In the last century, growing food demand was satisfied through various technological innovations, including a widespread expansion of irrigation such that irrigated cropland now constitutes almost 20% of all cropland. In meeting the food challenges of the current century, continued expansion of irrigation is not feasible due to diminishing land and water availability. Still, irrigated agriculture produces nearly 40% of the global food harvest, and thus irrigated agriculture will remain crucial to meeting food demand. The challenge for irrigated agriculture going forward is to sustain productivity in the face of reduced resource availability, and to do so in a way that minimizes negative environmental impacts.

One strategy for maintaining productivity is to make greater use of marginal quality waters and lands. A key to sustaining systems using degraded irrigation waters is salinity management. Irrigation waters, especially recycled or otherwise marginal quality waters, contain salts that can accumulate in soils over time and reduce yields. In arid and semi-arid regions where rainfall is not sufficient to flush the salts from the root zone, it is necessary to apply excess irrigation water to leach the soil. To avoid wasting water, and to lessen impacts on groundwater quality, it is desirable that soil leaching be minimized to the extent possible.

Standard guidelines exist for managing soil salinity, but because of their generality, they recommend in some cases more irrigation and leaching than is necessary. At present, there is interest in developing site-specific tools that can improve upon the classical guidelines. One approach is to use computer models such as UNSATCHEM that simulate in detail water flow and salt transport processes in the root zone. Simulation models allow for consideration of site-specific soil, water, and crop parameters and can account for time-varying field conditions and processes. However, the modeling approach to salinity management is relatively complex, with model predictions and related management recommendations containing significant uncertainty.

A group of researchers from the United States Salinity Laboratory (USSL) of USDA-ARS is developing integrated decision-support systems for irrigation management that include modeling analyses. In a new study published in the May 2014 issue of *Vadose Zone Journal*, the group demonstrated that global sensitivity analyses can be used in conjunction with UNSATCHEM simulations to help characterize and reduce model uncertainties and reveal which parameter variations or uncertainties have the greatest impact on model outputs.

The USSL researchers used the elementary effects method to obtain global sensitivity analyses of seasonal simulations of forage corn production with differing water qualities and irrigation rates. Sensitivities were determined with respect to four model outcomes: crop yield, average root zone salinity, water leaching fraction, and salt leaching fraction. For a multiple-season, quasi-steady scenario, the sensitivity analysis found that, overall the most important model parameters were the plant salt tolerance parameters, followed by the solute dispersivity. For a single-season scenario with irrigation scheduling based on soil water deficit, soil hydraulic parameters were the most important; the computed salt leaching fraction was also strongly affected by the initial ionic composition of the exchange phase because of its impact on mineral precipitation.

An important observation from the study is that with complex models and modeling applications, sensitivity results are generally specific to a particular modeling scenario. A multitude of possible scenarios exists for degraded irrigation water management, and each scenario can have different degrees and types of uncertainty. Thus it is emphasized that rather than seeking universal sensitivity results, sensitivity and uncertainty analysis should be made a routine part of modeling assessments of crop production with degraded irrigation waters.


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Salt-affected cropland near Lemoore, CA.