Water Efficiency for Instream Flow:

Making the Link in Practice

Page Topic

Resource Section 4

Agricultural Water Efficiency:

Examples of California District and On-Farm Practical Experience

Several examples of on-farm and water district efficiency efforts drawn from California are presented here. These were developed and contributed by the Agricultural Water Management Council, to help illustrate not only the range of possibility in creatively managing water use, but also provide some indication of the range of variables that can be accommodated through intelligent water use efficiency programs.

More information on the Council is at **www.agwatercouncil.org.**

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Irrigation System Choices: Consolidated Irrigation District

Water use efficiency efforts are not always driven by conservation considerations. California's diverse agriculture industry, like the rest of the western U.S., is the result of many different water supply sources, climates, soil types and topography. A choice in one region, such as choosing to plant an orchard to grow peaches or nectarines, is likely not appropriate in another region where soils may be shallower and winter temperatures are not conducive to the production of stone fruit. In the Northern San Joaquin Valley of California, deep loamy soils and cold, foggy winters lend themselves to producing fruit crops that mature in the late spring and summer. Conversely, in the much drier Imperial Valley more than 400 miles away, a year-round growing season and hot temperatures make alfalfa production a staple as a feed supply for its local cattle industry.

Located in the Central San Joaquin Valley near the town of Selma and straddling Highway 99, Consolidated Irrigation District (CID) provides surface water for farmers in its 144,000-acre service area. Additionally, five cities lie within the district—Fowler, Kingsburg, Parlier, Sanger, and Selma—all of which draw their water supplies from groundwater sources underlying CID.

CID has water rights on the Kings River, a source that is fully appropriated among a total of 28 irrigation districts, or "units." Kings River water rights are defined in a document known as "the blue book," which defines the volume of water each unit receives according to its place in line among water rights holders on the river.

Flow on the Kings River is governed by releases from Pine Flat Dam. With a storage capacity of 1 million acre-feet in Pine Flat Lake, the multi-purpose project was constructed by the Army Corps of Engineers from 1949 to 1954. Pine Flat Dam's primary purpose is one of flood control, with irrigation and recreation following in order of priority. CID stores its annual water allotment in Pine Flat Lake and releases supplies through the summer irrigation season to meet the needs of the farmers in the district. Since Pine Flat Dam is first and foremost a flood control project, the Army Corps of Engineers has the first say in how much water is stored and released from the dam, especially in wet years when flood risk is greatest.

CID water is allocated to each farmer in "turns" with each turn being two cubic feet per second for one day for each 10 acres of land. At this rate a 100-acre farm would receive 10 days water service at two cfs, or slightly less than 0.4 acre-feet per acre per turn. The number of turns received by farmer in a season varies based upon how wet the year. The approximate water supply average for lands on water service within CID is 2.5 acre feet per acre while the average for all California farms is 3.5 acre-feet per acre. The cost for CID water is about $26 per acre, fairly low compared to other areas of the state. Some agricultural economists theorize that low water costs are associated with waste and that higher prices are necessary to send a conservation-based price signal to water users. That has not been the case among CID farmers. Despite a relatively low water rate, limited supplies necessitate wise use of the limited water available.

Selma-area farmer Larry Cruff grows raisin and wine grapes on 500 acres in CID. Of the acreage he farms, 450 are family-owned and the remaining 50 acres are leased from a neighbor. Starting in 1981 Cruff began installing drip irrigation systems on all of his 450 acres and while he expected to see water usage drop, it has remained about the same while crop production increased. He attributes this to the fact that more of the water is being used by the plant rather than percolating into the ground or evaporating. Cruff said another benefit achieved by drip irrigation is that distribution uniformity (the uniformity at which water is applied over the entire acreage) has improved. Fertilizers are also applied through the drip system, which reduces tractor operations and saves money on fuel and labor. Cruff handles irrigation responsibilities on his own but says his operation would require two additional employees if he irrigated using conventional methods.

Cruff isn't alone when it comes to irrigation system changes over the years. District-wide, CID has seen many farmers invest in costly systems, not primarily because they reduce the amount of water needed to grow a crop, but because they deliver a higher economic return through increased crop production. A typical drip irrigation system can cost as much as $1,200 to $1,400 per acre in California to design and install, which would be cost prohibitive based only on the price of water available to these farmers and their potential conservation savings. The real incentive is the flexibility gained in farm operations and potential increases in crop production.

Interestingly, despite Cruff's experience, district records indicate that the prevalence of drip systems has had a measurable impact on district operations and water use. Historically, peak summer demand hovered around 1,600 cfs to meet the needs of the farmers throughout the district. Today, drip and other micro irrigation systems have reduced peak summer demand to around 1,200–1,300 cfs. That allows the district to extend the irrigation season, further enhancing crop production potential over a time when the district's irrigation supplies normally were exhausted by the end of the summer. This benefits all the farmers in the district.

A potential problem in the future as a result of improved irrigation efficiency is the water supply for the five cities in CID. Like most Valley communities, Selma and the others draw their water supplies from groundwater resources. Long term average annual precipitation in the San Joaquin Valley is much less than the annual water use of these communities. Historically over-irrigation of farm water has contributed to sustaining the groundwater aquifers the rural communities depend on. Reduced groundwater recharge by agriculture, either as a result of changing irrigation practices or actual reductions of supplies to farms, may lead to increased groundwater overdraft by communities the Valley, and necessitate building more diversion facilities and canals diverting additional new streamflows.

Improved agricultural water use efficiency can help reduce costs for farmers and potentially increase crop production and revenue. In areas such as Consolidated Irrigation District where water costs are low and water supplies are often available, investing in expensive irrigation systems may not seem to make sense. But these farmers recognize technological advancements that have benefits beyond what meets the eye and have implemented new technology as it becomes available and affordable.

Drip Irrigation Technologies and Methods: Stamoules Produce Co.

Expanding growers' adoption of complex on-farm irrigation technologies and techniques can greatly affect both the amount of water used in the production of food crops and fiber and the quality and quantity of those products. One such technology is buried drip tape, also often known as subsurface drip irrigation (SDI).

Drip irrigation is a technology not uncommon in America's backyards—and is also utilized by many growers looking to improve water application. One specialized form of drip irrigation is subsurface drip irrigation (SDI), used in many of the fruit, vegetable and melon fields of California. Growers successfully adopting SDI have learned to balance the demands of the new technology by adapting their farming techniques to achieve numerous benefits.

The many reported benefits of SDI include:[1]

1. Permanent installation below the plow depth provides considerable labor savings and irrigation can be applied while equipment is in the field.
2. The subsurface drip system is buried and not handled annually. The subsurface system is out of the sunlight and not subjected to constant wetting and drying and heating and cooling, therefore it is expected that the system will last longer than one which is on the surface and exposed to the changing environment.
3. The top layer of soil remains dry; hence, evaporation of water from the soil surface will be limited to vapor diffusion because of the mulching effect of the dry soil and less salts will accumulate at the surface.
4. Any soil surface crusts which usually cause infiltration problems will be bypassed.
5. Application uniformity is improved: water running off the surface forming localized ponding will be eliminated.
6. Water distribution throughout the field along the laterals is improved.
7. Reduced soil compaction by equipment improves soil moisture uptake.
8. Water and nutrients are applied directly to the root zone. In addition, the roots will take up and use nutrients more efficiently provided that the irrigation and fertilization schedules are adequate.
9. Application of fumigants and/or pesticides through the subsurface drip system will provide enhanced use of chemicals for weeds and pest control; this is true particularly if the surface is irrigated simultaneously to seal the soil surface temporarily.
10. Since the topsoil is kept dry during most of the growing season, occurrence of fruit rot and soil borne diseases enhanced by wet soils should be minimized. Germination of shallow weed seeds will be decreased because of lack of necessary soil water.
11. Double cropping is facilitated due to laterals remaining in place.

Farmers choosing SDI must balance these benefits and the potential for improvements in yield and crop quality against increased costs associated with implementation, particularly those of SDI purchase, installation and maintenance, as well as the substantial increase in power used to filter irrigation water sufficiently to pass through SDI tape. Recent advances in farming techniques and irrigation technologies have helped farmers use SDI for crops where it was not previously suitable. For instance, the development of on-farm GPS systems has helped to serve as a catalyst for economical implementation of SDI on an increasing number of fresh produce and vegetable farms, as well as an increasing use of it for forage and hay crops.

[1] University of California Irrigation Program Publication 3376 by Blaine Hansen, Larry Schwankl, Stephen Grattan and Terry Prichard.

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"One of the primary benefits of SDI is the ability to deliver precise amounts of water directly to the crop's root zone. This ability is used in conjunction with expert irrigation scheduling to deliver water where it is best used by the plant, when it is needed," states Mike Wade, Executive Director of the Agricultural Water Management Council.

Numerous farms use SDI effectively across the nation on annual fresh produce crops, such as peppers, cantaloupe, tomatoes and other fresh produce. One California farming operation that has seen the value of integrating SDI into their operation toolkit is the Stamoules Produce Company near Mendota, CA in Fresno County.

Stamoules Produce Co. is a leading producer of fresh fruit and vegetables in California's San Joaquin Valley. Their operation is located on the west side of the San Joaquin Valley near the town of Mendota. At 12,000 acres, Stamoules was one of the nation's first large operations to implement SDI in fresh produce and vegetables on an extensive scale.

They have been implementing drip irrigation on much of their acreage for the past 13 years, perpetually fine-tuning their micro-irrigation drip techniques as they learn from their experience. These substantial investments and efforts have served them well. Stamoules averages just 1.75 acre-feet per acre of applied water in the Central Valley, a reduction from their prior per acre application of more than 2.5 acre-feet per acre. An accomplishment achieved through their commitment and investments in innovative water management strategies such as SDI.

"We couldn't do this without the drip system," says Chuck Dees, who has been in charge of irrigation at Stamoules since 1998. "All of our crops are grown with the drip system, except our sweet corn."

SDI has been installed underground across 12,000 acres. The system is controlled via radio frequency from a small control structure atop a building in the farm's shop and equipment yard. Control boxes are installed throughout the farm, connecting the infield irrigation systems to the irrigation office.

In many farming regions around California the average lifespan of SDI drip tape is 2–4 years, but Stamoules has already achieved a longer lifespan for the drip tape at their operation. Exactly how much longer remains to be seen.

Attesting to the on-farm benefits of SDI, Dees contends:

"We consistently use less water, less fertilizer, and find tillage and ground preparation less costly. In addition, yields are higher and the quality of the product we grow is better."

Water Efficiency as Part of a Package: West San Joaquin River Salinity Management Program

Throughout the west side of California's San Joaquin Valley, rich soils and ideal weather allow farmers to produce a multitude of crops. The introduction of irrigation water to the region in the latter half of the 19th century allowed farmers to specialize in fruits, nuts and vegetable crops that thrive under these growing conditions. In addition to these valued conditions, growers must manage two concerns that threaten the longevity of the area—naturally occurring salts and minerals, and a shallow groundwater level.

Maintaining agricultural production in a region faced with shallow groundwater and naturally occurring salts and minerals is a challenge that in the past has been undertaken by individual farmers, working independently to reduce the impacts of these conditions through various drainage and irrigation method improvements. Since the 1950's farmers have installed hundreds of miles of subsurface tile drains designed to remove mineral-laden subsurface water from fields and to lower the water table to a point below the root zone, enabling them to continue to farm. Much of this historical drainage water ended up in the San Joaquin River, delivered through channels that served to provide habitat for waterfowl.

After selenium issues led to the closure of Kesterson Reservoir in 1985, drainage containing selenium needed to be removed from channels used to deliver water to wetland areas between the Grassland Basin Drainage Area and the San Joaquin River. Regulatory water quality objectives for selenium in the San Joaquin River and its tributary sloughs were targeted by state regulators, while ongoing water quality regulations required significant reductions in salt, boron and other drainage constituents.

Recognizing the need for a more comprehensive and systematic approach to resolving drainage issues, growers and irrigation districts partnering with the U.S. Bureau of Reclamation formulated the San Joaquin River Salinity Management Program. The Program area encompasses approximately 100,000 acres of the San Joaquin Valley's Westside extending roughly from the City of Mendota northward toward the City of Dos Palos.

The Program is designed to improve drainage water management by avoiding the delivery of drainage containing selenium for habitat purposes while improving the quality of drainage water. Prior to the Program, subsurface drainage water was conveyed through those channels en-route to the San Joaquin River and limited the channel's availability to deliver high-quality water to habitat areas. The Program consolidates subsurface drainage flows on a regional basis and utilizes a portion of the federal San Luis Drain to convey the flows around the habitat areas.

Successful implementation of the Program will have noticeable short and long-term benefits, helping to maximize the agronomic efficiency of irrigation water, and helping to improve in-stream water quality. To date, efforts from this continuing project have resulted in a 77 percent reduction in drain water discharge, helping to reduce selenium, salt and boron by 89 percent, 77 percent and 73 percent over 1995 levels respectively.

Approximately 120 farmers and two water districts working together as well as individually in support of the Program goals are focused on several short-term projects to provide immediate results. They have identified several areas to improve the management of drainage discharge, with more efficient water use prominent among these.

First, the Program calls to reduce the volume of drainage water by reducing the amount of applied water and establishing recirculation systems that allow for recycled water to be remixed with fresh water in conjunction with an overall drainage reuse plan.

These efforts to improve water application and distribution include the installation of improved irrigation systems by farmers that feature drip or micro-sprinklers to replace furrow irrigation, with farmers installing drip irrigation on approximately 60,000 acres of permanent and annual crops, or approximately 45 percent of the Program area.

While growers are working to improve the irrigation infrastructure, water suppliers working with state and federal partners such as the U.S. Bureau of Reclamation are making significant investments to change the delivery system by lining or piping channels. Unlined irrigation canals contribute to unwanted groundwater in the Program area. Studies have shown that 200 acre-feet of seepage occur annually from each mile of unlined distribution canals. To date, approximately 3 miles of canal have been piped or lined, resulting in approximately 600 acre-feet of seepage reduction annually. When complete, district infrastructure efforts will reduce seepage by more than 2,000 acre-feet/year from lining or piping more than 10 miles of distribution system in the Program area.

The second step in improving agricultural water management in the Project is through enhanced groundwater management. Pumping groundwater helps lower the perched water table and further reduces the volume of water entering the drainage system. A total of eight wells have been drilled in the project area which have lowered the perched water table. This action has also resulted in a reduced amount of water collected in subsurface drains that flow into discharge channels.

The third step is an innovative way of seeking to optimize water use efficiency in this project—the conscious effort to use the drainage water on crops of increasing levels of salt tolerance. This drainage reuse includes growing a variety of very different salt-tolerant crops. This effort has expanded to include 6,000 acres under the San Joaquin River Salinity Management Program. Most of the land is planted to forage and grasses that can tolerate different salt levels in the irrigation water. Some acreage is also planted to pistachios.

Nearly 100,000 acres of farmland in the project area continue to be productive due to the innovative efforts by farmers to reduce drainage water to the San Joaquin River, including more efficient water use. More than $100 million of crops are harvested annually from the acreage, providing continuous year-round employment for hundreds of workers and thousands more during the harvest season. An additional $126 million in economic activity is generated by farming operations that support the rural communities in an area struggling with high unemployment.

A fully successful program would totally eliminate the release of agricultural drainage from the Project area to the San Joaquin River. Reducing drainage to the San Joaquin River is a multi-step process that involves innovative technology and adaptive management. Reducing drainage from its source and re-circulating drain water where it can still be used for irrigation purposes helps reduce the original volume, while future partnerships may ultimately allow for the final step toward zero river discharge by treatment and disposal of the last remaining saline drain water. Treatment in a reverse osmosis facility can generate water at a quality high enough to further use for agronomic purposes. The cost of treatment could be underwritten by an urban water supplier in exchange for fresh supplies from other sources that would have otherwise been available to lands in the project area.