Effects of increasing drainage in the San Joaquin Valley

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Most soil salinity problems in the San Joaquin Valley are directly related to shallow saline water tables. Where no such water tables exist, soil salinity problems usually do not occur, because irrigation water used in the Valley is generally very low in salts.

Clay lenses underlying irrigated land in the Valley restrict the downward movement of both deep percolation from irrigation and seepage from ditches, canals, and rivers. The percolating water builds up on these lenses, and eventually a shallow water table develops. This water table is also saline because of the leaching of salts added to the soil by irrigation water and salts occurring naturally in the soil.

A shallow saline water table causes soil salinity problems by a combination of upward flow of saline water and inadequate leaching. Soil water evaporation and plant transpiration can cause shallow saline groundwater to flow upward from the water table into the root zone, carrying salts with it. The salts remain in the soil after the water is removed, and they accumulate in the root zone. A University of California study has indicated that this upward flow can contribute 20 to 80 percent of a crop's water requirements. Periodic leaching of the root zone is required to remove accumulated salts. If, however, subsurface drainage is poor, as in areas of saline shallow water tables, adequate leaching may not be possible. The combination of the two factors creates levels of soil salinity detrimental to plant growth.

The traditional method of coping with water table problems is to install a subsurface drainage system. This lowers the water table, minimizing upward flow, and also provides for adequate leaching. The drainage water collected is normally discharged into an areawide disposal system. In the San Joaquin Valley, however, disposal of the drainage water is as serious problem as is soil salinity.

Increasing drainage

About 400,000 acres in the Valley have shallow water tables with concurrent salinity problems. Affected acreage is expected to increase to over a million acres during the next 100 years. This, in turn, will increase the number of acres drained.

The most positive effect of increased drainage is the preservation of one of California's natural resources — the soil of the San Joaquin Valley, an area unique in its capacity for agricultural production. The Valley has about 4.5 million irrigated acres, of which the projected 1 million acres of drainage problems is a significant percentage.

The Westlands Water District recently estimated grower revenue losses of about $17 million on about 260,000 acres of salt-affected soil with shallow water tables. Through proper salinity and water table control, which requires subsurface drainage, such soils can be reclaimed and productivity increased.

The negative effects of increased drainage lie in the disposal problem. Current disposal methods, none completely satisfactory, are to discharge drainage water into surface water used for irrigation by downstream users or into evaporation ponds. The effect of discharging into surface water depends on the volume and salinity of both the drainage water and the receiving water. The presence of toxic materials in the drainage water also needs to be considered.

The San Joaquin Valley Interagency Drainage Committee, in an attempt to develop a suitable disposal plan, concluded that a valleywide master drain discharging into the Sacramento-San Joaquin Delta would be the most feasible disposal method. Their studies also indicated that the drainage water should have a minimal impact on Delta receiving waters. Further studies on the effects of drainage water on the Delta are under way as part of the U.S. Bureau of Recla-

In areas of the San Joaquin Valley with saline shallow water tables, the most common method of lowering the water table and providing for adequate leaching is to install subsurface tile drains. Drainage water collected is normally discharged into an areawide disposal system or evaporation ponds. About 400,000 acres in the Valley have shallow water tables.

mation's effort to extend the existing San Luis Drain.

Until the discharge problems of a master drain are ironed out, evaporation ponds, both on-farm and districtwide, will increase. The most obvious negative effect, particularly for on-farm ponds, is the acreage lost to production. It has been estimated that at least 3,000 acres of ponds would be required to drain about 50,000 acres of land along the Kings River. For small on-farm ponds in some areas, however, this acreage may be as high as 1 acre of pond for every 4 to 5 acres of drained land.

Another negative effect of evaporation ponds is their long-term accumulation of salts. Disposal of the brine and precipitated salts in the ponds will eventually need to be addressed. Also, during their early life, these ponds will undoubtedly attract aquatic fowl and other wildlife. Excessive accumulation of toxic materials may become a problem: for example, at Kesterson Reservoir, a holding reservoir for water conveyed by the San Luis Drain, selenium in the drain water is thought to be responsible for recent deaths of waterfowl.

Minimizing negative effects

Minimizing the negative effects while maintaining an acceptable level of productivity means reducing the volume of drainage water and at the same time controlling soil salinity. Improved irrigation efficiency is one method suggested for minimizing drainage problems. Growers should design and operate their irrigation systems as efficiently as possible, but this alone will not solve the problem. A field that is efficiently but adequately irrigated may still have 10 to 20 percent of the applied water lost to deep percolation.

Another approach is better irrigation scheduling to reduce the number of irrigations. Using plant-based measurements for scheduling, UC researchers reduced the number of cotton irrigations by 15 percent in a drainage problem area. The advantage of this method, in contrast to traditional scheduling techniques, is that it accounts for both crop use of the shallow groundwater and salinity effects, an important consideration in such areas.

One means of reducing the volume of drainage water is to use this water for irrigation. UC researchers are currently studying the yield effects of irrigating with drainage water. Also, U.S. Department of Agriculture researchers are evaluating the use of low-salinity irrigation water in the early growth stages of the crop and then high-salinity water later.

Results from recent UC projects indicate that a systems approach to managing irrigation and drainage water might significantly reduce the volume of drainage water, yet maintain crop productivity. This involves controlling the water table depth so that maximum crop water use of the shallow groundwater occurs and managing irrigation so that deep percolation is less than this maximum.

On-farm and district-wide evaporation ponds to dispose of saline drainage water *can take as much as 1 acre in 4 out of* crop production.

In theory, a management scheme based on these results would operate systems only during irrigations, if needed to maintain adequate root-zone aeration. Leaching of salt could occur during a fall or winter preplant irrigation, when discharge into a valleywide drain and eventually into the Delta might occur during times of large Delta outflows. A key to any such management scheme, however, is to detect long-term increases in soil salinity that might cause yield reductions. Investigations of this scheme will continue.

Solving the problems

Whether or not the problems can be solved remains to be seen. In the long run, they may be more political than technical. The answer lies in solutions that adequately protect the Delta and San Francisco Bay as well as the soil of the San Joaquin Valley.

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