Soil Salinization

Salts occur naturally in the soil and in irrigation water. Additional salts may be introduced through the application of fertilizers. Through irrigation, some of these salts are carried away in agricultural wastewater, but over time salts build up in the soil, if not removed. Too high a concentration of salts in soil reduces the ability of crops and plants to take up water and leads to lower yields. Salinization of soil and removal of salt can also damage the ecosystem farther a field. Soil salinity has become a serious issue in California, with damage already occurring in some regions and some of the state's most productive agricultural regions in danger of becoming gradually less fertile.

About 4.5 million acres of irrigated cropland in California (more than half the total) are affected to some degree by soil salinization (Letey 2000). Most of the seriously affected acreage is in the Imperial Valley in Southern California and the Western San Joaquin Valley in Central California. A certain level of salinity exists in all untreated irrigation water, although this natural salinity tends to be low in California. Most crops take up little salt, so the evapotranspiration process concentrates salt in the soil. A semi-arid climate exacerbates the degree and rate of salinization because the state's main agricultural areas receive relatively little precipitation and have high evapotranspiration rates. This is especially true in the Imperial Valley, which coincidentally meets its water demand from the Colorado River, the most saline irrigation water in the state (Letey 2000).

Producers have dealt with soil salinization by leaching salts from the soil. Leaching entails applying extra water to carry the salts below the root zone of the crops, so crops are not affected. However, soil leaching means that saline water eventually enters groundwater basins. The salts concentrates in the groundwater, which causes damage if the water table rises or ground water is used for irrigation (Letey 2000). To avoid problems with ground water and contain the salinity problem, producers in the Imperial Valley have been discharging their drain water into the increasingly salty Salton Sea for more than one hundred years.

Salinity levels in the Western San Joaquin Valley have reached a point where the long-term productivity of the area is threatened (Letey 2000). The soil of the San Joaquin Valley is the residue of alluvium from when the area used to be below sea level. Therefore, the soil already contains high concentrations of salts and irrigation has exacerbated the problem. In the Western San Joaquin Valley, groundwater is of low quality so producers do not use it for irrigation, raising the water table. In contrast, groundwater quality in the Eastern San Joaquin Valley is of high quality, so producers use it for irrigation and keep the water table low. In 1981, the San Luis Drain was constructed to remove salts from the Western San Joaquin Valley and serve as wildlife habitat. However, construction was halted when it was discovered the high levels of selenium in the drainage water was causing bird deaths and deformities.

Federal and state agencies have coordinated their efforts to deal with soil salinity in California. Among the federal agencies involved are the Bureau of Reclamation, the Fish and Wildlife Service, and the Geological Survey. State agencies involved in the effort include the California Department of Water Resources, the Department of Fish and Game, and the State and Regional Water Quality Control Boards. The Central Valley Salinity Coalition, a non-profit organization, is also involved in salinity management in the San Joaquin Valley.

Federal and state agencies, and some drainage districts, such as the Tulare Lake Drainage District have both been involved with the construction of artificial bird and wildlife habitats constructed near evaporation ponds. Various means are used to entice the wildlife to the artificial habitats and to discourage settlement at the evaporation ponds with some success in preventing bird deaths. The construction of evaporation ponds without the use of compensation habitats may be destructive to bird populations. Although the ponds solve the problem of salinity by allowing salts to accumulate in designated areas, the high selenium levels affect migratory and resident waterfowl primarily by interfering with reproduction. Wastewater can be treated to remove selenium, but the treated water will still have high concentrations of salt. Drainage water could be desalinized through reverse osmosis, however, the desalinization process is expensive and the process creates brine, which must also be disposed.

Knapp and Baerenklau (2006) evaluated efficient use of groundwater reserves by limiting groundwater withdrawals, thereby extending their use over several decades or more. However, they note that even under efficient use, long-term use of groundwater reserves is not sustainable, in the sense that income will generally decline over time. Long-term sustainability requires that the amount of salt going in equals the amount coming out of a system. Producers seeking such a salt balance can implement source controls, including switching to more capital-intensive and efficient irrigation systems and planting more salt-tolerant crops. Compared to flood or furrow systems, sprinkler or microirrigation systems provide greater uniformity and low evaporative losses. By reducing the volume of water they use, they reduce the amount of drainage water they create. These systems are expensive and require high revenue per acre to payoff. The options for more salt-tolerant crops are limited. Often source control does not pay and does not completely deal with the problem of salt disposal and high water tables.

Land retirement reduces salty drainage, but is costly. Already at least 100,000 acres have been retired in the Westlands Water District. If producers are unable to dispose of their drainage, the amount of productive land will slowly decrease, with land with high water tables the first to exit. However, even land retirement may also lead to problems of unpredictable ponding with potentially toxic waters. If retired drainage-impacted lands are located down slope from lands with continued irrigation, the down slope water table will eventually rise and random ponds could present an environmental hazard.

Drainage can make salt-affected land more productive. This effort would entail collecting drainage water via tile drains and reusing it on a reduced land area. Reuse of drainage water, although not an optimal solution, is probably the most economically feasible solution (Knapp 2009). When combined with source controls such as crop switching, increasing irrigation efficiency and reducing applied water use, reuse of drainage water may cause the lowest drop in crop yields at the lowest expense to society. There is evidence that drainage water can be reused sustainably (Corwin et al. 2008).

Such lower quality water is already reused in the San Joaquin Valley because salt-tolerant crops such as cotton have shown evidence of being able to withstand moderate levels of salinity without significant drops in yield. Notwithstanding its salt tolerance, cotton acreage has fallen by 80 percent in California over the past decade and its future looks dim. There is some evidence that drainwater could be used for biofuels feedstock, but California faces other challenges in being a competitive producer of biofuels feedstock and in biofuels processing.

Of course, under the current water quantity situation and regulatory environment, and with droughts more likely, land is coming out of production because of a lack of access to irrigation. Thus salinity could become less of a problem simply because another issue dominates.

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