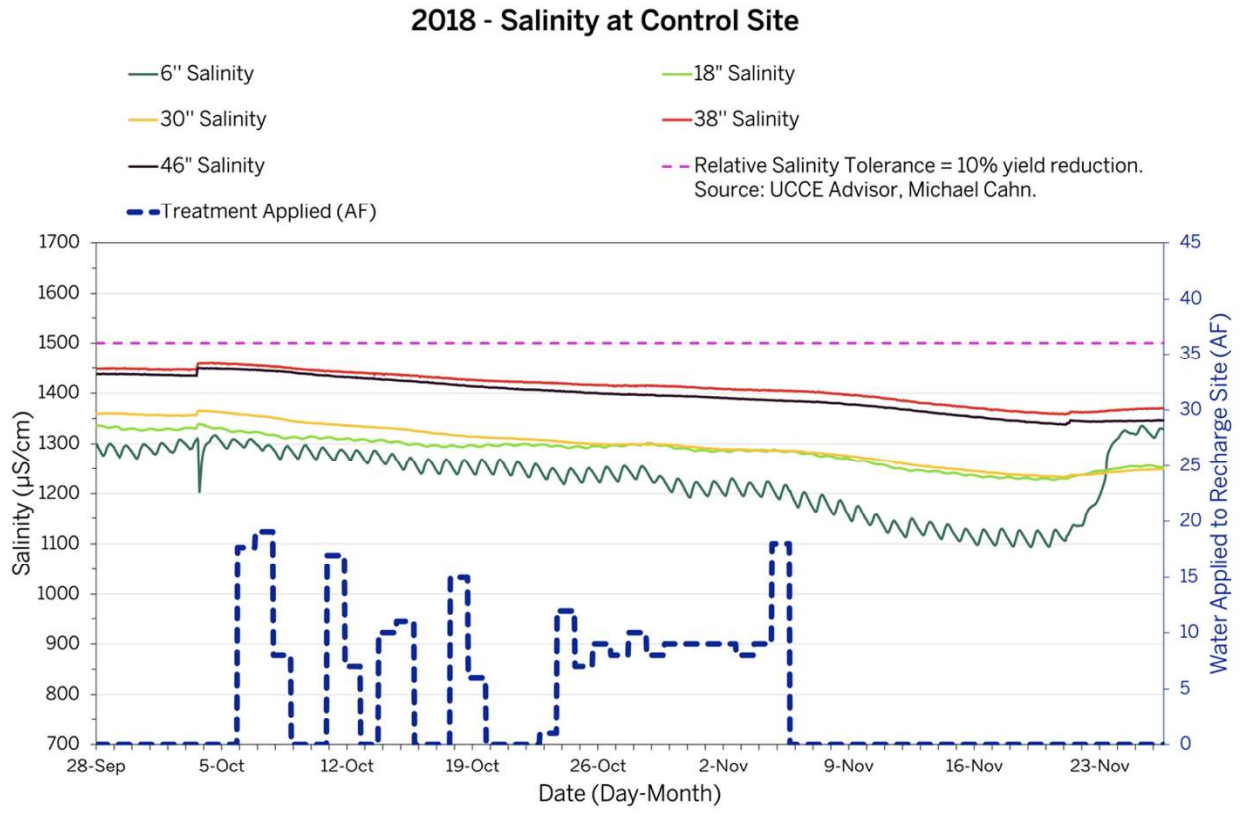
Dates of recharge	Duration (days)	Field size (acres)	Water applied (total acre-feet)	Water applied (feet per acre)	Etc (feet)	Net water recharged (total acre-feet	Net water recharged (feet per acre)
Dec. 9–Dec. 31	23	23	223.47	9.72	0.01	223.15	9.70
Rain							0.49
Total							10.19

Table notes: Dates of recharge, field size, and water applied sourced from the grower. ETc value sourced from California Irrigation Management Information System station #71C.
Net water recharged = water applied – (1.2 x ETc x acres).

Changes in Field Conditions

Category	2018	2019
Diseases and weeds	The grower did not notice any increase in disease activity over the standard practice of routine powdery mildew and bunch rot prevention sprays that were also used on the control plot.	The grower did not notice any increase in disease activity of powdery mildew and bunch rot in the grapevines.
Yields	The recharged field yielded 2.29 tons per acre. The control field produced no significant difference in yield compared to the recharged field. Year 2018 was an off-year of production. In normal years, production is twice the tonnage per acre.	Not known.
Salinity	In the charts below, see an example of salinity dilution occurring during the application of recharge water within the first 46 inches of soil. Many growers refer to this as an immediate benefit from on-farm recharge to their crop growth and development. Growers throughout the Central Valley have commented on the excess salt buildup in the soil because of drought in California which has been compounded by drip irrigation in reducing yields and quality of crops.	Soil salinity levels were ideal, between 800–1,143 microSiemens per centimeter (µS/cm) in the first 46 inches of soil. These levels were well below the grapevine's tolerance level of 1,500 µS/cm.
Changes to field practices	The grower did not notice any increase in disease activity over the standard practice of routine powdery mildew and bunch rot prevention sprays that were also used on the control plot.	The grower did not notice any increase in disease activity of powdery mildew and bunch rot in the grapevines.


2018 - Salinity at Recharge Site
6" Salinity
18" Salinity
30" Salinity
38" Salinity
46" Salinity
Relative Salinity Tolerance = 10% yield reduction.
Source: UCCE Advisor, Michael Cahn.
Treatment Applied (AF)
Salinity (µS/cm)
Water Applied (AF)
Date (Day-Month)
28-Sep
3-Oct
8-Oct
13-Oct
18-Oct
23-Oct
28-Oct
2-Nov
7-Nov
12-Nov
17-Nov
22-Nov


2018 - Salinity at Control Site
6" Salinity
18" Salinity
30" Salinity
38" Salinity
46" Salinity
Relative Salinity Tolerance = 10% yield reduction.
Source: UCCE Advisor, Michael Cahn.
Treatment Applied (AF)
Salinity (µS/cm)
Water Applied to Recharge Site (AF)
Date (Day-Month)
28-Sep
5-Oct
12-Oct
19-Oct
26-Oct
2-Nov
9-Nov
16-Nov
23-Nov

Grower's Experience

Category	Details
Grower observations	Mr. Costa believes his field could receive a lot more water if it is available and if he has continued access to local incentive assistance funding to help offset electrical bills for pumping.
Grower motivations	• Mr. Costa wants to recharge for replenishing overdrafted aquifers in order to meet Sustainable Groundwater Management Act goals. Also, he wants to help ensure the production of agriculture for future generations. • Mr. Costa thinks the immediate benefit of on-farm recharge is reduction in soil salinity, which promotes a healthier plant.

Groundwater Fate

The farm is located near the Mokelumne River, prompting interest in determining if recharged water flowed toward or away from the river. The North San Joaquin Water Conservation District funded a groundwater fate engineering study to understand where recharged water was going. According to their data, all monitoring wells confirmed increases in groundwater levels following the 2018 and 2019 recharge events. In both years, the most significant changes in water levels occurred at wells farther from the river relative to the recharge field indicating that the bulk of the recharge water was moving away from the river. This farm is somewhat unique because the soil is so sandy, but these results counter the commonly held belief that applying water on farms near rivers or streams does not contribute to aquifer recharge.

Position of monitoring well relative to recharge field	Approximate distance to the Mokelumne River	Increase in water levels from 2018 recharge (approximately 3 months after recharge commenced)	Increase in water levels from 2019 recharge (approximately 4 months after recharge commenced)
North of recharge field, away from river	2,600 feet	9.6 feet	1.5 feet
North of recharge field, away from river	2,550 feet	4.8 feet	5.3 feet
West of recharge field, parallel to river	2,160 feet	5.4 feet	4.9 feet
Recharge field	1,750 feet	4.0 feet	4.0 feet
South of recharge field, next to river	500 feet	0.8 feet	0.4 feet

LEFT Photograph: On-farm recharge in mid-January 2022. The water head height is 3–5 inches.

RIGHT Photograph: Jose Luis, the field manager, is standing on the west side of the Costa vineyard where the recharge water is pumped into the field from about 1,500 feet of underground pipe using a lay-flat perforated temporary conveyance pipe, which is connected to risers at the head of the plant line. The field manager handles all of the logistics for successful on-farm recharge without unintended consequences. This picture was taken on January 25, 2023, about two weeks following a flood overflow breach from the Mokelumne River after on-farm recharge efforts in December 2022.

The Mokelumne River is the water supply for the Costa vineyard. But as of early January 2023, all on-farm recharge efforts ceased because of river overflow and flood conditions in Acampo, CA.

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