Irrigation drainage reduction

In a large area on the West Side of California's San Joaquin Valley, natural drainage is severely limited by impermeable soil layers. Irrigation drain water that percolates through the upper layers of soil has traditionally been collected by underground drainage systems and discharged into Kesterson Reservoir or the San Joaquin River. The discovery of high levels of selenium in the drain water in 1984 resulted in the closure of Kesterson and plugging of the 80-mile-long San Luis Drain leading to it. Without a readily available, environmentally-safe alternative for drain water disposal, many growers on the West Side are farming land without drainage. Minimizing irrigation drainage and deep percolation is of paramount importance.

One approach to the problem is to improve the efficiency of irrigation systems in the region and thereby reduce the volume of water that needs to be removed. The following articles report on some ways University of California scientists are studying to achieve this goal: more efficient, better managed irrigation systems, reuse of irrigation drain water, and new irrigation techniques.

Dick Venne

The San Luis Drain at Kesterson Reservoir before it was closed.

A systems approach to drainage reduction

Blaine R. Hanson

Subsurface drainage problems in farming areas historically have been dealt with by installing systems to collect and convey drainage water to a disposal site. While these systems remove drainage water as it is generated, no source reduction is considered. The saline and toxic nature of drainage water in the San Joaquin Valley, however, precludes this traditional disposal method.

The alternative is drainage reduction through irrigation and drainage water management, through a systems approach that considers interactions between yield, irrigation, and drainage. Components of this approach include irrigation system design and operation, irrigation scheduling, drain water reuse, drainage system design and management, leaching, and crop yield.

Irrigation systems

The performance of irrigation systems is determined by:

☐ Application efficiency — ratio of the amount of water stored in the root zone to average amount of water applied.

☐ Coefficient of uniformity/distribution uniformity — measure of the uniformity of water applied throughout a field.

☐ Deep percolation ratio — the amount of applied water that infiltrates below the root zone; the leaching fraction.

☐ Tailwater ratio — ratio of surface runoff to amount of applied water.

Adequate irrigation at the maximum application efficiency is the primary goal of irrigation system design and management. Adequate irrigation is normally the application of a desired amount of water to 80 percent of a field. The actual amount applied, however, depends on the system management. In the San Joaquin Valley, where subsurface saline and toxic drainage water has caused substantial adverse environmental effects, reduction of subsurface drainage should also be a major design and management objective.

Subsurface drainage comes from nonuniform water application and from overirrigation. Keys to drainage reduction through irrigation water management are thus the uniformity of the applied water and the average depth of water applied. The higher the uniformity, the higher the potential of the irrigation system for drainage reduction and for producing desired yields. If substantially more water is applied than needed for crop production (overirrigation), reducing the depth applied to that required will decrease drainage. This required amount, however, depends on the uniformity; the higher the uniformity, the smaller the average depth needed. If a system is operated as efficiently as possible for existing conditions, drainage reductions will occur only by deficit irrigation of the field. The higher the system uniformity, the smaller the deficit and the less the yield reduction.

The relationship between uniformity, average depth applied, percent of area deficit-irrigated, and subsurface drainage is shown in the cumulative distribution of water in figure 1. The cumulative distribution shows the area of the field that receives at least a given amount of water. For example, in figure 1a, 100 percent of the irrigated area received at least 2 inches of water; the dashed line shows