governing groundwater. Such congressional action has been the history of this country. If states fail to address problems that can have a long-term impact on the production and transportation of food and fiber, federal laws are inevitable. As of December, 1983, a congressional bill (H.R. 2867) proposes a "National Groundwater Commission" to investigate groundwater problems nationwide.

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Economics of salinity management

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With future water supplies for agriculture likely to be increasingly limited, it is important to consider direct use of water of impaired quality — increasing use and resue over time of water with varying levels of total dissolved solids. Plant breeding will provide some salt-tolerant varieties that can produce yields nearly equivalent to those of crops traditionally produced in areas without salinity problems. Harmful physical and economic effects may thus be lessened, but farms in areas unaffected by salt buildup may still be able to produce better quality products at lower cost than those in salt-affected areas.

Irrigation scheduling and use of improved low-volume application technology can slow salt buildup and decrease its harmful effects in many irrigated areas. However, the capital cost of introducing this new technology may be beyond the repayment capacity of the more extensive agricultural crops. Improvements in plant breeding and irrigation management may ease short-run transition problems, but the extent of their efficacy over the long run is not certain.

Climate, soil permeability, drainage (natural or artificial), and the salt tolerance of crops adaptable to specific locations determine whether or not irrigation water of a given quality is usable. Crop, soil permeability, and drainage limitations are not absolute: some substitutions are possible among the physical conditions. Artificial tile drainage, for example, can be substituted for water quality through the use of a higher leaching fraction. Or, if economic factors permit their production, crops with higher salt tolerance can replace sensitive crops as water quality deteriorates. Using the concept of a long-term steady state, one can describe or define the limitations to a long-term irrigated agriculture, based on these physical factors. These factors thus determine the **necessary** conditions for a successful long-term irrigation agriculture, but they do not describe or define the **sufficient** conditions: these are found in economic factors influencing the choice of crop to be produced and the income it can generate.

Physical production response functions can be developed for most crops. These functions can be used to develop complex production response relations for numerous combinations of irrigation treatment, water quality level, and leaching fraction for various soil types and crops. From these, "efficiency frontier" functions are developed to show the tradeoff, or substitutability, among water quality, water quantity, and capital investment. The conclusion is that, to obtain the same yield of a particular crop as water quality declines (soil salinity increases), larger and larger volumes of water must be applied. A companion problem is salt accumulation: salinity of the drainage water or percolating water may increase, leading to degradation of groundwater or rising water tables that may hasten the increase in local soil salinity.

Extended economic analyses by the Department of Agricultural Economics at the University of California, Davis, of the effect of water quality on Imperial Valley farms served by Colorado River water predict 12 to 15 percent declines in income level over time as salinity of the water increases by a projected 33 percent by the year 2000. Alternatively, if by desalinization or dilution it were possible to reduce Colorado River salinity by 50 percent, net returns to agriculture would increase by 12 to 14 percent. These changes are explained by changes in total crop acreage, in the proportion of high-valued salt-sensitive crops, in the leaching fraction, and in the irrigation regime.

With increasing salinity levels, projected cropping changes include both reduced total acreage in crops and reduced double-crop acreages. Changes in crop mix, which have an important influence on net returns, include reduction of sensitive crops such as lettuce and alfalfa and an increase in fallowed land.

In all solutions to increasing salinity in irrigated agriculture, one overwhelming problem remains — the removal and disposal of accumulated salts away from the root zone. For an irrigation economy to be sustained, adequate drainage must either be available naturally or be supplied by installation of buried drains. The drainage outflow must be disposed of without creating problems in other areas of the environment.

According to one estimate, as much as 15 to 20 percent of the land now in irrigation would have to be removed from production to provide space for evaporation ponds in regions where remote disposal is impossible. With current values of even submarginal land in the range of $500 to $1,000 per acre, the potential regional investment in salt disposal is formidable. To this must be added costs of a collection-drain system and possible on-farm tilling. The investment will probably have to come from agricultural interests, but the long-term alternative may be even greater financial loss with land being abandoned as regional salinity builds up.

Even if geneticists are able to shift salinity tolerance of plants to permit using water with ever-increasing saline content, drainage requirements cannot be reduced to zero. The soil is a reservoir for holding moisture and nutrients and a repository of precipitated salts. If placed under stress by excess deposition of salts or inadequate drainage in relation to the quantity of water applied, the set of resources that make up the root zone can pass a critical level and become irretrievably salinized.

Given the level of irrigation technology, the optimum rate at which the absorptive capacity of the root zone is used (salt buildup) depends on the long-term interest rate and a positive net income in each planning period. Economic survival of irrigated agriculture requires that periods of low commodity prices in the future be more than offset by periods of positive net incomes sufficiently large to cover costs of drainage, collection, removal, and disposal of salts.

For land in which the salt level in the root zone is currently not in equilibrium (progressive salinization), increasing the salt tolerance of plants and improving irrigation management technologies merely postpone the time when capital investment for drainage and disposal must be made. The physical, economic, social, and institutional costs and feasibility requirements for salt disposal will have to be met as part of the necessary and sufficient conditions for a prosperous long-term agriculture.

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